THURSDAY, NOVEMBER 30, 1905.

LAGUERRE'S MATHEMATICAL PAPERS.

Œuvres de Laguerre. Tome ii. Pp. 715. (Paris: Gauthier-Villars, 1905.) Price 22 francs.

THE publication of the mathematical papers of Laguerre, undertaken after his death in 1886 by MM. Hermite, Poincaré, and Rouché under the auspices of the Academy of Sciences, has at length been completed. A first volume, to which M. Poincaré contributed as a preface an admirable appreciation of the author, appeared in 1898; and now some eighty papers which treat of geometrical subjects have been collected from the various scientific journals and reprinted in a second and final volume of more than 700 pages. Most of these papers are of but four or five pages in length, for it was Laguerre's habit, when a mathematical investigation had aroused his interest, to return to it again and again as new ideas occurred to him; and so it comes to pass that the majority of his writings on geometry may be classified as dealing with one or other of some half-dozen wide but distinct subjects.

The discovery with which Laguerre made his entry into the ranks of original investigators is of such moment in the history of modern mathematics that we will pause in order to realise the condition of geometrical knowledge at the time, and the circumstances in which it was made. The first three of the papers now under review bear the dates 1852–3, and were written when the author, a student eighteen years of age at the Institution Barbet, was still only a candidate for admission to the École Polytechnique. It was a time when a great change in geometrical thought had been initiated. Poncelet and Chasles had begun to build up the theory of projective geometry, and through it mathematicians had been made to recognise that theorems previously regarded as wholly without connection might in reality be but different presentments of the same more fundamental fact. But the structure was as yet very far from complete; many of the chief features of the theory as we now know it were still obscure and needed explanation. It fell to Laguerre to provide the most important and prolific discovery on which modern geometrical theory has been founded, the inner meaning of angular magnitude. In the second of his three early papers was enunciated for the first time the proposition that the sides of an angle form with the two isotropic lines through the vertex a pencil the anharmonic ratio of which depends only upon the magnitude of the angle.

This was no chance discovery, lighted on by a stroke of undeserved good fortune, for the rest of the paper shows how true a grasp of the new principles Laguerre had already obtained. He goes on to point out that the proposition furnishes the solution of the problem of homographic transformation of angular relations—a problem which had baffled the founders of projective geometry—and gives many further developments and results, a special case of one of which may be cited as illustrative. The well known theorem of Menelaus concerning the ratios of the segments into which the sides of a triangle are divided by any straight line is identical with the theorem that the angles of a triangle make up two right angles; either theorem can be deduced from the other. It is regrettable that English treatises upon analytical geometry so rarely attribute theorems to their authors, for it is with this discovery, rather than any achieved later in more advanced subjects, that we should wish the name of Laguerre to be always associated. Certainly no discovery has had so far-reaching an influence upon geometrical research during the past half-century.

In the twelve years which followed Laguerre published nothing. His military duties as an officer of artillery at first absorbed him; then, having been transferred to the manufactory of arms at Mutzig, he found leisure to take up once more his favourite study; it was not, however, until 1865, after his recall to Paris to the École Polytechnique, that he published the first of the series of original papers which he continued without intermission until his death.

A large number of these are concerned with analytical geometry, and through an interesting section of them runs an idea allied to his earlier work, the use of imaginaries in geometry. Thus in one of the first papers we find a full exposition of the theory of foci as extended from conics to plane curves of any class, and the distinction is drawn between ordinary foci and singular foci of a curve which passes through the circular points. Another such matter with which Laguerre frequently occupied himself, and which seems never to have received the attention it deserves, is the means of representing in a concrete manner the points of a plane or in space the coordinates of which are complex quantities. Imaginary values of the coordinates may satisfy the equation of a curve, and are then often spoken of as the coordinates of an imaginary point on the curve; cannot geometry suggest some mode of representing these points similar to that of Argand, which plays so important a part in the theory of equations involving a single variable? No solution could be satisfactory which varied with the coordinate-system employed. Laguerre's method was to represent a pair of points the coordinates of which are conjugate complex quantities by a real segment of a line, distinguishing the two imaginary points when necessary by the sense in which the segment is measured; the ends of the segment are the intersections of the lines which join the imaginary points to the circular points. Thus the line joining two real foci of a conic represents the two imaginary foci. It now becomes feasible to express the conditions of collinearity, &c., of imaginary points by properties of their representative segments. For points in space a similar procedure is adopted; a point the coordinates of which are complex is represented by a real circle, which must be described in a definite sense.

Having extended the notion of a focus to curves other than conics, it was natural that Laguerre should study curves which possess focal properties; accord

ingly he made many investigations upon special quartic curves, both plane and twisted; he considered the meaning of a focus of a curve traced on a sphere, showing that the method of inversion changed the ordinary foci of such a curve into foci of the inverse curve; he published many investigations upon a class of loci to which at the time considerable attention was paid, anallagmatic curves and surfaces. Other papers treat of the cyclide of Dupin, the curve of intersection of two quadric surfaces, and a family of curves called by Laguerre Cassinians: and it is to be noted that while writing upon a particular curve he would at times include theorems of wider application.

A passing mention may be accorded to an interesting statement of the addition theorem of hyperelliptic functions closely resembling that derived from Poncelet's polygons in elliptic functions; to researches upon Steiner's Roman surface and its reciprocal, known as Cayley's cubic surface, and other applications of the theory of forms to geometry. Finally, at the end of the book we meet with a series of papers in which Laguerre's discovery of *geometry of direction* is developed. The idea from which this sprang is elementary enough; a straight line or a circle may be traced out by a moving point in two opposite senses, and therefore is regarded by Laguerre as composed of two "half-lines" or two cycles. The notion of tangency is modified when a curve is described in a definite direction, so that a cycle is regarded as possessing one tangent only parallel to a given half-line. Following up this thought, Laguerre is led to divide all curves into curves of direction, which can be divided analytically into two trajectories traced out in different senses, and curves which have not this property; he finds the form of the tangential equation of the most general curve of direction. By help of a highly ingenious "transformation by reciprocal half-lines," it is shown how certain problems may be greatly simplified; the problem of drawing a circle to touch three given circles, for example, is reduced to that of drawing a circle through three points. The theory is extended also to spherical geometry.

Laguerre's life-work in geometry forms a volume which no mathematician can study without being profoundly impressed by the ingenuity of the author and his skill in handling every method which he employs; papers such as his, models of clear polished style, are read with keen intellectual enjoyment. Yet when the book is laid down and we reflect on the work as a whole, there comes a regretful conviction that what has been accomplished is very far from all that could have been hoped for from the powers of the author and his brilliant first achievement. Delicate in health and of retired life, Laguerre's isolation from the march of scientific thought is betrayed in his writings. General notions appealed to him solely by their applicability to particular problems, and he therefore chose to bestow the utmost care upon a number of short discussions of special topics. Let the reader, if he would appreciate what is best in these collected writings of Laguerre, realise when he takes up the book that its author was one of those who are content to apply to small things powers capable of far higher work, and he will find matter to arouse his interest and admiration in every paper reprinted in the volume.

PHILOSOPHICAL STUDIES.

(1) *Goethe's Philosophie aus seinen Werken.* Edited with an introduction, by Max Heynacher. Pp. viii+428. (Leipzig: Dürr'sche Buchhandlung, 1905.) Price 3.60 marks.

(2) *Immanuel Kant, Physische Geographie.* Second edition. Edited by Paul Gedan. Pp. xxx+386. (Leipzig: Dürr'sche Buchhandlung, 1905.) Price 2.50 marks.

(3) *Dialoge über natürliche Religion, über Selbstmord und Unsterblichkeit der Seele.* By David Hume. Translated into German and edited by Dr. F. Paulsen. Third edition. Pp. 165. (Leipzig: Dürr'sche Buchhandlung, 1905.) Price 1.50 marks.

(4) *Immanuel Kant's Kleinere Schriften zur Logik und Metaphysik.* Second edition. Edited by Karl Vorländer. In four parts. Pp. xxxii+169, xl+172, xx+175, xxxi+176. (Leipzig: Dürr'sche Buchhandlung, 1905.) Price 5.20 marks.

(5) *G. W. F. Hegel, Encyclopädie der philosophischen Wissenschaften im Grundrisse.* Second edition. Edited by Georg Lasson. Pp. lxxvi + 522. (Leipzig: Dürr'sche Buchhandlung, 1905.) Price 3.60 marks.

(1) GOETHE'S work was so many-sided, and withal so voluminous, that it is a real service to educated thought to have presented, as here, a volume of extracts, in moderate compass, containing in his own words an account of the great writer's philosophic and scientific views, and of the influences exerted on him by different systems. Herder, Spinoza and Kant all obviously attracted him at various times, and his name must find a place in any account of the theory of colour or of comparative anatomy—to name only two of the scientific subjects in which he was interested. With these and kindred matters the editor deals in a well-informed introduction. He knows the literature well, his Eckermann, the Goethe Jahrbuch, and Goethe's poetry. Goethe's title to be regarded as a forerunner of Darwin is duly emphasised.

(2) That Kant should thus have lined the wings of his spirit in the dregs of the sensible world will astonish the average reader, for this work condescends to minute details regarding the animal, vegetable, and mineral kingdoms, the characteristics of different races of men, and the like. Even one of the earlier parts, dealing with mathematical preliminaries, is not at all speculative in its nature, and only one or two paragraphs in the introduction, which point out that geography deals with facts in space as history with events in time, remind us of the Critique of Pure Reason; but the services of Kant to geography are not negligible, and have been attested by Helmholtz.

The present edition contains a full statement of

variant readings, and many corrections of the text due to this editor.

(3) Hume's dialogues on natural religion run on much the usual lines. The characters are three in number, Demea the representative of believing scepticism, Philo of unbelieving scepticism, and Cleanthes of conciliatory rationalism. But there is this peculiarity in Hume's treatment, that, while there is no doubt that his own standpoint is that of Philo, he has chosen to make Cleanthes the hero, and concludes his work with the opinion that Philo's principles are more probable than Demea's, but that those of Cleanthes approach still nearer to the truth. The essays on suicide and on the immortality of the soul have been preserved only by accident, as their author attempted to suppress them. The German translation and introduction are from the pen of the well known professor in Berlin, and, like everything published in this philosophical series, are excellent.

(4) This volume contains about fifteen of Kant's smaller metaphysical and logical works, some of them translated from Latin, some of them written before the birth of the "critical" philosophy, not all of them interesting or important. They range over a variety of themes, from the dreams of a spiritist (viz. Swedenborg) to the well known prize-essay on the progress of metaphysic since the time of Leibniz and Wolf. This editor's introductions to the various essays and treatises are extremely helpful and interesting.

(5) The encyclopædia, the only complete and authentic statement of Hegel's system—best known to English readers by the late Prof. Wallace's translations of its first and third parts—is here published in an excellent form. In the introduction the editor discusses (*a*) the fundamental ideas of the Hegelian philosophy; (*b*) philosophy as science; (*c*) the encyclopædia, and Hegel's relation to earlier systems.

OUR BOOK SHELF.

The Oxford Geographies. Vol. ii. The Junior Geography. By A. J. Herbertson. Pp. 288. (Oxford: Clarendon Press, 1905.) Price 2*s*.

WHEN a school-book treats of the geography of the whole world in less than 300 pages of large, clear print, interspersed with abundant diagrams, its claim to compete with the ordinary class-book must be based on the substitution of quality for quantity, wise selection and arrangement for all-including comprehensiveness. The book before us may fairly make such a claim. There is nothing of the gazetteer about it: its method is that of connected description; in place of statistical tables we have an abundance of distribution-maps, and continents and countries are divided according to physical features more than by political boundaries. Thus in the case of England the counties are entirely ignored, and the pupil is spared the necessity of learning as many "facts" about Oxfordshire as about Lancashire. So, too, in the case of Europe, there is a special section on Alpine lands, which renders possible a connected account of the railway routes across the Alps, and should prevent the common misconception of the Alps as coextensive with the political area of Switzerland.

Nearly one-third of the book is occupied with the British Isles, and about as much with Europe, the remainder being about equally divided between Asia, Africa *plus* Australia, and America. It would be easier to form a judgment on the opening part if the "Preliminary Geography," which is intended to precede it, had been published. As it stands, this opening part, consisting of a large number of distribution-maps (orographical, climatic, industrial, &c.) of the British Isles, with a discussion of their meaning and relations, is full of suggestiveness to the enthusiastic teacher, and in his hands is capable of expansion into a course of practical geography.

In such a book the critic can, of course, find plenty of missing "facts," though we have found remarkably few of first-rate importance. Several which we failed to find in the text turned up in the maps, which is just as well in view of the importance which the author attaches to the study of maps. ("Look at the map and notice . . ." is a constantly recurring phrase.) Chicago, it is true, appears to be only casually mentioned on p. 262, without any allusion to its unique geographical position with reference to the Mississippi basin and the great lakes; and along with the trans-Alpine routes to which we have already referred we should have expected to find some account of the longitudinal route of the Orient express. While the numerous diagram-maps form one of the best features of the book, their execution is unequal, the lettering on some being indistinct and the shading sometimes amateurish. In the map of the chief North American railways the names of the lines might be given as far as possible, and the route of the projected Grand Trunk Pacific continued to Port Simpson instead of ending at Winnipeg; while in Fig. 22 it seems unnecessary to distinguish part of the Scotch coal-fields merely because the coal is of Lower Carboniferous age. A. M. D.

Organic Evolution. By C. W. Saleeby, M.D. Pp. 124. (London and Edinburgh: T. C. and E. C. Jack, n.d.) Price 1*s*. net.

DR. SALEEBY has written a little book on a great subject, and there is much to admire in his achievement. Without technicalities and with vivacious clearness he discusses the history of the idea of organic evolution, the so-called evidences which show the validity of the evolution-formula, the conditions of evolution (heredity and variation) and the factors in the process (natural and sexual selection), the evolution of plants, the history of the horse, the past and future evolution of man. And we can get all this for a shilling! The author writes in an unconventional chatty way, and is nothing if not up to date. He seems, however, to have written in hot haste, for he makes many slips. Perhaps it does not matter much that he speaks of Alfred Russel Wallace as being in 1858 "a young surgeon," but it is hard on the whale to have it said of him that his five "fingers, hand and all, are buried deep in blubber, and serve him no purpose whatever." Surely Dr. Saleeby's teacher, Sir William Turner, to whom he gracefully refers, will be rather shocked at this libel on the whale's flipper. Perhaps it does not matter much that a certain Matthew Hay (Patrick Matthew?) is credited with having conceived the idea of natural selection in the early years of the nineteenth century, but we are somewhat baffled by being twice told that while the hen has three and a half fingers, the embryo chick has *a five-fingered hand*. If we dissect the embryo we shall see this, we are told. We do not like Dr. Saleeby's version of the lineage of extinct forms "which continuously connect the horse of to-day with a five-toed ancestor," but we object still more to the statement that "the adult or fully-developed barnacle is far inferior to the larva, for it

is little more than a fixed fleshy stalk, upon which grows the body and its shell "—"a palpable case of what we call degeneration." If all degeneration were on the lines of the barnacle's life-history, it would be difficult to distinguish it from progress. We wish there had not been these and other blemishes in this sprightly and interesting little book, for it is sure to be popular. J. A. T.

Le Chauffage des Habitations par Calorifères. By M. Raymond Périssé. Pp. 173. (Paris: Gauthier-Villars et Fils, n.d.) Price 2½ francs.

THIS little work is of a very practical nature; and although it appeals more particularly to the engineer and architect it may be read with advantage by the general reader, for it sets out, in a manner which is clear and easily intelligible to all, the advantages which accrue from the systems of heating dwellings by the various warming apparatus which are installed, not in the living rooms, but on the ground floor or in the basement. The advantages in the use of steam, hot-water, or hot-air apparatus, instead of fireplaces or stoves, are certainly real ones; for the house is more uniformly and better heated, at a less expense, trouble, and risk, and the apartments are not encumbered with the large stoves so generally seen on the Continent.

The advantages and disadvantages of the different systems are explained, and various applications of these systems are illustrated. The reader is also told how each may be best applied and regulated to meet the variable requirements as to heat, the different circumstances of the dwelling, the conditions of occupancy, and the like.

Auslese aus meiner Unterrichts- und Vorlesungspraxis. By Dr. Hermann Schubert. Erster Band. Pp. 240. (Leipzig: G. J. Göschen, 1905.) Price 4 marks.

TEN chapters dealing with a variety of subjects—logarithms, cyclotomy, the theory of physical dimensions, systems of circles and spheres being the most important. The principal novelty is the treatment of logarithms (pp. 1–68), fair approximations being obtained by combining inequalities such as

$$-\log m+2\log(m+1)-\log(m+2)>0.$$

The method is quite elementary and very ingenious, but it has no practical value, and strikes one as being artificial. The chapter on dimensions (reprinted from the *Naturw. Wochenschr.*, 1895) is interesting, but not convincing; its essential feature is

$$[\text{mass}]=[\text{length}]^3[\text{time}]^{-2}.$$

Pangéométrie; ou Précis de Géométrie fondée sur une Théorie générale et rigoureuse des Parallèles. By N. J. Lobatschewsky. Réimpression facsimilé conforme à l'édition originale. Pp. 279–340, and list of errata. (Paris: A. Hermann, 1905.) Price 5 francs.

LOBATSCHEWSKY shares with the Bolyais the credit of founding the theory of non-Euclidean geometry, in which Euclid's axiom of parallels is not assumed to be true. His "Pangéométrie" was communicated to the mathematical faculty of the University of Kazan in 1855 on the occasion of his jubilee; this fact might well have been indicated in the present reprint. It is the author's last and most complete exposition of his theory, and mathematicians will be glad to have it in this accessible form, though, like other similar reprints, it is rather trying to the eyesight.

LETTERS TO THE EDITOR.

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

The Bates-Müller Hypothesis of Mimicry: a Question of Historical Accuracy.

A PAPER dealing with the above subject, by the late Dr. A. S. Packard, has just been published in the *Proceedings of the American Philosophical Society* (vol. xliii., No. 178, p. 393), in which this well known entomologist endeavours to show that the markings of organisms ("pœcilogenesis") are "due to the physical rather than to the biological environment." I must leave it to others to consider how far the late author has established his case as against Bates, Fritz Müller, and those who have accepted the theories of mimicry associated with these names. My object in asking you to give space to this letter is to point out a distinct error which, if allowed to pass unchallenged, is likely to be accepted as a true statement of Darwin's views in the sense conveyed by the American writer.

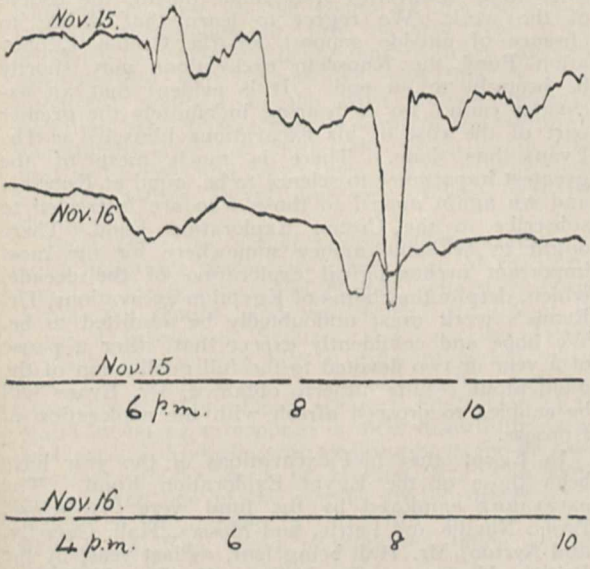
Happening to know the actual history of the Müllerian theory of mimicry through the courtesy of Mr. Darwin himself, I can assure those who read the paper that the passage which is quoted does not refer to that theory at all. In the letter to Fritz Müller referred to (August 28, 1870) Mr. Darwin says:—"I should not be at all surprised if your suggestion about sexual selection were to prove true; but it seems rather *too speculative to be introduced in my book*," &c. ("More Letters," vol. ii., p. 91). Now Dr. Packard quotes only the words which I have italicised as "Darwin's own estimate of Müller's little paper," but this is a misstatement of the facts. Darwin, it will be observed, is referring to a suggestion about sexual selection, and I am in a position to state what that suggestion was. At the date of the correspondence quoted (1870), Fritz Müller had observed the striking resemblances, or "mimicry," between butterflies belonging to "protected" groups, as, in fact, Bates had done before him. In searching for an explanation of this apparent violation of the Batesian theory, he suggested that it almost appeared as though the females of one protected species had been influenced in their choice by seeing the predominant pattern of other protected species always about them. Mr. Darwin was good enough to allow me to read Müller's letter to him, and in forwarding it to me in 1872 he added:—"You will also see in this letter a strange speculation, which I should not dare to publish, about the appreciation of certain colours being developed in those species which frequently behold other forms similarly ornamented" ("Charles Darwin," by E. B. Poulton, p. 202). This is the "suggestion about sexual selection" to which Darwin refers in his letter to Müller, and, so far as my memory serves me, I do not think this speculation was ever formally published to the scientific world.

The Müllerian theory which the late Dr. Packard considered that he had demolished was not published until 1879, the "little paper" in question having been contained in a number of *Kosmos* which Mr. Darwin forwarded to me in that year. On reading the said note I was at once convinced that Müller had found the true explanation of mimicry between protected groups, and I accordingly directed Mr. Darwin's attention to the matter and published a translation of the paper (*Proc. Ent. Soc.*, 1879, p. 20) in order to bring it under the notice of English entomologists. Writing to me in 1879 about this paper, Mr. Darwin said:—"F. Müller's view of the mutual protection was quite new to me" (Poulton, *loc. cit.*, p. 213). It is thus evident that Dr. Packard confused a tentative speculation of Müller's, which was contained only in a letter to Darwin, and probably never intended for publication, with the now well known Müllerian theory which was published formally some nine years later.

R. MELDOLA.

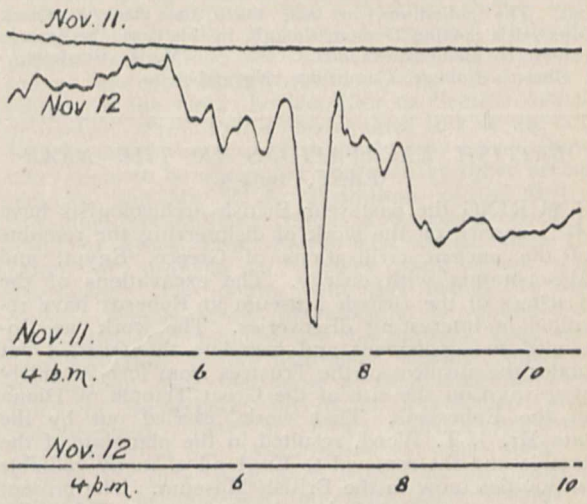
Magnetic Storms and Aurora.

IN view of the interest recently displayed in theories as to the origin of magnetic disturbances, attention may be directed to some rather curious phenomena exhibited during the magnetic storms experienced lately. Usually when a magnetic element during a storm suffers a large deviation in one direction it does not simply return to, but overshoots, its original value, and oscillates about its undisturbed position. If we liken the curve to the outline of an island on a map, a conspicuous indentation of the coast line is usually accompanied by a correspondingly pronounced promontory. Whilst this is much the more common phenomenon, it is by no means very unusual to have, as it were, an isolated bay in an otherwise straight coast line; only when this happens the "bay" seldom forms a deep indentation, and the curvature of its outline is seldom very great. On November 15, during the recent display of aurora, a somewhat remarkable instance of a nearly isolated "bay" presented itself in the declination curve trace at Kew. Taking, again, the geographical analogy, it resembles—as may be seen from the accompanying copy of the curve[1]—a regular estuary. We have, commencing at 8.53 p.m., an easterly movement, which in twelve minutes reduced the declination about 32′, while in the subsequent twenty minutes the declination increased 34′, thus returning very nearly to the value it had half an hour before. This was by no means the only movement during the magnetic storm of November 15, but it was far and away the most conspicuous one. Its remarkable form would predispose one to attribute it to some very special cause, which one would naturally associate with the coexisting aurora. Curiously, however, a very similar movement was experienced three days earlier, when no special auroral display seems to have been noted in this country, the intervening days being free from any large disturbance. This earlier disturbance—a copy of which is also shown—took place on November 12, also in the evening, but nearly 2½ hours earlier than that on November 15. The conspicuous movement on November 12 began about 6.30 p.m. The easterly movement was fully larger than on November 15, being about 35′·5, while the return swing to the west was about 36′·5. The double movement occupied about thirty-eight minutes, and so somewhat longer than on November 15, but this is chiefly due



to the movement on November 12 beginning and ending somewhat less abruptly.

The total ranges of the declination disturbances on November 12 and 15 were respectively about 42′ and 50′. The other elements were also disturbed, the horizontal force range being approximately 200 γ on November 12 and 250 γ on November 15 (1 γ=0·00001 C.G.S. unit). In each of these horizontal force curves there was also a prominent movement somewhat analogous to the above movements in the declination, but not synchronous with them, and with an *increase* of force. The horizontal force movement on November 12 was the more striking, the force increasing by about 180 γ in thirteen minutes, and



then falling off about 155 γ in the next thirteen minutes. On November 15 the nearest analogous movement was of a more normal character, an increase of 110 γ, occupying about ten minutes, being followed by a fall of 160 γ in the next twenty minutes. On November 12 the prominent horizontal force change was only a few minutes later than the prominent declination change, but on November 15 the most prominent horizontal force movement preceded the prominent declination movement by about 2¾ hours. There were considerable horizontal force movements at the time of the prominent declination movement on November 15, but they were of a more commonplace character. The disturbance on November 12 commenced about 9.30 a.m., terminating about midnight; that on November 15 lasted much longer, starting about 3.15 p.m., and continuing for about thirty hours.

CHARLES CHREE.

National Physical Laboratory, November 21.

[1] Two days' curves—each with its base line—are taken on each photographic sheet; the upper is always the earlier.

Absorption Spectra of Ultra-violet Rays by Vapour and Liquids

IN connection with some letters recently published in NATURE (vol. lxxii. pp. 557, 630), the following note may perhaps have some interest. Researches on the above named subject have been made in the physical institute of the University of Erlangen. Dr. Pauer (*Wied. Ann.*, lxi., p. 363, 1897) has determined for a great number of substances the position of the absorption bands, and Dr. Müller (Erlangen Inaugural Dissertation, 1903, *Sitzungsberichte der physikalisch-medicinischen Societät in Erlangen*, vol. xxxiv., p. 188, 1902) has tried to get some values of the absorption coefficients of vapours. By the researches of Friedrichs and Grebe, the results of Pauer have been in many respects amplified. Perhaps I may direct attention to the fact that Dr. Pauer found that the law of Kundt on the displacement of the absorption bands towards the red with increasing refraction index or dispersion is true when passing from the vapour to the liquid and then to the solutions in different media. His observations were made on benzol, toluol, the isomers of xylol and æthylbenzol, chlorobenzol, bromobenzol, iodobenzol, anilin, nitrobenzol, pyridine, bisulphide of carbon. Benzol and bisulphide of carbon were especially carefully treated by him.

Erlangen, November 13 E. WIEDEMANN.

The Second Law of Thermodynamics.

Is it not true that the Second Law of Thermodynamics is contradicted by the known facts of diffusion? When, for instance, masses of hydrogen and nitrogen are separated by a palladium partition, a difference of pressure is set up, owing to the diffusion of some of the hydrogen into the compartment which at first contained only nitrogen. In this condition the system is able to do work at the expense of its own heat, or heat entering from without. The palladium, in fact, takes the place of Clerk Maxwell's Sorting Demon, though, in this case, the process cannot be made continuous. M. A. BROWNE.

Christ's College, Cambridge, November 19.

BRITISH EXCAVATIONS IN THE NEAR EAST, 1904–5.

DURING the past year British archæologists have carried on the work of disinterring the remains of the ancient civilisations of Greece, Egypt, and Mesopotamia with energy. The excavations of the Trustees of the British Museum at Ephesus have resulted in interesting discoveries. The work was intended to supplement and complete that carried out under the auspices of the Trustees from forty to thirty years ago on the site of the Great Temple of Diana of the Ephesians. That work, carried out by the late Mr. J. T. Wood, resulted in the planning of the temple and the removal to England of many valuable antiquities now in the British Museum. The present work was entrusted by the trustees to the distinguished archæologist Mr. D. G. Hogarth. It has resulted in the discovery, undreamt of by Wood, of the remains of two earlier temples below that of the Crœsus temple, which he supposed to be the earliest, and of a vast number of votive objects of the eighth and seventh centuries B.C., among them many of gold and silver, besides Egyptian blue composition scarabs of the early twenty-sixth dynasty period. These were found underneath the second or "præ-Crœsus" temple. By the laws of Turkey, the antiquities, especially those of precious metal, must go to the Museum of Constantinople, but duplicates will come to the British Museum. Much new knowledge of the third or Crœsus temple, discovered by Wood, has also been gained. The two earlier ones seem to have been of interesting construction. Much heavy pumping work had to be carried out in the temple area, which had become filled with water. Mr. Hogarth is to be congratulated on having brought this interesting work to a successful conclusion.

On the mainland of Greece, Lakonia has been handed over by the Greek Government to the British School of Athens for excavations. Several minor discoveries of interest have been made, including that of a fifth-century local *heroön*, or hero-shrine, with its equipment of cultus-images, reliefs, figurines, and votive cups, &c., near Monemvasia. The work was carried out by Mr. R. C. Bosanquet, the Director of the School, and Mr. F. C. Hasluck.

The Cretan work of the British School has now been brought to a conclusion. The excavation of the site of Palaíkastro, in the province of Sitía, has not yet been completed, but is suspended, let us hope not for long. Mr. R. McG. Dawkins was in charge, and carried out his work most successfully under adverse conditions, owing to the now unhappily renewed troubles in the island, due to the fixed determination (whether it be right or wrong) of the Cretan people to effect their union with Greece. We can, parenthetically, only pray that Candia may not be the scene of riots, not for the sake of the Cretans, but for that of the museum, which contains all the trophies of the last few years' wonderful discoveries at Knossos and Phaistos, the destruction of which would be an irreparable loss to the whole civilised world.

This by the way. Mr. Dawkins's work has resulted in the discovery of the complete stratification of the temple site back to the first post-Neolithic age, and the discovery of fine pottery of the various stages of the Minoan period. It is evident that the later temple was built over the Minoan settlement, probably as the result of a survival of religious tradition in connection with the site. The exploration of the Minoan town has been regularly continued. In the hills near by Mr. Dawkins also discovered a Neolithic settlement with a very interesting deposit of twenty stone axes, "more than half of them in brand-new condition. This discovery gives us, for the first time in the Ægean, a definite idea of a Neolithic homestead."

The explorations of Messrs. Arthur Evans and Mackenzie at Knossos have been continued with the assistance of Mr. Doll as architect. By the kindness of Dr. Evans we are enabled to give a short sketch of the results of his work this season in advance. The chief work has been the exploration of the magazines on the paved way leading west from the "Stepped Theatral Area" (see NATURE, October 5). More stores of tablets relating to the royal chariots and armoury have been found, and a complete building excavated. On the hillside beyond the Candia road, the building to which the way led from the palace has been found and partly excavated. It proved to be a late Minoan house, larger than any other *dépendance* of the palace, and in it were found the remains of a shrine containing fetish images in the shape of natural stalagmite blocks of quasi-human form, together with a painted clay goat and other figures. Owing to heavy rainfall, the modern wooden pillars of the quadruple staircase in the main palace gave way, and Dr. Evans was obliged to rebuild the whole. This he did in more solid form with stone pillars of ancient shape and appearance. More interesting discoveries were made during the course of the work. We regret to learn that owing to absence of outside support for the Cretan Exploration Fund the Knossian excavations may shortly be brought to an end. It is evident that an excavator cannot go on bearing indefinitely the greater part of the cost of his excavations himself, as Dr. Evans has done. There is much more of the greatest importance to science to be found at Knossos, and we again appeal to those who are interested to subscribe to the Cretan Exploration Fund. There ought to be some money somewhere for the most important archæological exploration of the decade, which, despite the claims of Egyptian excavations, Dr. Evans's work must undoubtedly be admitted to be. We hope and confidently expect that, after a pause of a year or two devoted to the full publication of the momentous results hitherto obtained, Dr. Evans will be enabled to proceed afresh with the exploration of Knossos.

In Egypt the chief excavations of the year have been those of the Egypt Exploration Fund. The excavators employed by the fund were, as before, Profs. Naville and Petrie, and Messrs. Hall, Currelly, and Ayrton, Mr. Hall being lent, as last year, by the British Museum. To Messrs. Naville, Hall, and Ayrton was assigned the continuance of the excavations at Dêr el-Bahari, with the assistance of Mr. and Mrs. H. Garnett-Orme, who kindly gave their services to the Fund for this work. Messrs. Petrie and Currelly, with a party of helpers, among whom may be mentioned Captain Weill, of the French *génie*, were commissioned to investigate and clear

the well known temple of Sarábit el-Khadim, in the Sinaitic peninsula. Captain Weill has made the Egyptian inscriptions of Mount Sinai his special study.

The results of the first season's work on the eleventh dynasty temple at Dêr el-Bahari were described in NATURE, June 16, 1904; those of the second season have been equally interesting and important. The new temple is, in fact, the oldest now known at Thebes, and is the best preserved of the older temples of Egypt. It is the only temple of its period (about 2500 B.C.) known to us, and is therefore important as telling us previously unknown facts with regard to the architecture and art of that time. The temple is the funerary chapel of King Neb-hapet-Rā (formerly called "Neb-kheru-Rā") Mentuhetep, the first great Theban king. Last year's excavations were brought to an end when only a corner of the temple had been uncovered. Those of this year have resulted in the clearance of the main portion of it, leaving only the western end to be excavated this winter. It is a symmetrical rectangular building built upon an artificially levelled platform of rock. In the centre is a square erection which was apparently the base of a dummy pyramid of small size. Round this is an ambulatory or corridor of octagonal pillars, the outer wall of which was decorated with coloured reliefs. The platform was approached from the east on its centre line by an inclined plane or ramp, flanked by colonnades of square pillars on the lower level. This arrangement of platform, ramp, and flanking colonnades was apparently copied by the later architects of the temple of Queen Hatasu or Hatshepsut close by, which was excavated for the Egypt Exploration Fund by Prof. Naville, assisted by Mr. D. G. Hogarth and others, some years ago. The main arrangement of the old temple, with its central pyramid, &c., was not copied by Hatshepsut's architects.

A large number of fragments of the reliefs already mentioned have been found this year as last, and were exhibited at the annual exhibition of the Egypt Exploration Fund in the rooms of the Society of Biblical Archæology in July of this year. The brilliancy of their colouring and delicacy of their workmanship were remarkable, and they form an important addition to the chief known relics of Egyptian art. The carving of some of the sculptured hieroglyphs is of the finest style, which is not often seen in Europe, and was hardly known to many who had not visited Egypt and seen Abydos and Dêr el-Bahari.

Apart from the actual temple-buildings, the two most important discoveries were those of the sarcophagi of the priestesses of Hathor who were buried within the temple, and six portrait statues of the King Usertsen or Senusret III. of the twelfth dynasty, representing him at different periods of his life. The heads of two are missing. The portraits, especially the two oldest, are very fine. One of the white limestone sarcophagi is most beautifully carved with scenes of offerings being brought to the deceased priestess, of the cows of Hathor, &c. The sarcophagus and one of the statues are illustrated in an article on the temple by Mr. Hall in the August number of *Man*, from photographs taken by Mr. Ayrton.

The small votive offerings which were such a feature of last year's discoveries were not found in any quantity this year, but instead a much larger number of workmen's tools, hoes, baskets, mallets, &c., were found.

Prof. Petrie's work consisted in the clearance and planning of Sarábit el-Khadim and the study of the Wadi Maghara inscriptions. In the Wadi Maghara an inscription of the early King Sa-nekht, whose tomb was discovered by Mr. Garstang at Bêt Khallâf, in Upper Egypt, a few years ago, was found. The peculiarities of the plan of Sarábit el-Khadim had long been known, and now that they have been fully made out they appear sufficiently curious to demand some explanation, which Prof. Petrie has attempted to give. He explains the building as not primarily an Egyptian but a Semitic shrine, with *ḥanefiya* courts like those of a mosque, while the peculiar stelæ inscribed with records of Egyptian miners and the upright stones, which are such a feature of the place, he identifies as Semitic *bethels* or *baetyli*. Prof. Petrie also claimed this as the only Semitic temple known. His conclusions do not, however, seem to be altogether approved by other archæologists, and Mr. R. C. Thompson, of the British Museum, has criticised them in a recent article in *Man*, to which Prof. Petrie has replied, with the result of drawing a further reply from Mr. Thompson. The point about this being the only Semitic temple must undoubtedly be abandoned; the Babylonian temples are far older. That they are Sumerian is no argument against this, for the Semites took over most of their religious ideas from the Sumerians; but to an unprejudiced critic the weakest point of Prof. Petrie's argument seems to be the identification of the stelæ as *bethels*. If they were, they would, as Mr. Thompson says, be inscribed, not with mere records of Egyptian garrison and mining officials, with prayers to the Egyptian goddess Hathor, as they are, but with inscriptions of *Semitic* religious import, recording dreams and prophecies, &c. Prof. Robertson Smith's "Religion of the Semites" should be consulted on this point. The form of the stelæ is as Egyptian and non-Semitic as their inscriptions; we may compare with them the stela or obelisk of Usertsen I. at Begig, in the Fayyûm, and the two great stelæ in front of the funerary temple of King Sneferu at Mêdûm, discovered by Prof. Petrie himself in 1891.

A large number of interesting objects were brought back by the expedition, and were exhibited by the Egypt Exploration Fund at University College, Gower Street, in July.

Excavations have been carried on by Mr. Garstang for the University of Liverpool at Kom el-Ahmar, the site of the ancient Hierakonpolis, at Hissaya, south of Edfu, and at Esna. At Kom el-Ahmar Mr. Garstang found interesting remains of the third dynasty or earlier, at Hissaya graves of the Persian period, and at Esna a series of town-remains from Hyksos times until the twentieth dynasty. Two remarkable tomb-structures were found, of eight or ten chambers on the ground floor and a stairway leading up to the first floor, where there was a similar series. The site in general illustrated in an interesting fashion the provincial art of Egypt at the period. Excavation is to be resumed on it next year. We are indebted for these details to the kindness of Mr. Garstang.

In Mesopotamia the excavations of the British Museum at Kuyunjik, the site of Nineveh, have been brought to an end under the direction of Mr. R. C. Thompson, after the departure of Mr. L. W. King. The excavations have resulted in the discovery of many interesting buildings previously unknown, including a temple of the god Nabu and a new palace of Sennacherib. The planning of the whole mound of Kuyunjik and its ruins has been carried out to its completion. Messrs. King and Thompson also visited the rock of Behistun or Bisutun in Persia, and re-copied the famous historical inscription of Darius, originally copied by Rawlinson. The text obtained by them will be the

most complete and authoritative existing. Messrs. King and Thompson have also taken some unique photographs of the monument.

In the Sudan, Dr. Budge, of the British Museum, and Mr. J. W. Crowfoot, Inspector of Education in the Sudan, have completed the work which the former began at Meroe in 1903. They finally cleared out the shrine of the largest pyramid, and made some interesting explorations in the country near the Second Cataract. Dr. Budge, whose services had been previously lent to the Sudan Government by the British Museum in 1897, 1899, and 1903, is now engaged on an account of his four missions to that country, which is announced to appear in the spring.

We cannot close this account of British archæological work without a word of congratulation to our American friends on the success of the excavations of Mr. Theodore N. Davis, assisted by Mr. J. E. Quibell, the British Inspector of Antiquities in Upper Egypt, in the Valley of the Tombs of the Kings at Thebes. Mr. Davis found the untouched tomb of Iuaa and Tuaa, the father and mother of the great Queen Tyi, consort of Amenhetep III. and mother of the heretic King Akhunaten. The tomb was full of the most magnificent furniture, chariots, &c., mostly thickly overlaid with gold. Mr. Davis will proceed with his excavations this winter with the assistance of Mr. Ayrton, who has left the Egypt Exploration Fund for this purpose.

THE BEAUTY OF MINUTE STRUCTURE IN NATURE.[1]

ONE of the many ways of beginning the study of natural science is with a "beauty-feast"—of flowers or birds, of shells or gems, of anything—for all natural things are beautiful, in their proper setting at least. It is an old-fashioned mode of approach, commending itself to children and simple minds, but one which often leads far beyond æsthetic pleasure to the joy of understanding. It affords a dynamic to investigation, and fosters a healthy reverence for things. In school "nature-study" the æsthetic factor should be characteristic, though it is too often conspicuous by its absence. Indeed, if we had to choose, we should prefer admiration without science to science without admiration. But a simple book like that before us shows that there is no necessary antithesis; it is a disclosure of beautiful things, and yet within its limits it is quite scientific.

The author's aim is to illustrate by well chosen examples the beauty of minute structure, the beauty which the microscope discloses, and he is to be congratulated on his success. While older books on "the wonders of the microscope" had to be content with drawings, some of which were exquisitely done, this book presents us with photomicrographs of the highest excellence. It is difficult to over-praise them. Moreover, while the older books gave too much prominence to curiosities and out-of-the-way objects, we are here brought into close quarters with the familiar, with diatoms and Foraminifera, the whelk's radula and the barnacle's cirri, the butterfly's "tongue" and the scales of the sole, the spine of the sea-urchin and the spider's foot, a gnat and a house-fly's eggs, the dodder entering the clover, the bud of the lily flower, the sting of the nettle and the stem of wheat, and so on through a long list. Along with each of the sixty-five illustrations there is a short and clear description, and a note of the conditions of the photograph, *e.g.* magnification, focal distance, and exposure. The photographs were taken by Mr. Arthur E. Smith, and are certainly among the finest that have ever been published. They were taken, for the most part, on 12 by 10 plates, and have been somewhat reduced in the process blocks. Mr. Smith contributes a useful chapter of practical hints on photomicrography.

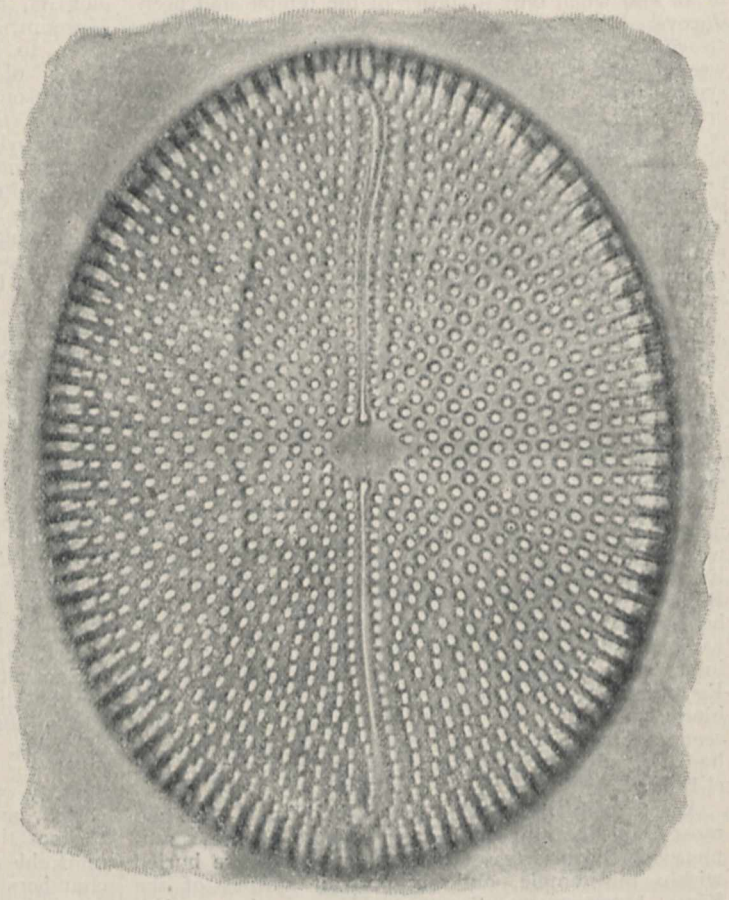


FIG. 1.—Diatom, from Bori, Hungary, ×1000. From "Nature through Microscope and Camera."

Mr. Kerr is an enthusiastic photographer, who believes in his "intellectual pastime" as helping, indirectly, to remedy some of the ills we are heir to, such as "the amusement fetich." But he is more, he is a student of the beautiful things which he delights in, and he can tell their story in a plain, straightforward way. The moral that adorns his tale is expounded by Prof. G. Sims Woodhead in a finely conceived introduction; but we shall only say this, that the whole spirit of this beautiful book is well

[1] "Nature through Microscope and Camera." By Richard Kerr; with 65 photomicrographs by Arthur E. Smith. Pp. 197. (London: Religious Tract Society, 1905.) Price 6*s.* net.

expressed in the prefatory quotation from Sir J. F. W. Herschel:—"To the Natural Philosopher there is no natural object that is unimportant or trifling; from the least of Nature's works he may learn the greatest lessons." J. A. T.

THE WASTAGE IN ARMIES BY DISEASE.

THE recent utterances of Sir Frederick Treves on the subject of the Army Medical Service (see NATURE, November 2, p. 15), and the discussion on enteric fever in the army which has appeared in the columns of the *Times*, have again directed attention to the inadequacy of the means taken in our army to prevent the incidence of enteric fever and other filth diseases. The crux of the matter is this: we have to provide hospital accommodation for 10 per cent. of our forces in the field, the Japanese for but 2 per cent. Why this difference? In the South African campaign no less than 746 per 1000 of the fighting forces were admitted into hospital for disease which is mainly preventable. In this war there were something like 450,000 admissions to hospital on account of sickness and some 22,000 admissions on account of wounds or injuries received in action.

"Among those admitted to hospital on account of disease alone, there were 14,800 deaths during the whole war; further, so far as can be estimated at present, 42,741 of the total admissions to hospital on account of disease, and 7998 of the deaths from disease, were due to enteric fever, while 31,363 of the admissions and 1248 of the deaths were from dysentery. In other words, no less than one-tenth of the admissions on account of disease were for enteric fever, and one-fourteenth were for dystentery, or these two diseases alone were the cause of practically one-sixth of the total admissions and about two-thirds of the total deaths on account of disease; these two diseases also accounted for nearly one-half of the total losses by death from all causes during the war. As we know that both enteric and dysentery belong to the group of diseases which are largely the outcome of faulty environment, the sanitary significance of these figures needs no argument."[1]

How does the Japanese Army deal with the prevention of disease? The following record sufficiently answers this question:—

"The care of the sick and wounded occupied but a small share of the time of the medical officers. The solution of the greater problem of preventing disease by the careful supervision of the smallest details of subsistence, clothing and shelter was their first and most important duty. Nothing was too small to escape their vigilance, nor too tedious to weary their patience, and everywhere, in the field with the scouts or in the base hospitals at home, the one prevailing idea was the prevention of disease. The medical officer was to be found both in the front and in the rear. He was with the first screen of scouts, with his microscopes and chemicals, testing and labelling wells, so that the army which followed should drink no contaminated water. When scouts reached a town, he immediately made a thorough examination of the sanitary conditions, and if cases of contagious or infectious disease were found, he put a cordon around the quarter where they were. A medical officer accompanied foraging parties, and, with the commissariat officers, sampled the various food, fruit, and vegetables sold by the natives before the arrival of the army. If the food were tainted, or the fruit over-ripe, or if the water required boiling, notices to that effect were posted in suitable places. So strict was the discipline from commanding officer to rank and file that obedience to the orders of the medical officer was absolute. The medical officer also supervised the personal hygiene of the camp. He taught the men how to cook, how to bathe, how to cleanse the finger nails so as to free them from bacteria, as well as how to live in general a healthy, vigorous life, and it was a part of the soldier's routine to carry out these instructions in every particular. As a result of this system the medical officer was not obliged to treat cases of dysentery and fevers that follow the use of improper food and the neglect of sanitation. During six months of terrible fighting and exposure in a foreign country there was only a fraction of 1 per cent. of loss from preventable disease."[1]

It may be true that vehicles other than water, particularly dust and flies, convey the infection in enteric fever, diarrhœa, and dysentery, but much can be done by safeguarding the water supplies.

Diminish the incidence of these diseases by any means whatever and the subsequent incidence of the disease will naturally be lessened—cases beget cases.

It may or may not be practicable to sterilise the drinking water for a big army in the field, but in camps and in small campaigns such as our "little wars" on the Indian frontier, and in Africa, a great deal more could be done than has been done. Thus in the Tochi Valley, in 1897, a force of some 4000 men was condemned to inactivity and suffered severely from diarrhœa, dysentery, and enteric. The British troops averaged an *annual* strength of 622, and among them there were 59 cases of enteric with 30 deaths, 371 cases of dysentery with 65 deaths, and 211 cases of diarrhœa with 10 deaths. Here was an ideal instance in which sterilisation of the water or distillation for the sick (as the water was very saline) could have been carried out, as there was plenty of fuel, and the extra cost involved would probably have been more than covered by the saving in pensions, &c. Lieut. Nesfield, I.M.S., in the Tibet campaign used his iodide iodate tablets (see NATURE, July 27, p. 303, and August 31, p. 432), with the result that of 700 men who drank water sterilised with them, none contracted cholera, while of other batches of men passing through the same region a few days later an average of 3 per cent. contracted cholera.

There can be no question that the medical officers of our army are a devoted body of men, highly trained, and fully alive to what should be done, but they are too few adequately to cope with the problem of prevention, and what is more they receive little encouragement in this direction from those in authority. In addition, a body of intelligent trained non-commissioned officers and men, a sanitary corps, is required to carry out the policy of the medical officers. At present guards for the water supply and similar purposes are drawn from the ordinary strength of the regiments, with, of course, no special training. In the China Relief Expedition in 1900 the Japanese provided three skilled men to take care of their sick and wounded for every two provided by the other armies. In olden times it was thought cheaper to obtain a new soldier than to cure a sick or wounded one; the reverse is the case nowadays if the authorities would but appreciate it, and prevention is even better than cure. R. T. HEWLETT.

[1] Lieut.-Col. Firth, R.A.M.C., *Journ. of Hygiene*, Sept., 1905, p. 543.

[1] *Brit. Med. Journ.*, 1904, ii. p. 1332.

NOTES.

WE announce with deep regret that Sir J. S. Burdon Sanderson, Bart., F.R.S., late Regius professor of medicine in the University of Oxford, died at Oxford on November 23.

PROF. EMIL WARBURG, president of the Reichsanstalt in Charlottenburg, and Prof. Henri Moissan, of the University of Paris, have been elected corresponding members of the Academy of Sciences of Münich.

THE twenty-first anniversary of the Royal Scottish Geographical Society was celebrated by a dinner in Edinburgh on Monday, November 27. Prof. J. Geikie, the president of the society, presided.

THE death is announced of Dr. James Monckman on November 18, at the age of sixty-three. In 1879, after acting as honorary assistant to Prof. J. J. Thomson at Cambridge, Dr. Monckman received the degree of D.Sc. of London University. At Bradford he acted occasionally as consulting analytical chemist, and he carried out some researches in chemistry, as well as work in geology and botany. He assisted in the formation of the Bradford Scientific Society, and was thrice elected its president.

A DISTINCT earth tremor occurred in Manchester and Salford about 3.45 a.m. on November 25. Many people dwelling on the north-west side of the city and borough reported that they were disturbed from sleep by violent shaking of their rooms and the ringing of bells. Some persons reported that they heard a loud thud; others that there was nothing but one violent shock, followed by a tremor lasting several minutes. In the Seedley district of Salford some chimney stacks were displaced, but there was no other damage.

DR. F. AMEGHINO seems to be impressed with the idea that Argentina is the "centre of the universe," and that almost every group of mammals may be traced back to a South American ancestor. In the third of three papers dealing with the presence of a perforation in the astragalus of several groups of mammals, published in vol. xiii. of the *Anales* of the National Museum of Buenos Aires, he gives, for instance, a phylogeny in which both pangolins (Manidæ) and aard-varks (Orycteropodidæ) are placed as being derived from armadillos (Dasypodidæ). A more unsound pedigree it would be almost impossible to invent. Dr. Ameghino has detected the above-mentioned foramen not only in Orycteropus, but also in Canis, Typotherium, and certain mammals from the Middle Miocene of France.

AMONG the contents of the November issue of the *Naturalist* is a communication by Mr. A. Whitaker on the breeding habits of British bats. Unfortunately, the author's attempts to rear bats in captivity have been only partially successful, in some degree owing to the circumstance that it was not ascertained until too late that a female specimen was pregnant. One noctule bat gave birth, however, to an offspring almost immediately following its capture, and it was noticed that the squeak of the "baby" was even more high-pitched than that of its mother. When the young one was eleven days old (and still blind and naked) the parent escaped, but apparently returned and carried away her offspring. Neolithic remains from the Durham caves form the subject of a paper by Mr. C. T. Trechmann in the same issue.

ACCORDING to *Museum News*, No. 4, the Brooklyn Museum, which is in the van of progress, has been trying the experiment of placing, for the use of visitors, books relating to the subject of the specimens exhibited on tables alongside the various cases. So far the experiment seems to have been a decided success, but whether it could be repeated in this country may be doubtful. Apropos of descriptive labels in museums, it is stated in the same periodical that if ninety-nine objects are labelled and the hundredth is not so treated, visitors will pass over all the former and inquire for the label for the latter. Again, a visitor has been known to look at a label some six feet long, inscribed in letters three inches high "Atlantic Right Whale," and then turn round and ask the nearest official "what that animal is called"!

No. 25 of the "North American Fauna," issued by the U.S. Department of Agriculture, consists of an account of the biological survey of Texas which has been recently carried out. This part, which is by Mr. V. Bailey, deals, however, only with the determination of life-zones, and the reptiles and mammals, the birds being reserved for a future issue. The economical aspect of the subject has claimed a large share of the attention of the workers, especially as regards the suitability or otherwise of particular crops to particular climatic zones. The mapping of these zones—which are necessarily also life-zones—cannot fail to be of advantage to agriculturists, for "as a crop becomes an established success in one locality, a study of the zone-map will show over what adjoining county it can be profitably extended." Of the nine new mammals described, all but one are subspecies, thus showing how thoroughly the country has been worked.

DR. FORSYTH MAJOR has favoured us with a copy of an interesting and important paper from the October and November numbers of the *Geological Magazine* on certain rodents from the Pleistocene of the western Mediterranean countries. He first of all deals with the picas, or "mouse-hares," of the extinct genus Prolagus, which, instead of being confined to Sardinia and Corsica, is also continental, and extends as far west as Spain. Next it is shown that Hensel's *Mus orthodon*, which has been supposed, apparently owing to a misconception, to be akin to *M. sylvaticus*, represents a genus—Rhagamys—by itself. It has, for instance, tall-crowned molars with very thick enamel, and nearly vertical tubercles, which when worn present a characteristic pattern. Finally, the Pleistocene *Arvicola henseli* is shown to form a kind of connecting link between the Pliocene Mimomys, in which the molars are rooted, and modern voles, the dentine surfaces of the prisms of the latter being incompletely separated.

RECENT miscellaneous results of the work of the U.S. Bureau of Entomology are summarised in Bulletin No. 54 of that section of the Agricultural Department. One article is devoted to the sugar-cane beetle (*Ligyrus rugiceps*), on which a special investigation was undertaken last year, owing to the fact that the insect, and the best means of checking its ravages, had received practically no attention for the last five-and-twenty years. It is hoped that the remedies suggested will be found efficient by southern planters. "Conchuella," a Mexican cotton-pest, which it is feared may spread to Texas, has also received attention at the hands of the bureau's officers, while the demonstration of the efficiency of cold storage for "cow peas" (so largely used as fodder and for the improvement of the soil in the States) as a protection against the attacks of the three species of weevils to which they are subject may be regarded as a triumph for the bureau.

WE have received from the trustees a copy of "A Guide to the Fossil Reptiles, Amphibians, and Fishes in the Department of Geology and Palæontology in the British Museum (Natural History), Cromwell Road," issued at the price of sixpence. Although on the title-page merely stated to be the "eighth edition," this excellent little handbook has been entirely re-written by Dr. A. Smith Woodward, the keeper of the department, whose name is a sufficient guarantee that it is thoroughly up to date, and at the same time lucidly and simply written. In its new form it constitutes a brief, popular introduction to the study of the extinct representatives of the groups to which it is devoted. The most striking illustration is one of Mr. Carnegie's dinosaur, Diplodocus, which from considerations of space has been mounted in the gallery mainly devoted to recent reptiles, instead of among its fellow monsters. The plate of the skulls of two of the wonderful extinct horned tortoises—one from Queensland and the other from Patagonia—likewise merits a word of commendation.

MR. WINSLOW AND MISS ROGERS have suggested a new classification of the bacterial family Coccaceæ (*Science*, xxi., No. 539, p. 669). The family is divided into two subfamilies, the Paracoccaceæ and Metacoccaceæ, the former being subdivided into two genera, Diplococcus and Streptococcus, the latter into three genera, Micrococcus, Sarcina, and Ascococcus. We are not sure that this revised classification is a material improvement on the classifications which already exist. For instance, the Pneumococcus is included among the Diplococci, but culturally it is unquestionably a short Streptococcus, and in the sputum may occur in chains of four elements.

ALTHOUGH yams, the tubers of species of Dioscorea, are extensively cultivated in the West Indies and the tropics of South America for domestic consumption, their value as a food does not appeal to the Ceylonese, who show a preference for the less tasty and less nutritious imported potato. In the Circulars (vol. iii., No. 1) of the Royal Botanic Gardens, Ceylon, Mr. H. F. Macmillan has written some notes on Dioscoreas with the object of directing attention to their value as a vegetable, and also to assist cultivators in identifying the different varieties.

THE members of the Scottish Antarctic Expedition were prevented by stress of weather from making a complete exploration of Gough Island, so that the collection of plants obtained by Mr. R. W. Brown, and described in vol. xxxvii. of the *Journal of the Linnean Society*, is probably incomplete. Of the phanerogams and ferns, numbering twenty-seven, the most conspicuous were *Phylica nitida*, a tree characteristic of the Tristan da Cunha group, tussac-grass, *Spartina arundinacea*, and the tree fern *Lomaria Boryana*. The flora is very similar to that of Tristan da Cunha, but two endemic species, a Cotula and an Asplenium, were obtained.

AT the recent Colonial Exhibition held in the Crystal Palace, of the West Indian colonies Jamaica took the foremost place, receiving, amongst other distinctions, the gold medal presented by the West Indian Cable Company for the best collective exhibit. Of Jamaica produce, oranges and bananas are both much in evidence; the sugar and rum industries are prospering, while the cultivation of cacao, rubber, cotton, and tobacco are all more or less suited to the climate. In the *Agricultural News* (October 7) mention is also made of a tea plantation of 90 acres that promises well under the careful management of the owner, Mr. H. E. Cox. This and a plantation in Carolina, U.S.A., are said to be the only tea plantations in the western hemisphere.

MR. D. E. HUTCHINS, conservator of forests, Cape Town, presents an admirable survey of the past history and present condition of forestry in South Africa in the recent record of "Science in South Africa." The institution of a forest department in Cape Colony dates from 1881; since that time three-quarters of a million pounds has been expended, and the staff now numbers no less than 110 conservators and foresters. Yellow-wood furnished by two species of Podocarpus, the most widely spread indigenous timber trees, is not so valuable as the Clanwilliam cedar, *Callitris arborea*, which takes the place of Baltic pine; this cedar having been cut out in the past, future supply is dependent upon the timber that is now being raised in the Cedarberg country. Of exotic trees, species of Eucalyptus and Cupressus have been largely introduced for timber, and wattles for the production of tan bark.

NEARLY all parts of the British Islands experienced very severe southerly and south-westerly gales on Sunday last, November 26, which, in connection with the spring tides, occasioned great damage, especially on the west and south coasts, many houses being flooded, while the service in the English Channel was quite disorganised. The weather report issued by the Meteorological Office on Saturday morning notified the approach of an important depression off the coast of Ireland, and the chart for Sunday morning showed that the centre of the storm had already reached the west coast of that country, and that the barometer had fallen 0·7 inch in the last twenty-four hours. In the north-west of England the strongest winds were felt between 10h. p.m. and midnight, and the gusts reached a velocity of 66 miles per hour; in the south-west of England the velocity was at least 75 miles an hour. At the mouth of the Thames it is estimated that the gusts were at the rate of about 60 miles an hour. Notwithstanding the great damage caused by wind and sea combined, it does not appear that the wind-velocity was so great as in the storm of March last, when a rate of 100 miles an hour was recorded in the south-west of England, and 83 miles an hour in the north-west. By Monday morning the central part of the storm had advanced to the coast of Norway.

IN the Journal of the Meteorological Society of Japan for September will be found a very useful summary (in English) of the rainfall of China and Corea, by Mr. T. Okada. Some years ago Dr. Supan published a valuable paper on the subject in Petermann's *Mitteilungen*, but since that time the number of stations has increased, and Mr. Okada has summarised in a handy form the results for forty stations, mostly on the coasts of China and Corea, for the years 1892–1901. The materials are obtained from observations published by the Zi-ka-wei and Hong Kong observatories, and other sources. In northern China the average annual rainfall is under 40 inches; it increases to the southward, and decreases from the coast towards the interior of the Empire, and in individual years it is subject to large fluctuations. In Corea the annual fall is about 36 inches on the west coast, and is generally more than 40 inches on the east and south coasts. In northern China the wettest months are July and August, and February is the driest month. In southern China the wettest month is June, and the driest December. Tables are given showing the average monthly falls at all stations. The coast of central China has an average of 120 rainy days, southern China 80 days, and northern China 60 days. Heavy rainfall in twenty-four hours is rather rare, but falls of 4 inches frequently occur between April and August. In Corea falls of more than 4 inches in a day rarely occur. There is only one instance of more than 8 inches. A table is given showing the greatest daily falls in each month for all stations.

A REPORT has been received on the use of platinum resistance thermometers in determining the temperature of the air at Helwan, the central Egyptian observatory. The object of the paper is to justify the use of a special form of platinum thermometer invented by the writer of the report (Mr. E. B. H. Wade), in conjunction with Prof. Callendar's electric recorder. Instead of coiling the platinum wires on mica supports, and enclosing them in a solid tube for protection, as in the ordinary recorder, Mr. Wade arranged them in an open manner on a light ebonite frame, somewhat in the form of a gridiron, without any kind of casing, the wire being completely exposed to the air. It is claimed, among other things, that the influences of radiation and the Joule effect are much

smaller in this type than in the ordinary one, that it acts more rapidly in its indications, and that the combined recorder and open thermometer may be standardised in such a way as to require no control readings. The author gives a number of tables which seem to show that the advantages claimed are supported by the results obtained. Specimens of thermograms obtained by the employment of the usual and of the modified type show that the fluctuations are more minute in the latter case. It is also stated that Prof. Callendar has expressed approval of the reasons which have led to the adoption of the modified type of thermometer.

THE *Rendiconti* of the Royal Lombardy Institution, xxxviii., 16, contains a short abstract of the report for 1904 of the meteorological observatory on Monte Rosa, by Dr. Camillo Alessandri. The "Capanna Regina Margherita," of which the first wing was opened in 1893, has from that time onwards been visited by many observers, chiefly in connection with physiological researches, and Prof. Mosso's work in this direction is well known; but it was not until May, 1904, that the Italian Meteorological Office placed Dr. Alessandri in official charge of a meteorological station there. During the short time available up to the date of the report, observations were made of temperature, atmospheric electricity, refraction, and time. The climatic conditions occasion great difficulties with the use of instruments, and the author proves the necessity of devising new forms of instruments specially adapted to these conditions. As a beginning, a new metallic thermometer and a registering electrometer have been described by Dr. Alessandri himself.

THE twentieth Bulletin issued by the Geological Survey of Western Australia (Perth) covers 127 pages, and forms a further report by Mr. A. Gibb Maitland on the geological features and mineral resources of the Pilbara goldfield. It includes full details regarding the Nullagine, Warrawoona, and Marble Bar fields, and is accompanied by coloured geological and mining maps. Special interest attaches to the Nullagine district on account of the occurrence of gold in sedimentary rocks bearing a close resemblance to the auriferous conglomerates of the Witwatersrand. The auriferous deposits of Warrawoona and of Marble Hill are quartz reefs.

AN interesting preliminary report has been issued by the mines branch of the Canadian Department of the Interior on the raw materials, manufacture, and uses of hydraulic cements in Manitoba. It has been drawn up by Mr. J. Walter Wells, and involved an examination of the limestones, marls, clays, shales, and coal deposits of the province. Particulars are added of the cement mills in North Dakota, in Minnesota, and in South Dakota; and much information is given regarding the manufacture of cement from the raw materials available that cannot fail to be of practical value in furthering the cement industry of Manitoba. In that province timber is becoming scarce, and suitable building stone and bricks are expensive. Cement is therefore coming into increasing use in house and farm construction, in railway work, in municipal work, and in factories and mills; and within the last eight years the uses of concrete have been greatly extended by the introduction of iron and steel reinforcements, consisting of skeleton structures so arranged in the concrete masses that rods, bars, wires, and bands help in resisting stresses in tension. A very important application of reinforced cement concrete in Manitoba is the construction of grain elevators. The various applications of cement in the province are well shown in photographic illustrations accompanying the report.

AT the last meeting of the Institution of Mechanical Engineers a paper was read by Dr. H. C. H. Carpenter, Mr. R. A. Hadfield, and Mr. Percy Longmuir on the properties of a series of iron-nickel-manganese-carbon alloys. It constituted the seventh report to the Alloys Research Committee, and formed an interesting continuation of the previous reports presented by the late Sir William Roberts-Austen. The research was carried out at the National Physical Laboratory, the alloys having been prepared by Mr. Hadfield at his works at Sheffield. The alloys contained on an average 0·44 per cent. of carbon and 0·88 per cent. of manganese, and the following percentages of nickel:—A, nil; B, 1·20; C, 2·15; D, 4·25; E, 4·05; F, 6·42; G, 7·95; H, 12·22; J, 15·98; and K, 19·91. The report embodies the results of an exhaustive examination of the mechanical, physical, chemical, and metallographical properties of these alloys. It has previously been shown that an increase in the content of nickel raises the maximum stress and lowers the extension. The present research shows that, so far as industrial products are concerned, a danger limit for nickel content is found at 4½ per cent. when carbon and manganese are present to the extent of 0·44 per cent. and 0·88 per cent. respectively. The brittle zone extends from about 5 per cent. to 16 per cent. of nickel. The report, which covers 102 pages, contains a mass of observations of the greatest scientific interest, and the Institution of Mechanical Engineers is to be congratulated on having promoted a costly research of which the immediate practical value to the engineer is very slight.

WE have received from Mr. A. Gibb Maitland a copy of an interesting paper read by him before the Western Australian Natural History Society on the salient geological features of British New Guinea. The territory was annexed to the Crown in 1888, and in 1901 passed into the possession of the Commonwealth of Australia. The geology presents many points of interest. New Guinea rests upon a submarine bank which has been termed the Melanesian Plateau and is separated from another by an abyss 2000 fathoms deep. The coral formations of British New Guinea are very remarkable. All gradations from reefs only a few feet above the water up to 2000 feet in height were noticed. The reef masses are composed of very hard limestones. Coral fragments do not appear to be very common. The volcanic phenomena present all phases, their products being scattered over almost the whole length of the possession. The various sedimentary rocks are well developed in many portions of the territory, and, so far as at present understood, they comprise:—(1) Kevori grits (post-Tertiary); (2) Port Moresby beds (Pliocene); (3) Boioro limestones (undetermined age); (4) Purari River beds (Cretaceous); (5) Strickland River shales (Jurassic); (6) Tauri limestones (Devonian); and (7) metamorphic rocks and crystalline schists. The last named are of considerable economic importance in that they form the original matrix of those deposits that have yielded, from 1888 to 1904, alluvial gold to the value of 255,115*l*. Fragments of coal have been met with in the Purari River beds. It is believed that the formation must attain a thickness of 3000 feet, which would leave room for the intercalation of coal seams. Should a coalfield exist it might exercise a great influence on the future of the possession.

AN interesting paper on the linear force of growing crystals is contained in the *Proceedings of the Washington Academy of Sciences* (vol. vii. p. 283); the authors, Messrs.

G. F. Becker and A. L. Day, direct attention to the fact that in the study of ore deposits occurrences are observable in which crystals have exerted a very considerable force. Pyrites, for example, is formed in slate in such a way as to drive apart the laminæ of the rock without any perceptible deformation of the crystals occurring. A description is given of some experiments performed in order to determine the lifting force exerted by crystals of alum growing in a saturated solution whilst subjected to the pressure of a heavy weight. Under the title "An Interesting Pseudosolid," the same authors contribute an account of some investigations of the behaviour of fresh white of egg beaten into a fine foam with an equal volume of powdered sugar. Cylinders of uniform size were cut out of the mass of foam and subjected to compressive or tensile stress, the changes in the dimensions being carefully observed. A series of photographs of the entire foam cylinder after successive increments of compression was made, and then, by superposing the plates, accurate traces of the path of each component particle were obtained. The authors consider that the results obtained offer a confirmation of Prof. J. J. Thomson's theory of solids.

MR. WILHELM ENGELMANN, of Leipzig, has published a fourth, revised edition of Prof. P. Groth's "Physikalische Krystallographie und Einleitung in die krystallographische Kenntnis der wichtigsten Substanzen." The third edition of Prof. Groth's famous book was the subject of an article in our issue for January 30, 1896 (vol. liii. p. 289). Many students of crystallography will welcome the present edition.

A SECOND edition of Dr. F. Mollwo Perkin's "Qualitative Chemical Analysis, Organic and Inorganic," has been published by Messrs. Longmans, Green and Co. The first edition was reviewed in our issue for August 22, 1901 (vol. lxiv. p. 397); and all that need now be said is that more theory has been introduced, the portions dealing with the analysis of acids and the treatment of the substance to be analysed have been recast, and several additions have been made, those in organic analysis being specially intended for university and pharmaceutical students.

A SIXTH edition, revised and enlarged, of Prof. R. Wiedersheim's "Vergleichende Anatomie der Wirbeltiere" has been published by Mr. Gustav Fischer, of Jena. An English edition, founded on the third German edition, was reviewed in NATURE for September 1, 1898 (vol. lviii. p. 409). It is only necessary to state here that this standard work continues to grow in bulk; for instance, the bibliographical appendix, which in the English edition referred to runs to some ninety pages, occupies in the new edition nearly 140 pages.

MR. AKSEL G. S. JOSEPHSON, of the John Crerar Library, Chicago, has sent us a copy of a pamphlet in which he puts forward a proposition for the establishment of a bibliographical institute. Mr. Josephson maintains that as there are laboratories for chemical, physical, and hygienic research, there should also be an institute for conducting bibliographical research, where records of literary productions would be made systematically, and to which persons desiring information of a bibliographical character could turn with their inquiries. Such an institute, he remarks, organised as a bureau of scientific information, would be a boon to all investigators. The institute should be established on an international basis, and its function should be to record, classify, and evaluate printed literature. It should be part of the regular duty of the staff of the institute to index the society publications which are not included in existing indexes to periodical literature. Bibliographies of special subjects should be prepared to fill existing gaps. To establish such an institute on a reasonably permanent basis would, Mr. Josephson estimates, require an endowment of at least 200,000*l*.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN DECEMBER:—

Dec. 2. 5h. Saturn in conjunction with Moon (Saturn 1° 21′ S.).
,, 3. 10h. 49m. Minimum of Algol (β Persei).
,, 6. 7h. 38m. Minimum of Algol (β Persei).
,, 8. 5h. 35m. to 6h. 43m. Moon occults μ Ceti (mag. 4·4).
,, 9. 4h. 49m. to 5h. 43m. Moon occults *f* Tauri (mag. 4·3).
,, 9. 5h. 48m. to 7h. 21m. Transit of Jupiter's Sat. III. (Ganymede).
,, 10. 4h. 58m. to 5h. 56m. Moon occults γ Tauri (mag. 3·9).
,, 10. 14h. 52m. to 15h. 53m. Moon occults α Tauri (mag. 1·1).
,, 10. Saturn. Major axis outer ring = 38″·34. Minor axis = 7″·31.
,, 10–12. Epoch of December meteors (Geminids, Radiant 108° + 33°).
,, 15. Venus. Illuminated portion of disc = 0·970. Of Mars = 0·960.
,, 16. 9h. 5m. to 10h. 41m. Transit of Jupiter's Sat. III. (Ganymede).
,, 19. 19h. 53m. to 21h. 2m. Moon occults γ Virginis (mag. 3·0).
,, 22. 0h. Sun enters Virgo. Winter commences.
,, 23. 12h. 26m. to 14h. 6m. Transit of Jupiter's Sat. III. (Ganymede).
,, 25. 16h. Mars and Saturn in conjunction (Mars 0° 30′ N.).
,, 26. 7h. Uranus in conjunction with the Sun.
,, 26. 9h. 21m. Minimum of Algol (β Persei).
,, 29. 6h. 10m. Minimum of Algol (β Persei).
,, 30. 20h. Neptune in opposition to the Sun.

COMET 1905*b*.—The observation of comet 1905*b* at Bamberg on November 18 was made by Prof. Hartwig, who, in addition to determining the position given in these columns last week, recorded that the magnitude of the comet was 7·5, that the object was round with a diameter of 10′, and that the central nucleus had a magnitude of 11·0.

An observation made by Prof. Aitken at the Lick Observatory on November 18 gave the comet's position, at 8h. 17m. 31s. (Mount Hamilton M.T.), as

R.A. (app.) = 0h. 33m. 54·4s., dec. = + 77° 17′ 26″.

The appearance and the rapid apparent movement of this object seem to point to its comparative proximity to the earth (*Astronomische Nachrichten*, No. 4055).

The following elements and ephemeris, which have been computed by Herr M. Ebell from the observations of November 18, 19, and 20, are given in Circular No. 80 of the Kiel Centralstelle:—

Elements.

T = 1905 October 27·4926 (Berlin M.T.).

$$\left.\begin{array}{l} \omega = 135^\circ\ 38'\cdot7 \\ \Omega = 223\ 45\cdot4 \\ i = 138\ 54\cdot6 \end{array}\right\} 1905\cdot0$$

$\log q = 0\cdot02626$

Ephemeris 12h. (Berlin M.T.)

1905		α	δ	log Δ	Brightness
		h. m. s.	° ′		
Dec. 2	...	23 30 49	... + 1 11·8	... 9·7150	... 0·20
6	...	23 30 49	... − 4 46·6	... 9·8163	... 0·12
10	...	23 31 28	... − 8 36·1	... 9·9002	... 0·08

Brightness at time of discovery = 1·0.

An observation made at Bamberg on November 21 gave corrections of −32s. in R.A. and +4′·1 in declination to the above ephemeris.

AN UNTRIED METHOD OF DETERMINING THE REFRACTION CONSTANT.—In No. 8, vol. xiii., of *Popular Astronomy*, Mr. Geo. A. Hill, of Washington, describes a new and, as he believes, an untried method for determining the constant of refraction.

Briefly, the method consists in observing the times at which two stars, separated by about twelve hours in right ascension, and both of nearly the same declination, transit across a horizontal wire *in the prime vertical*. In each case the refraction decreases the hour angle, and the arithmetical sum of the hour angles of the two stars will differ from the difference between their right ascensions by twice the refraction, expressed in time, at the zenith distance at which they were observed.

To make this observation Mr. Hill proposes the employment of an instrument similar in form and in the rigidity of its parts to the modern zenith telescope. The telescope is to be established in the prime vertical, and mounted so that it is capable of rotation about a rigid vertical axis. Two stops fixed to the base of the instrument would ensure that when the telescope was rotated in azimuth about the vertical axis its line of collimation would still be in the prime vertical. Obviously the ideal position for the making of the observations would be at or near to the earth's equator. Many other details of the proposed plan of observations are given at length in Mr. Hill's paper.

SPECTRA OF BRIGHT SOUTHERN STARS.—An appendix to vol. xxviii. of the Annals—the volume in which appeared the "Catalogue of the Spectra of Bright Southern Stars"—has just been published by the Harvard College Observatory. It contains two tables, in the first of which there are given the particulars of sixty-nine stars which were accidentally omitted from Table I. in the original volume, and in the second the corrected classification of the spectra of thirty stars which were previously wrongly described.

A CATALOGUE OF 4280 STARS.—No. 15 of the *Publications of the Cincinnati Observatory* is devoted to a catalogue of the positions and precessional constants of 4280 of the stars given in Piazzi's catalogue.

All the stars given by Piazzi that were north of the equator in 1800, except those included in the Berlin "Jahrbuch" and eighteen of the Pleiades group, are included in the catalogue, and the Piazzi number, the position for 1900, the precession, the proper name, and the magnitude are given for each. An appendix contains the proper motions of 35 stars which were placed on the observing list, mostly taken from the Cambridge A.G. Catalogue.

HIGHER EDUCATION AT THE CAPE.

HIGHER education in Cape Colony is at the present time in a very interesting and perhaps critical condition. It is indeed characteristic of the tardiness of progress in that colony (the eternal motto is "Wacht een beetje") that the crisis should not have arrived until nearly eighty years after the foundation of the first institution designed to promote advanced studies—the South African College in Cape Town. The causes of this retardation are to be found partly in dissipation of effort, partly in the mischievous influence of an iron system of external examinations. The South African College was started on a small scale in 1829 through the liberality of a number of citizens of Cape Town, who became "shareholders" in the venture; but though after a few years it was recognised as a public institution and received support from the public treasury, it did not at first develop with much rapidity; and in 1849 Bishop Gray, after an unsuccessful attempt to buy out the majority of the "shareholders," founded the Diocesan College as a rival institution in the suburbs, thus inaugurating the unhappy policy of multiplying colleges from which the colony still suffers. Four years later Sir George Grey's administration instituted a public board of examiners with power to grant certificates in various subjects, another fateful step, for from that board there sprang in 1873 the University of the Cape of Good Hope, the only body in South Africa which has the right to confer degrees. The character of this so-called university deserves notice. It was modelled on the old University of London, the example of which it follows only too faithfully. It is managed by a council, half the members of which are appointed by Government, the other half elected by the convocation of graduates. It exercises the two functions of examining and granting degrees, but it does not teach. So abhorrent to it, indeed, is any connection with teaching that it does not allow teachers of candidates to take part in the examinations, a most deleterious prohibition, since in many subjects the only experts belong to the staffs of the colleges. Dissatisfaction with this examining university is the chief cause of the present crisis. Meantime the multiplication of colleges and the wasteful reiteration of similar work in a number of centres has gone on apace. Some of the smaller colleges have, it is true, died out; but there still remain, in addition to the two already mentioned, the Victoria College at Stellenbosch, which was incorporated in 1881, the Huguenot College for Women at Wellington (1898), and the Rhodes University College, which in 1904 took the place of St. Andrew's College at Grahamstown. The western province, therefore, has four colleges, all within forty miles of Cape Town, and the eastern province has one. They are bound hand and foot by the syllabuses and regulations of the university, for the examinations of which they prepare. Alike in strength and in character, however, they vary greatly. The South African College has in recent years developed with wonderful rapidity. It now supports seventeen chairs and has about 260 students, whom it draws in approximately equal numbers from the British and from the Dutch, and in thus bringing the two races together exercises a most beneficent influence, which it rightly regards as one of its chief claims to support. Its arts buildings are old and need reconstruction, but blocks of science buildings have lately been erected which would do credit to any unversity in the Empire, and the intention is to house the arts also on a similar scale. The only other college approaching it in strength is that of Stellenbosch, which has also developed recently, though it remains somewhat smaller and is less well equipped for the teaching of science. That the two strongest colleges should be in such close proximity is a particularly unfortunate result of the short-sighted policy (or lack of policy) which has been characteristic of the educational administration of the colony in the past. On purely educational grounds this duplication cannot be justified. But it is to be feared that racial rather than properly educational motives have led to the development of a second large college so near to Cape Town, and this may be said without any reflection upon the instruction given at it. For the Victoria College is almost completely under the influence of the neighbouring theological seminary of the Dutch Reformed Church; its students are almost entirely Dutch; it is in sentiment and in popular estimation the Dutch College. Even were the instruction provided the best in the world, it would be still altogether deplorable that this tendency to racial separatism in education should have gained recognition and support. Of the remaining colleges, that at Grahamstown has a fairly large staff, but as yet few students and no buildings, and in view of the backward state of education in the east its position seems a little precarious, but if it can encourage the schools in that part to improve it should prosper. The Diocesan College and the Huguenot College are both small, and probably they will in the end have to unite with their more powerful neighbours.

The education provided by the colleges is not so good as it might be under more favourable conditions. One at least of them, the South African College, is in every way competent to give as advanced instruction as most colonial universities, and equally with them to promote research; but it is hampered at once by the schools below it and by the university above it. In mathematics, indeed, the general standard of the schools is remarkably high; a few schools maintain a fair standard in science as well, but in literary subjects they are all miserably weak. This is partly due to the absence of any proper system of secondary or of intermediate education. The Education Department is frequently accused of an undue affection for red tape, with which it is said to strangle the more advanced and ambitious schools in the interests of weaker country schools, that have to be kept up to the mark by strict regulations. However that may be, there is no advanced secondary education in the colony. The schools do not

carry their classes beyond the matriculation examination of the university, which thus serves as a general leaving examination, and when their pupils have passed it there is nothing for them to do, if they wish to prosecute their studies further, but to go on to college, however young and crude they may be. So long as the present university system endures it is difficult to foresee any remedy for this. The university does not demand of its candidates for the higher examinations that they should have been trained at a college, and were the schools to develop advanced classes they would merely compete with the colleges in teaching for the intermediate degree examination, the standard of which would be still further lowered. What is wanted is a system of secondary schools entirely independent of any university, the pupils of which would not be sent on to college until they had reached a decent maturity. As things are, the whole educational system of the colony is absolutely subject to the tyranny of external examinations, and for this the university is chiefly responsible.

So unsatisfactory a state of affairs cannot endure much longer. The only radical cure for it is one which Mr. Rhodes attempted to bring about years ago, the institution of a single teaching university in Cape Town. (The eastern province is not yet sufficiently developed to support a separate university, but in view of its great distance from Cape Town the college at Grahamstown might perhaps remain as an affiliated institution until it is strong enough to stand alone.) Such a teaching university Mr. Rhodes would have endowed, and even though, through local jealousies, the chance of his munificence has been lost, his plan remains the wisest and even the most economical. The Government is remarkably liberal in the cause of higher education. It pays, usually up to a limit of 200*l.* a year, half the salary of all professorships or lectureships the institution of which it approves; it pays half the expenses of general maintenance, and issues loans in aid of building schemes on very favourable terms. In the case of colleges which confine themselves to work above the standard of matriculation and have not less than seventy-five matriculated students—*i.e.* at present in the case of the South African and Victoria colleges—the grants in aid of salaries may be increased up to a limit of 350*l.* The public expenditure on behalf of higher education is thus very considerable, but it is dissipated among several centres, and the benefits accruing from it are necessarily less than they would be were it directed to the support of a single teaching university.

Unfortunately, this ideal is even more unlikely of achievement now than it was in Mr. Rhodes's lifetime. Public opinion remains inert, but the colleges have grown, and it would be almost impossible, and probably undesirable, to force them into reluctant amalgamation. Yet something must be done. The country colleges would prefer probably the conversion of the present university into a federal system of constituent colleges, a policy which has, of course, been tried elsewhere, but without much success. In Cape Town, on the other hand, the feeling is growing that, even though other centres may stand aloof, the city itself should do its best to realise Mr. Rhodes's purpose by founding a teaching university. In the South African College it has the means of doing so, and when that institution has completed its present scheme of development its just claim to independence could not be refused. Nothing could be more beneficial to the colony than such a university in Cape Town with well staffed and well equipped professional schools attached to it. Not only would it raise the general standard of education, as no merely examining body can, but it would draw together and train together the best intellects among the youth of the country, and would thus prove an invaluable factor in the work of uniting the races. No doubt it is a costly scheme, and since the Government cannot concentrate its support of higher education, but will have to continue to assist some at any rate of the local colleges, a great part of the burden must fall on private benefactors. But at the Cape itself to arouse enthusiasm for a great ideal should not be difficult, and it may even be hoped that among the men of millions "who live at home at ease," and who are at last beginning to appreciate the dessert of universities, some may be found willing to assist a scheme which is not the less deserving because it is South African.

THE BATOKA GORGE OF THE ZAMBESI.[1]

WHEN I undertook to examine the geological structure of the country around the Victoria Falls on behalf of the council of the British Association, it appeared to me that there were two essential matters on which our information was very inadequate. The first was with respect to the origin of the falls themselves and the singular gorge associated with them, and the second as to the course of the great river for 70 or 80 miles below the falls. The opinion of David Livingstone, stated fifty years ago, that the gorge must have been formed by the sudden opening of a zigzag crack in the earth's crust, had been adopted without question by all subsequent travellers, although hardly anything was known of the cañon beyond the immediate vicinity of the falls.

Before I left England last June, however, a timely store of new information was forthcoming that materially lightened my task. In an able article on "The Physical History of the Victoria Falls" (*Geograph. Journ.*, January), Mr. A. J. C. Molyneux, of Bulawayo, produced strong evidence to prove that the majestic waterfall and its concomitants have been slowly developed by the erosive power of the Zambesi itself. With regard to the course of the river below the falls, unpublished information was most courteously placed at my disposal by the authorities of the British South Africa Co., which showed that a distinguished officer of the company, Mr. F. W. Sykes, the District Commissioner at Livingstone, had succeeded three years ago in penetrating the hitherto unknown country bordering its northern bank for some 40 miles to the eastward of the falls. The report on this journey prepared by Mr. Sykes, and the beautiful photographs by which it was illustrated, were sufficient in themselves to explain the ruling features in the physiography of the district, and incidentally afforded further testimony in favour of Mr. Molyneux's conclusions.

During my own examination of the district in July and August last, I had the inestimable advantage of the personal guidance of Mr. Sykes in my traverse of the country on the northern side of the river from Victoria Falls to Wankie's Drift. In this traverse we were accompanied by Colonel Frank Rhodes,[2] and for part of the distance by Lieut. Burgin, in command of a detachment of native police. The journey entailed a devious and somewhat arduous march of about 120 miles across an almost trackless country, consisting mainly of rugged stony ground covered with low trees. Wankie's Drift appears to lie considerably to the eastward of the position assigned to it on existing maps, its distance in an east-south-easterly direction from Victoria Falls being probably not less than 75 miles as the crow flies.

Our route was roughly parallel to the course of the Zambesi, at first south-eastward for about 20 miles (in a direct line), then toward east-north-east for a further 35 miles, until we crossed the Ungwesi or Kalomo River, and finally east-south-eastward for nearly 40 miles, to the river-crossing at Wankie's. The deep impassable chasms into which all the tributary streams are precipitated as they approach the Zambesi, and the extremely rugged character of the much-dissected ground between them, forbade any passage along the brink of the main gorge except for short distances, and our general line of march was therefore taken beyond the heads of the side-chasms, often many miles from the Zambesi itself. At four places, however, before reaching the Ungwesi, we struck southward to the main river; and at three of these we managed by rough scrambling to descend into the bottom of the gorge. Finding in these places that the ancient lavas of the surrounding plateau—the "Batoka Basalts" of Molyneux—were still, as at the Falls, the only rocks exposed in the gorge, we decided, as time was pressing, to continue along

[1] Abstract of "Report on the Batoka Gorge of the Zambesi and the Country between Victoria Falls and the Confluence of the Deka River," brought before the Geological Section of the British Association at Johannesburg on August 29, by G. W. Lamplugh, F.R.S.

[2] The news, which reached me during the homeward voyage, of the untimely death of Colonel Rhodes at Cape Town on September 21 has overshadowed the otherwise delightful memory of this journey. To have known Colonel Rhodes, the most cheery of travelling companions, at all was inevitably to hold him in affectionate regard. His deep and cultured sympathy in all that pertained to the magnificent Falls, and his efforts to maintain their loveliness unimpaired, deserve the grateful remembrance of all interested in Rhodesia.

the main route until the termination of the basalts was reached. These rocks proved unexpectedly to be continuous to Wankie's, although the "Batoka Gorge" (as it is proposed to name this cañon of the Zambesi) itself ceases 6 or 8 miles above Wankie's, giving place to an open valley with a broad shallow river sprinkled with islets.

On ferrying in a native "dug-out" across the Zambesi at Wankie's we were met by Mr. H. F. Greer, of the British South Africa Co., who holds charge in the district south of the river. Here Mr. Sykes and Colonel Rhodes struck southward to reach the railway at Wankie Coal Mine, 35 miles distant, while Mr. Greer and myself took a westerly course parallel to the Zambesi for about 60 miles, still traversing a basalt-country. We turned aside twice in this westward journey in order to examine the Zambesi valley at places eastward of those reached from the north bank. One of these was at the confluence of the Matetsi with the Zambesi, which is a little below the termination of the narrow gorge; and the other place was about 15 miles farther west, where the structure of the cañon is not materially different from that which it presents in the place where it had been last entered from the northern side of the river.

Mr. Greer having very kindly undertaken to escort me to the headwaters of the Deka River, where previous information had led me to expect that the base of the Batoka Basalts would be found, we then took a south-westerly course to Matetsi Camp. Crossing the railway there, we continued our journey westward, southward, and south-eastward across the upper part of the basin of the Matetsi River, and after some days of hard trekking struck the higher reaches of the Deka, only to find that the interminable plateau-basalts over which the whole of our route had hitherto lain were still the underlying rocks, and that the surrounding country gave no indication of structural change. It had been our intention to return from Deka to the Falls by the old traders' route past Pandamatenka and Gasuma; but as the Bushmen reported that, owing to the exceptionally dry season, no water would be found in Gasuma Vley, this plan became impracticable, and we decided to follow a north-eastward route, parallel to the Deka River for about 60 miles, to the Wankie Coal Mine. Geologically, this proved to be the most interesting part of my journey, and I therefore spent four days at Wankie in further investigation, profiting greatly from the guidance and kind hospitality of the manager of the mine, Mr. J. M. Kearney.

The basalts are cut off abruptly along the lower portion of the Deka valley by a great fault striking approximately north-east, which brings in the sandstones and shales with which the Wankie coal-seams are associated. Some fragmentary plant-remains were collected from the Wankie Coal-measures, and among these Mr. A. C. Seward has recognised Vertebraria, which indicates that the deposits are of Permo-Carboniferous age, as indeed had been previously surmised. Returning by rail from Wankie Mine to Victoria Falls, I spent a few more days in examining the head of the gorge and its surroundings, and was then compelled to leave Rhodesia in order to join the Association at Johannesburg.

The 600 miles of actual trekking that was accomplished embraces a region of some 2000 square miles, of which all except about 80 square miles east of the Deka is underlain by the Batoka Basalts. The full extent of these ancient lava-fields is still unknown, but, judging from information that I obtained, it is likely to be not less than 7000 square miles. Their thickness is also unknown, but in the lower part of the Batoka Gorge, where the original surface of the basalts must have been very considerably lowered by denudation, the Zambesi has sunk for 800 feet further through these rocks without revealing their base. In their prevalent characters they are remarkably uniform, consisting generally of thick bands of close-grained dark-blue rock alternating with red, purple, or ashy-looking amygdaloidal bands which mark off the surfaces of successive lava-flows. These less massive bands frequently show a fragmental structure, and occasionally pass into fine and coarse agglomerates suggestive of volcanic tuffs or ashes; but I think that this structure may represent the brecciation of the solid crust of the lava-flow before its onward movement had ceased, and is not indicative of true ashes. In the whole course of the journey I did not find any trace of an eruptive centre or volcanic orifice, and the rarity of dykes was also remarkable. Neither did I find any interstratified sediments among the basalts in the country traversed, though there appear to be some interstratified red and green beds of shaly aspect in the railway cuttings of the Katuna valley west of the Deka, which I had no opportunity to examine. Like similar "plateau-basalts" in other parts of the world, this immense mass of lava has probably had its origin in "fissure-eruptions," by which a vast tract was flooded under rapidly recurrent flows of high fluidity.

We still lack definite information as to the geological age of the Batoka Basalts; by Mr. F. P. Mennell and Mr. A. J. C. Molyneux they are regarded as most probably Tertiary, while Dr. S. Passarge correlates them with the Loale Amygdaloid, which he considers to be of Secondary age, perhaps Jurassic; but the evidence for either view remains inconclusive.

The surface-deposits of sand, sandy limestone, cavernous quartzite and hematite which locally overlie the basalts in this part of the Zambesi basin, though of considerable interest, must be dismissed for the present with the remark that their mode of occurrence in this region is not favourable to Dr. Passarge's view that they represent a definite order of events. The red sand (equivalent to the "Kalahari Sand" of Passarge, and probably in part to the "Forest Sandstone" of Molyneux) may, indeed, denote a period of conditions different from those now existing; but the limestones and quartzites appear to me to be due to purely local circumstances that still prevail.

Let us now turn to regard briefly the physiography of the region;[1] in which respect that wonderful natural feature, the Victoria Falls, is, of course, the main pivot of interest.

Above the Falls, the Zambesi flows sedately in a broad mature valley with low sides, excavated in the upper portion of the Batoka Basalts. The gentle slopes of this valley are partly buried under ancient desert-sands—the "Kalahari Sand" of Passarge—and all the features point to a long continuance of relatively stable conditions during which the river has done very little erosive work. On the brink of the Falls its bed is still about 3000 feet above sea-level; but at this point, suddenly, with a majestic plunge, the Zambesi begins its impulsive descent from the central plateau, and thereafter tears its way forcefully across the mountainous margin of the continent, through a succession of gorges alternating with relatively placid reaches according to the variable endurance of the rock-masses that lie in its path. It is to this rejuvenation of the river at the present margin of the plateau, and its resultant influence upon certain structures of the basalts, that, as Mr. Molyneux has shown, we owe the magnificent Falls, and not to any catastrophic rending of the earth's crust.

The Batoka Basalts are traversed by a regular and persistent system of close-set joints striking approximately east and west, and are also occasionally fractured in the same direction by still bolder vertical planes, probably representing lines of fault, that are sometimes accompanied by veins of calcite and other minerals. At the surface of the plateau the basalts are much weathered, and this weathering sinks deepest along the joints and fractures, whereby these become the lines of readiest erosion.

The rivers of this country are characterised by the enormous difference that obtains between their volume in the dry and in the wet seasons, a difference which affects the great Zambesi proportionately almost as much as its tributaries. During the shrinkage of the streams, the greater portion of their broad rocky beds is laid bare, and the water is confined within narrow gullies along the joints and lines of readiest erosion, so that for more than half the year it is in these channels only that there is any wearing down of the stream-bed, while in flood-time it is still along these gullies that the water is deepest and most forceful, and that the chief portion of the detritus (astonishingly scanty in these African rivers) is swept. Thus, granting a sufficient gradient, these dry-season channels become deepened and enlarged until they are

[1] This portion of the report was illustrated by lantern slides showing the chief features of the Gorge.

capable of carrying the flood-waters also, and the course of the stream becomes fixed along them. We found striking illustrations of these conditions both in the Batoka Gorge and in the beds of the tributaries in many places. The sudden and acute bends that are so peculiarly characteristic of the Zambesi below the Falls are in this way readily explicable.

A broad ancient river-flat, with low sloping banks on both sides, excavated across the edges of the gently dipping lava-flows, is distinctly traceable for many miles below the Falls, until obscured by the breaking up of the plateau by the gradually lengthening development of the lateral chasms of the rejuvenated tributaries. This flat is comparable in breadth and general aspect to the valley of the Zambesi above the Falls; and the presence of a few rounded pebbles upon it above the brink of the gorge gives further evidence for the former flow of the river over its surface. It is continued southward as a shallow depression in the surface of the plateau for five or six miles from the Falls, and then curves eastward.

It may be mentioned here, as a matter deserving the attention of archæologists, that rudely chipped implements of chalcedony, agate, and jasper are very abundant in many places on this ancient river-platform, and also upon the low rocky hummocks bordering the Zambesi above the Falls. A few of these implements show signs of wear as if by river-action, and may therefore possibly be of considerable antiquity. We found them, here and there, in profusion during the first 20 miles of our eastward journey, but very rarely during the later stages of the trek. A collection of these implements was exhibited at a meeting of the Anthropological Section.

The erratic zigzags of the Batoka Gorge swing to and fro within this broad depression, but without escaping from it. Even within the gorge, the river, still possessing a high gradient, tends to confine itself within narrower limits as it scoops out the less resistant portions of its bed, leaving many abandoned channels, rock-terraces, and spur-like ridges to break the severity of its cañon walls.

Nowhere can these features be better studied than in the left bank of the Gorge, about 7 miles below the Falls, around the confluence of the Songwe, a little tributary which has itself carved out a narrow chasm about three-quarters of a mile long and more than 400 feet deep into the margin of the plateau. As well for its savage magnificence as for its scientific interest, this spot deserves to be visited; and one may be allowed to express the hope that the responsible authorities will undertake the comparatively light work of clearing a track from the Falls, to render it accessible to the tourist.

To one whose first impressions of the Zambesi had been gained from the mile-wide river above the Falls, it was astonishing to find the whole river, at its present low stage, confined at this place within a channel not more than 35 yards in width—bordered, it is true, by a rocky scar, about 150 yards wide, honeycombed with deep "pot-holes," which was evidently submerged during the floods. After seeing it one could understand how the idea has arisen—and still lingers—that part of the Zambesi is swallowed up at the Falls into an underground channel.

But even this is not the narrowest limit within which the great Zambesi can confine itself at low water; for on reaching the bottom of the gorge at the Tshimamba Cataracts, some 20 miles east of the Songwe, we found the whole river raging tumultuously through a water-channel which, at one place, was less than 25 yards in breadth (Fig. 1). This place is apparently the only part of the interior of the Batoka Gorge that was ever penetrated by the white man until Mr. F. W. Sykes's expedition of 1902. His predecessor here was David Livingstone, who in his second book of travels tells how he turned aside on his eastward journey at the rumour of another great waterfall, and was disappointed to find, not a second Victoria Falls, but only a bold cataract, in which the river drops about 20 feet. Nevertheless, the Tshimamba also, were it rendered more accessible, would be well worth visiting, if but to see the mighty river shrunk to this little measure; and one may expect, sooner or later, to find it included within the "grand tour of the Zambesi."

Although the surface of the basalt plateau falls steadily eastward, the Zambesi within its gorge sinks somewhat more rapidly in the same direction, so that while immediately below the Victoria Falls the river is barely 400 feet below the lip of the gorge, this is increased to about 500 feet at the Songwe, to about 600 feet at the Tshimamba, and to 800 feet at the place some 35 miles farther east which we reached from the south bank. Aneroid observations showed a difference of more than 900 feet between the level of the river at the foot of the Falls and Wankie's Drift, which represents the descent of the water in passing through the Batoka Gorge; and until this steep gradient is very much reduced the Zambesi must continue to deepen its channel along the easiest lines before there is time for it to straighten out the angularities of its course.

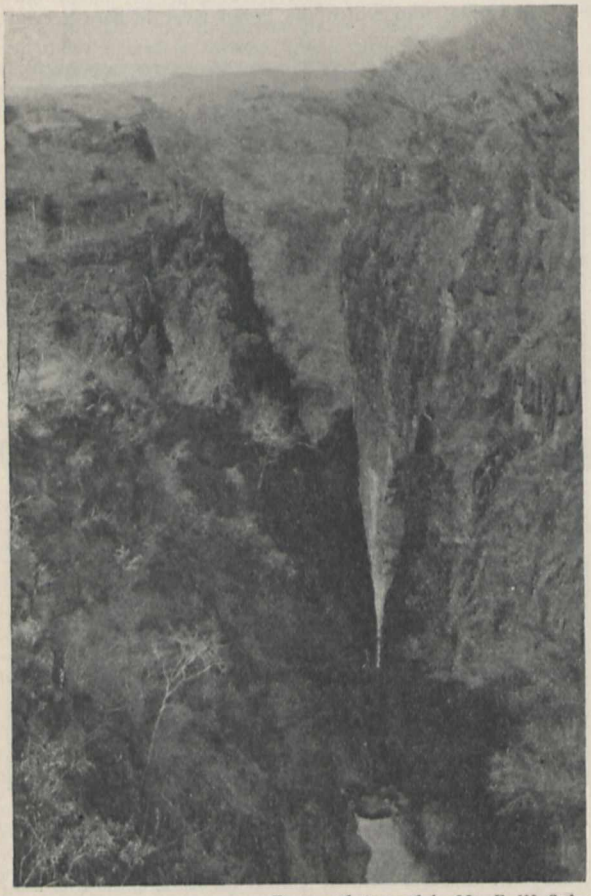
The results attained by this selective erosion are strikingly exemplified in the immediate surroundings of the Victoria Falls. The wonderful Chasm, in places only 80 yards wide, into which the broad river is here precipitated, owes its chief features to the presence of an east and west vein, probably a fault-plane, that cuts vertically through the basalts. This vein, which I found to be well exposed in the steep Recess or gully at the eastern end of the Chasm, is partly filled with calcite and other soft vein-stuff, and the rock adjacent to it is shattered and readily decomposed. When the falls, in receding northward, struck upon this vein, they readily hollowed out a transverse trench across the whole breadth of the river, from which the waters escape southward through a single narrow channel. But, having passed this easy place, it is becoming increasingly difficult for the shallow river to support a fall of its full width, and consequently the wearing back of the lip is at present progressing most rapidly in a comparatively narrow space at its western margin. Here the "Leaping Water" pours a strong flood perennially into the corner of the Chasm, and may eventually concentrate the whole of the river into its trough, unless, as Mr. Molyneux has suggested, the deep oblique cleft that is being rent across Cataract Island should gain precedence

From a photograph by Mr. F. W. Sykes.

FIG. 1.—The Gorge immediately below the Tshimamba Cataract. The depth of the cañon here is about 600 feet. The Zambesi, in the foreground, is confined in a channel from 20 to 25 yards wide. Note how the strong jointing of the basalt governs the course of the river and tends to produce zigzags in the low-water channel.

in the backward race. The narrowness of the cañon below the falls, as compared with the breadth of the river above them, shows that only by such concentration has the Zambesi been enabled to tear out its gorge so far back into the plateau.

Mr. Molyneux has rightly laid stress on the behaviour of the tributaries as proof of the erosive origin of the Batoka Gorge. Above the Falls the tributaries have so nearly reached their base-level relatively to the Zambesi that they hold deep back-waters where they join the main river, of which the Maramba, 2 miles from the Falls, presents a good example. But below the Falls they have at first been left in shallow open "hanging valleys," high above the main artery; and thus rejuvenated by a sheer drop of 350 feet or 400 feet, each little stream has begun to work vigorously backward into the



From a photograph by Mr. F. W. Sykes.

FIG. 2.—Kalonga's Cleft on the Karamba River. The walls are about 300 feet high.

plateau along its own line of drainage. Each waterfall tends to recede farther and farther within its own precipitous rift as we followed the Zambesi downward, so that while at first it was possible to round the heads of these by a detour of a few hundred yards, we found that farther east not only do they extend far back into the plateau, but many minor clefts branch out from them, rendering the country a maze of dangerous chasms. In these waterfalls and rifts the salient features of the main gorge are often reproduced in miniature. The most remarkable example that we visited occurs on the Karamba, a stream which joins the Zambesi about 35 miles east of the Falls. Some 5 miles above its junction with the Zambesi this stream drops by a waterfall from its open shallow valley into a gloomy recess, from which it escapes by swerving at a right angle between nearly vertical rock-walls, 300 feet in height, through a cleft only 15 feet to 20 feet in breadth (Fig. 2).

If further proof for the erosive origin of the Batoka Gorge be needed, I would direct attention to the gradual falling off in the angle of slope of its sides as we descend the river. At the Falls, where the gorge is freshly cut, its walls are practically vertical; but a few hundred yards below they are already beginning to show the effect of weathering by a slight recession of their crest-line and by indications of terracing along the planes of stratification. At the Songwe confluence, 7 miles farther down, this recession and terracing have become so pronounced that the average angle of slope from base to crest is reduced to 60° or less; at the Tshimamba, about 30 miles below the Falls, it is no more than 35°; and at the mouth of the Karamba, 12 miles farther east, the sides of the gorge have been weathered down into bushy slopes, broken here and there by inconspicuous bars of crag, with an average inclination of about 30°, which is also the character of the cañon at the place where it was visited still farther eastward.

If time had permitted, I should have liked to discuss the curious difference between the broad basin of the Matetsi and the narrow trough of the Zambesi within the basaltic plateau, which presents an important problem in the physiography of the region, especially when we remember that the Batoka Gorge terminates at a short distance above the confluence of the Matetsi; but this would open up too wide a subject for the present occasion.

In the face of all the evidence we must conclude—not without a tinge of regret—that the Batoka Gorge can no longer be allowed to stand apart, a unique curiosity, among the valleys of the earth—that no exceptional forces have been brought into action to produce its wonders and its loveliness—but that the everyday effects of river and rain, with time—that indispensable factor to the geologist—a very long time—are ample to explain all its marvels, as they have already explained the marvels of many another noble cañon of the world.

I must not let pass this opportunity of expressing my gratitude for the kindness shown to me by the officers of the British South Africa Company in Rhodesia and also in London, by the engineers of the Wankie Coal Mine and of the Rhodesia railways, and by many other friends in Rhodesia. To Mr. F. W. Sykes I am peculiarly indebted for removing difficulties that, except for his self-sacrificing cooperation, might have proved insuperable.

G. W. L.

INDIAN DEEP-SEA HOLOTHURIANS.[1]

THE most recent addition to the list of publications issued by the Indian Museum, Calcutta, deals with a collection of deep-sea Holothurians made by the survey ship *Investigator*, which has rendered valuable service in the interests of deep-sea research. The extreme utility of this work, which will help to elucidate many of the problems connected with deep-sea life, is enhanced by the fact that the investigations have been carried on over comparatively unknown ground, so far as the great depths are concerned.

The area examined by the *Investigator* is a comparatively wide one, and ranges over the northern part of the Indian Ocean from the Persian Gulf to the east side of the Bay of Bengal.

Most of the deep-sea expeditions appear to have confined their labours to the Atlantic and Pacific Oceans, and even the *Challenger* did not touch the northern part of the Indian Ocean. The *Siboga* Expedition reached the extreme south-eastern portion of the *Investigator* area, and a comparison of the *Siboga* Holothurians with those in the paper under notice provides an interesting study, and, incidentally, confirms the opinion that a knowledge of the distribution of deep-sea forms derived from an examination of isolated areas is apt to be misleading.

Of the seventy-five species and varieties described in the report, no less than sixty are new to science. The Synallactidæ appear to be the predominant forms amongst the deep-sea Holothurians of the Indo-Pacific region, both

1 "An Account of the Deep-sea Holothurioidea collected by the Royal Indian Marine Survey Ship *Investigator*." By R. Kœhler and C. Vaney. Pp. 123; 15 plates. (Indian Museum, Calcutta, 1905.)

with regard to species and individuals. In the *Investigator* collection twenty-nine species are placed in this family, and the Molpadiidæ and Synaptidæ are well represented. The authors have found it necessary to form ten new genera, and a seventh family—the Gephyrothuridæ—has been added to the Aspidochirotæ.

There was a large number of specimens of the genus Pelopatides and its allies in the collection, and the authors were given an opportunity of revising the genus. Five new genera were established to receive forms closely related to Pelopatides. Dendrothuria is peculiar in having dendrochirote tentacles and an enormously developed pharynx. Pseudothuria has no single distinctive characteristic, but all its characters taken together separate it from the neighbouring genera. The genus Allopatides has been formed from a single specimen, and its main difference from Pelopatides appears to be the richly dendritic form of the spicules. It may be doubted whether this difference is of generic value, especially as some species of Pelopatides also possess branched spicules not differing greatly from those in the new genus; the difference appears to be merely one of degree. The genera Perizona and Bathyzona have been formed mainly with regard to the position of the pedicels. Five other new genera are also described.

The new family—Gephyrothuridæ—is founded on two specimens which differ from all other Aspidochirotes in the possession of ambulacral appendages on the bivium only. In external appearance this form somewhat resembles the Molpadiidæ.

The collection includes some forms described by Walsh in 1891; the authors have deemed it necessary to remove all his species to other genera.

With every increase in our knowledge of the deep-sea fauna, it becomes more possible to formulate with some degree of completeness definite ideas as to the distribution and the mode of evolution of the deep-sea forms; and the work under notice is of importance in this respect, suggesting as it does many interesting points in zoological distribution.

Comparing the *Siboga* list of deep-sea Holothurians with that of the *Investigator*, it is surprising to find that in the two collections from adjacent areas there are only six species common to both. The two gatherings are almost entirely dissimilar with regard to the species present, but an examination of the genera shows a close similarity. It is perhaps noteworthy that those species common to both districts are not confined to the eastern portion of the *Investigator* area, as one might expect, but are scattered equally throughout it.

Of the fifteen species previously described, six are Atlantic and five Pacific forms; there are three species in the collection the distribution of which has hitherto been limited to the Atlantic.

The descriptions are clear and not too scanty, as is often the case, and the plates are good. Altogether the authors have made a most valuable contribution to the subject, and they appear to have done extremely well with material that was evidently not in the best state of preservation.

J. P.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following decrees were approved by Convocation last Tuesday:—The curators of the University Chest were authorised to pay a sum not exceeding 150*l.* to the professor of botany to enable him to provide for the teaching of forest botany, until the appointment of a Sibthorpian professor under the new statutes of St. John's College.

Mr. Henry Balfour, Fellow of Exeter College, was reappointed curator of the Pitt-Rivers museum for seven years at a stipend of 200*l.* a year, and the annual grant of 200*l.* to the museum was renewed for seven years.

An examination will be held next February for a Radcliffe Travelling Fellowship of the annual value of 200*l.*, and tenable for three years. Candidates must have qualified for the degrees of B.A. and M.B., and have been placed in the first class in a university examination, or have gained a university prize. Names should be sent to the Regius professor of medicine.

The following is a list of the probationers for the Indian Forest Department and the Sudan nominated in 1905, with the colleges to which they are now attached:—C. W. Armstrong, scholar of Jesus College, Oxford; G. C. Clarence, Magdalen College, Oxford; T. Clear, science exhibitioner of Balliol College, Oxford; C. G. E. Dawkins, Balliol College, Oxford; C. C. Gaunt, exhibitioner of St. John's College, Oxford; H. S. Gibson, Trinity College, Oxford; H. M. Glover, mathematical demy of Magdalen College, Oxford; J. Gunn, Edinburgh University, now at St. John's College, Oxford; J. K. Hepburn, Queen's College, Oxford; N. W. Jolly, Adelaide University, now at Balliol College, Oxford (Rhodes scholar); W. A. H. Miller, St. John's College, Oxford; A. J. W. Milroy, Christ Church, Oxford; A. A. F. Minchin, Exeter College, Oxford; R. L. Robinson, Adelaide University, now at Magdalen College, Oxford (Rhodes scholar); E. A. Smythies, Christ's College, Cambridge, and Balliol College, Oxford; and G. C. Wilson, Queen's College, Oxford.

The Government of Mysore has sent two forestry students, M. M. Machaya and B. V. Ramaiengar, both of St. John's College, Oxford, and of Madras University.

CAMBRIDGE.—The Forestry Syndicate has now issued its detailed report on the scheme for establishing a diploma of forestry. It is proposed that a committee of the Board of Agricultural Studies be appointed to be called the forestry committee, the duty of which shall be to manage the examinations in forestry and to direct the instruction and training of candidates for the diploma. Details as to the constitution and duties of the committee are printed in this week's *Reporter*.

The general board of studies has appointed Mr. J. G. Leathem, St. John's College, university lecturer in mathematics from Christmas, 1905, until Michaelmas, 1910, and has re-appointed Mr. C. T. R. Wilson, Sidney Sussex College, university lecturer in experimental physics from Christmas, 1905, until Michaelmas, 1910; both these appointments have been confirmed by the special board for physics and chemistry.

Mr. A. C. Seward, of Emmanuel College, has been appointed chairman of the examiners for the natural sciences tripos, 1906.

The late Mr. G. R. Crotch, of St. John's College, some years ago left his collections of insects and his books to the Museum of Zoology, and also after the death of certain relatives his personal estate to the same museum. His brother, Mr. W. D. D. Crotch, who recently died, has left his residuary estate, the value of which is about 8000*l.*, to the same museum.

SIR ALEXANDER R. BINNIE will distribute the prizes at the Merchant Venturers' Technical College, Bristol, on Thursday, December 21.

THE Public Schools Science Masters' Association will meet for the annual conference on January 20, 1906, at Westminster School. The president for the year, Sir Oliver Lodge, will speak on the place of science in general education. Papers will be read upon the army examination and on the possibility of introducing a comprehensive syllabus of science teaching within the time limits of a classical curriculum. After the conference there will be an exhibition of scientific apparatus by various makers in the new science buildings of Westminster School.

THE North of England Education Conference will be held at Newcastle-upon-Tyne on Friday and Saturday, January 5–6, 1906. Among the subjects to be discussed are the following:—The teaching of elementary mathematics, paper by Prof. R. A. Sampson, F.R.S.; openers of discussion, Dr. Jude and Mr. J. H. Kidson. Regulations for secondary and higher elementary schools, papers by Mr. W. Edwards and Mr. W. J. Abel; openers of discussion, Miss M. Moberly and Mr. P. M. Greenwood. Organisation of evening classes, papers by Principal J. H. Reynolds and Mr. J. Crowther; opener of discussion, Mr. A. M. Ellis. Physical Training, papers by Prof. T. Oliver and Captain H. Worsley-Gough; openers of discussion, Dr. Ethel Williams and Captain F. C. Garrett. All com-

munications with reference to the conference should be addressed to the hon. secretaries, Mr. Alfred Goddard and Mr. F. H. Pruen, Education Offices, Northumberland Road, Newcastle.

SEVERAL changes have taken place, we learn from *Science*, in the staff of the research laboratory of physical chemistry of the Massachusetts Institute of Technology. Prof. W. D. Coolidge has accepted a position in the technical research laboratory of the General Electric Company at Schenectady. To Prof. Coolidge has been due in large measure the development of one of the most important lines of work in progress in the research laboratory of the institute—the investigation of the conductivity of aqueous solutions at high temperatures. Mr. Yogoro Kato, who has also been engaged on the conductivity investigation for two years, has accepted a position in the Technical High School of Tokio, where he will have charge of the work in electrochemistry. Dr. Wilhelm Böttger will return as privatdocent to the University of Leipzig, at which he will conduct one of the laboratory courses in analytical chemistry. In place of these retiring members, Messrs. William C. Bray, Guy W. Eastman, Gilbert N. Lewis, and Edward W. Washburn have been appointed to the research staff.

AT the distribution of prizes to the students of the Mechanics' Institute, Crewe, on November 22, Sir Oliver Lodge delivered an address. He emphasised the importance of the study of pure science and the application of its broad principles, whereby it is possible to make discoveries and to ascertain facts which are not known to the human race. After all the ages of the human race there are innumerable facts which we do not know, and it is now and then given to a man here and there to find them out and pass them on as common property never more to be lost. Sir Oliver Lodge went on to say he does not believe that a thing which really exists can go out of existence. There is an infinitude before us, and it behoves us to realise that and see to it that we fit ourselves for what is to come. We are parts of an industrial organism, parts of a much larger organism, the universe, and in the universe there is one great law of evolution, of growth, and development. The universe is not yet perfect; it is our privilege to help in the process of making it more perfect. Things will not be done on this planet unless we help to do them; we are agents for helping in the process of evolution. Errors or mistakes may cause dislocation or calamity in the great scheme. We have the power of causing dislocation or calamity by errors, or by living strenuous self-sacrificing lives we have the power of cooperating in the great scheme of helping towards the fruition, development, growth, and progress of the universe of which we are an infinitesimal part.

THE inaugural address delivered by Dr. B. C. A. Windle, F.R.S., president of Queen's College, Cork, at the opening of the session, is given the first place in the current number of the *University Review*. Dr. Windle deals in an exhaustive manner with the subject of examinations in Ireland and with the university question. Four deadly errors, he maintains, have long affected England and Ireland. These errors are that acquisition of knowledge and education are synonymous terms; that education—as apart from mere knowledge—can be easily, nay, more, can only be tested by examination; that a degree is in itself an object of value; and that a degree means the same however and wherever it may have been acquired. Dr. Windle regards examinations as an evil, but at present a necessary evil, and proceeds to discuss the objects such examinations should have in view. By means of an examination, Dr. Windle explains, an endeavour is made to ascertain whether the candidate has acquired the necessary knowledge of facts to enable him to proceed to a further stage of learning or—at the end of his course—a sufficient knowledge of his profession to be trusted to go out into the world and practise it independently. An examination is intended, moreover, to ascertain whether a student has acquired the proper methods of gaining and applying knowledge. To secure efficient examinations, the article lays it down, every teacher should take a large share in any examination which his students may have to confront, but the judgment of the teacher should be supported or corrected by the assistance of an external examiner. The conclusion of the article is that there is at present in Ireland, for the great majority of its inhabitants, "a university system which almost necessitates a method of examination which is harmful in its effects on education; a method which leads to subterranean complaints and accusations, which, though they may be, and almost invariably are, false, are none the less injurious to education generally; a method for which, indeed, no excuse can be urged except the excuse that the system arises out of the necessities of a position which never ought to have been created."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, Received September 28.—"Researches on Explosives." Part iii. Supplementary Note. By Sir Andrew **Noble**, Bart., K.C.B., F.R.S.

Since communicating to the Royal Society "Researches on Explosives," part iii., the author has succeeded in obtaining the paper (*Preuss. Akad. Wiss. Berlin Sitz. Ber.*, vol. v. p. 175) by Messrs. Holborn and Austin on the "Specific Heat of Gases at High Temperatures."

The attention of these investigators has been specially directed to carbonic anhydride, and their researches show a considerable (but rapidly decreasing) increment in the specific heat of CO_2 with increase of temperature.

If we suppose the same law of increment which appears to rule up to 800° C. to remain unaltered up to 1300° C., the increments at that temperature would vanish, and, if this be so, the author finds that the specific heat of CO_2, at constant volume, should be taken at 0·2111.

He has therefore re-calculated the specific heats given in his recent paper, and as the specific heats of the exploded gases at constant volume are reduced, the temperatures of explosion given in his paper should also be reduced.

The temperatures the author gives have been obtained by two different methods, firstly, by dividing the heats determined by the calorimeter by the specific heats, and, secondly, by using the equation of dilatibility of gases, and determining the temperature from

$$t = p - p_0/0{\cdot}00367p_0 \qquad (1)$$

where p is the pressure in atmospheres obtained from the explosion, and p_0 the pressure in atmospheres when the volume of gases generated is reduced to 0° C. and 760 mm. bar. pressure.

The differences of the results are very remarkable.

Taking, for example, cordite as an illustration, it will be seen that for the four highest densities given the temperatures derived from the two methods are but slightly different. At the higher density (0·5) the temperatures are 5275° C. and 5263° C., the higher being that derived from equation (1); at density 0·45 the temperatures from the two methods are identical, at density 0·40 the temperatures are 4902° C. and 4970° C., the lower temperature being from equation (1), but after density 0·35 the temperatures derived from equation (1) fall very rapidly.

The same general results are observable in the other two explosives experimented with, and it should be noted that in all three explosives, at the highest densities, the temperatures given by equation (1) are greater than those obtained by the second method.

The figures for the three explosives are given below, the temperatures obtained from $\frac{\text{units of heat}}{\text{specific heats}}$[1] being given in italics.

Cordite.

D=0·50	D=0·45	D=0·40	D=0·35	D=0·30	D=0·25
5275°	5090°	4902°	4710°	4480°	4165°
5263	*5090*	*4970*	*4860*	*4800*	*4770*
	D=0·20	D=0·15	D=0·10	D=0·05	
	3838°	3490°	3140°	2775°	
	4760	*4760*	*4790*	*4800*	

M.D.

D=0·45	D=0·40	D=0·35	D=0·30	D=0 25	D=0·20
4713°	4494°	4200°	3920°	3585°	3240°
4624	*4411*	*4215*	*4070*	*3945*	*3870*
	D=0·15	D=0·10	D=0·05		
	2890°	2530°	2160°		
	3840	*3830*	*3860*		

[1] Water gaseous.

Nitrocellulose.

D=0·45	D=0·40	D=0·35	D=0·30	D=0·25	D=0·20
4305°	4007°	3630°	3320°	3060°	2835°
3954	*3890*	*3795*	*3670*	*3530*	*3425*

D=0·15	D=0·10	D=0·05
2680°	2520°	2400°
3345	*3295*	*3255*

If these figures be examined, it will be noted that in each explosive at the higher densities the temperatures obtained by the two methods are nearly identical, those determined from equation (1) being the higher, but as the density of charge is decreased the difference at the very low densities is remarkable; some of this difference is doubtless attributable to the slow burning under feeble pressures, and to the rapid cooling, by communication of heat to the walls of the explosive vessel during the ignition of the charge, but it is impossible to ascribe the whole difference to this cause, and the author can only suggest that the explanation is to be sought in the probable dissociation of the carbonic anhydride and aqueous vapour at low pressures, this dissociation being prevented wholly or partially by the very high pressures at the higher densities.

Various substances such as carbon, metallic platinum, tantalum, osmium, and titanium have been placed in the charge, and all have been more or less fused and volatilised during the small fraction of a second to which they were exposed to the maximum heat.

A great part of the titanium was recovered in a fused crystalline condition.

Osmium and thin platinum foil were volatilised, and thick sheet platinum was recovered in the form of a button.

Received October 6.—"On the Isolation of the Infecting Organism ('Zoochlorella') of *Convoluta roscoffensis*." By F. **Keeble** and Dr. F. W. **Gamble**. Communicated by Prof. S. J. Hickson, F.R.S.

The authors have obtained experimental proof that the green cells (Zoochlorellæ) which occur in the superficial tissues of the turbellarian *Convoluta roscoffensis* arise in the body as the result of an infection.

Like those of previous investigators (Haberlandt), the authors' attempts to cultivate the green cells isolated from the animal have failed. Indeed, the evidence points to the conclusion that the green cells, once having entered into the body of the animal, lose all power of separate existence. Therefore, in order to solve the problem of the nature of the green cells, the authors were compelled to attack it at the other end, viz. to attempt to discover the organism *before* its entrance into the body.

From their observations on the normal course of appearance of the green cells in the bodies of just-hatched Convoluta, the authors were led to expect that the precursors of the green cells would be discovered on or in the capsules in which the eggs of Convoluta are laid. This proved to be the case. By the isolation of such capsules green colonies of a motile organism were obtained, and the organism was proved to have the power of infecting young, colourless Convolutas, hatched under sterile conditions, and of giving rise in these animals to green cells identical with those which occur in the normal adult.

The infecting organism is in its active state a unicellular four-ciliate alga. It has a single basin-shaped chloroplast occupying the greater part of the cell, an eccentrically placed plate-like eye spot, and a large octagonal pyrenoid at the posterior end of the body. The motile cells frequently come to rest and surround themselves with a thick striated wall. They may also in this resting stage undergo vegetative division, giving rise to a "palmella" condition.

These characters point to the membership of the infecting organism with the Chlamydomonadineæ.

Faraday Society, October 31.—Lord Kelvin, president, in the chair.—Alternate current electrolysis: Prof. E. **Wilson**. Experiments (*Roy. Soc. Proc.*, vol. liv. p. 407) made with platinum plates in dilute sulphuric acid show that of the total energy supplied to the cell in a given time, more is returned to the source when the frequency is high than when it is low, the maximum coulombs being of the order 0·0006 per sq. cm. in each case. If the quantity of electricity be plotted coordinately with the E.M.F. of electrolysis it is found that at the higher frequency, for about the same maximum coulombs, the curve has relatively a smaller area, such reduction being probably brought about by the greater reversibility. An experiment made at an intermediate frequency when the maximum coulombs were 0·0000023 per sq. cm. gave a still higher value for the proportion of the total energy which is returned to the source, demonstrating that the magnitude of the maximum coulombs has an important effect. When a metal is dissolved in an electrolyte by alternate-current electrolysis, the amount dissolved in a given time at a given current density is smaller at high than at low frequency. Besides this chief conclusion there are indications of other important effects. A complete investigation would need to take accounts of the density and temperature of the electrolyte, and possibly of other conditions.—Alternate current electrolysis as shown by oscillograph records: W. R. **Cooper**. Although polarisation is of the nature of capacity in an alternate current circuit, there is a considerable difference. What might be termed the E.M.F. of a condenser rises and falls as rapidly as the applied pressure, but although the E.M.F. of polarisation may rise as rapidly as the applied pressure, it falls more slowly, with the result that under suitable conditions the current curve may depart very considerably from the sine form. Actual oscillograph records are reproduced in support of this view. In considering the subject it has been very generally assumed that the current follows a sine curve. Since the curve obtained depends very much on the conditions of the experiment, it is necessary to define the conditions very carefully before conclusions can be drawn from different experiments. Oscillograph records of electrolytic rectification were also shown.—Note on the crystalline structure of electro-deposited copper: Prof. A. K. **Huntington**. In Mr. Cowper-Coles's process for making copper wire electrolytically a spiral scratch or groove on the mandril causes the copper deposited on it to part so easily that a long ribbon can be obtained. The author's explanation is that the direction of the lines of crystallisation of an electro-deposited metal is the same as in a casting made on surfaces having the same inclination, *i.e.* the crystals form at right angles to the surface on which the deposit or the casting is made.—Some observations respecting the relation of stability to electrochemical efficiency in hypochlorite production: W. P. **Digby**. The author commenced by directing attention to the fact that in all electrolytic methods of producing hypochlorite solutions, only a small portion, rarely more than 18 per cent., of the chlorine usually present in the form of chloride is converted into hypochlorite; and he suggested that the amount of available chlorine produced from a sodium chloride solution depends upon the relation which the amount of unconverted sodium chloride actually present between the electrodes bears to the current density.

Entomological Society, November 1.—Mr. F. Merrifield, president, in the chair.—*Exhibitions.*—(1) *Panurgus morricei*, Friese, a species of bee new to science taken near Gibraltar, of which it was remarkable that, whereas the species of this genus are wholly black, in this species the ♂ face entirely, and the ♀ partly, was bright yellow, the legs partly yellow, and the abdomen spotted down each side, somewhat as in Anthidium; and (2) the unique type specimen of *Eriades fasciatus*, Friese, a ♂ of the Chelostoma group taken at Jericho in 1899, in which again, while all its congeners are practically unicolorous, the abdomen is brightly banded like a wasp: Rev. F. D. **Morice**. A discussion followed as to the reason of the peculiar coloration in the species under review, the exhibitor pointing out that the colour mimicry in this species could not be due to parasitism, both Panurgus and Eriades being industrious genera.—A ♂ specimen of the earwig *Forficula auricularia* taken at Warwick in September last, with a drawing of the cerci (forceps), which were very abnormal, the broader basal part of the two appearing to be more or less fused together, while the legs of the forceps also were jointed to the basal part: W. J. **Lucas**.—Various interesting insects from Guatemala recently received from Señor Rodriguez, including *Heterosternus rodriguezi*, Cand., *Pantodinus klugi*, Burm., *Plusiotis adelaida*, Hope, and a species of Orthopteron greatly resembling a dead withered leaf, possibly a new species of Mimetica: G. C. **Champion**.—Two species of Coleoptera new to the British

Islands, *Loemophilus monilis*, F., taken in the neighbourhood of Streatley, Berks, and *Dacne fowleri*, n.sp., from Bradfield, with specimens of *D. humeralis* and *D. rufifrons* for comparison: Norman H. **Joy.**—A specimen of a new Agathidium discovered last year in Cumberland, and now taken by the exhibitor in Durham, and a series of *Prionocyphon serricornis* from the New Forest with a drawing of the larva, which he had found under water in the boles of trees, but appeared to emerge for pupation and descend into the ground: H. St. J. **Donisthorpe.**—Preparations of the scents of some African butterflies collected with the assistance of Dr. G. B. Longstaff during the recent visit of the British Association, together with examples of the species investigated: Dr. F. A. **Dixey.**—*Papers.*—A contribution towards the knowledge of African Rhopalocera: P. I. **Lathy.**—A new species of the hymenopterous genus Megalyra, Westwood: J. Chester **Bradley,** Ithaca, N.Y., U.S.A.

Linnean Society, November 2.—Prof. W. A. Herdman, F.R.S., president, in the chair.—Exhibition of the tails of trout and grayling to show the heterocercal origin of the homocercal tail, by means of the hypural bones which balance the vertebra turning upward towards the upper lobe: Rev. G. **Henslow.**—Plant œcology, interpreted by direct response to the conditions of life: Rev. G. **Henslow.** Plant geography and plant surveying—that is, phytotopography—comprise records of the fluctuating distribution of species within definite areas, and associations, the result of natural selection. Œcology proper, or the physiology of plant geography, imply what has been defined by Prof. Tansley as "the study of the vital relations of organisms to their environment." These include the origin of adaptive structures, as varietal, specific, and generic characters, by means of the protoplasmic response to what was formulated by Darwin as "the direct action of the conditions of life, leading to definite results, whereby new subvarieties arise without the aid of natural selection."

Royal Microscopical Society, November 15.—Mr. G. C. Karop, vice-president, in the chair.—Lucernal and solar microscopes by Adams presented to the society: W. E. **Baxter.**—Focusing magnifier made by Messrs. Taylor, Taylor and Hobson: Dr. **Hebb.** The magnifier was a small photographic auxiliary intended for focusing purposes, being placed against the ground-glass screen of the camera to magnify the image and examine its definition.—A new turntable invention: A. **Flatters** and W. **Bradley.** The turntable was driven by clockwork, and was designed for turning oval cells and ringing oval mounts of any proportions from 0″ to 3″×1¼″. By the use of the instrument it was also possible to run a ring round a needle point, strike a straight line, or turn circles.—Exhibition of dissections of the tsetse-fly and its trypanosomes: W. **Baker.** Mr. Baker said that, in addition to the slides illustrating the anatomy of the tsetse-fly, there was a specimen of the larva of Ochromyia, also from Africa, together with the perfect insect. The larva lives in the sandy earth, and attaches itself to the flesh and sucks the blood of the natives, causing very troublesome wounds. There was likewise a specimen of the ova of *Schistosoma sinensis* found in the body of a Chinaman who died at Singapore.

Chemical Society, November 16.—Prof. R. Meldola, F.R.S., president, in the chair.—Condensation of ketones with mercury cyanide: J. E. **Marsh** and R. De Jersey **Fleming-Struthers.** Acetone added to a solution of mercury cyanide in aqueous caustic soda gives a white precipitate, $Hg_3C_5H_2ON_2$, which dissolves on further addition of acetone. The reaction forms a good test for acetone applicable in presence of alcohol. The reaction appears to be confined to ketones containing the group $.CO.CH_3$.—Silicon researches, part ix., bromination of silicophenylimide and -amide, and formation of a compound including the group (SiN): J. E. **Reynolds.** Silicotetraphenylamide interacts quite regularly with about six atomic proportions of bromine in benzene. In the first stage bromine removes one of the aniline residues, and there remains a substituted guanidine in solution. This is then attacked with the formation of a soluble di-substituted di-imide. The substituted di-imide finally reacts with one molecular proportion of bromine, giving the compound $SiN.C_6H_3Br_2$.—Application of the microscopic method of molecular weight determination to solvents of high boiling point: G. **Barger** and A. J. **Ewins.** The apparatus used with low boiling solvents is modified by the addition of a "hot stage," whereby the tubes can be maintained at about 90° C.—Green compounds of cobalt produced by oxidising agents: R. G. **Durrant.** The conclusions arrived at are that these substances most probably all contain the nucleus $=Co.O.Co=$, on the persistence of which depends the green colour.—Dunstan, Jowett and Goulding's paper on "the rusting of iron": E. **Divers.** The author rejects the "hydrogen peroxide" theory of rusting advanced by Dunstan and his collaborators, and suggests instead that the active agents are the oxygen and the hydroxyl ions present in the water, the action being represented thus, $(O_2+2H.HO)+4Fe+2O_2=4HO.Fe:O$. In reply, Prof. Dunstan pointed out that the view expressed by Dr. Divers is not intelligible unless it amounts to what is virtually the hydrogen peroxide theory, which accounts for the inhibiting effect of potassium dichromate, as well as of alkalis, on the formation of iron rust in presence of water and oxygen.—Researches on the freezing points of binary mixtures of organic substances; the behaviour of the dihydric phenols towards *p*-toluidine, α-naphthylamine, and picric acid: J. C. **Philip** and S. H. **Smith.** The freezing-point curves indicate the existence of several new compounds of the above substances. These are shortly described.—Synthesis of tertiary menthol and of inactive menthene: W. H. **Perkin,** jun.—The synthetical formation of bridged rings, part ii., some derivatives of di*cyclo*butane: W. H. **Perkin,** jun., and J. L. **Simonsen.**—Optically active reduced naphthoic acids, part i., dextro-Δ^2(or 3)-dihydro-1-naphthoic acid: R. H. **Pickard** and A. **Neville.**—Hydrizino-halides derived from oxalic acid: D. A. **Bowack** and A. **Lapworth.**—The action of nitrogen sulphide on organic substances, part iii.: O. C. M. **Davis.** The investigation of the action of nitrogen sulphide on the aldehydes has been continued, and it has been found that the reaction is not so general as was expected.—The action of nitrogen sulphide on organic substances, part iv.: F. E. **Francis.** Nitrogen sulphide acts on acetic and propionic acids at their boiling points with the liberation of sulphur dioxide and smaller quantities of nitrogen, and the formation of the corresponding amides and di-amides.—Tetrazoline, part iii.: S. **Ruhemann** and R. W. **Merriman.**

CAMBRIDGE.

Philosophical Society, October 30.—Prof. Marshall Ward, president, in the chair.—On a well-sinking at Graveley, near Huntingdon: Rev. O. **Fisher.** Graveley is in an extreme western corner of Cambridgeshire. The well is 154 feet above O.D. It was begun in the spring of 1905 in Boulder-clay, which proved to be 50 feet thick. The Oxford-clay was then encountered and pierced through 252 feet. A bed of Oolitic Limestone was next met with, and punched through a foot and a half. Another foot of clay brought the auger to a second bed of rock, and no supply of water having been obtained, the work was abandoned.—On a portable gold-leaf electrometer for low or high potentials, and its application to measurements in atmospheric electricity: C. T. R. **Wilson.** The electrometer has an outer and an inner case; the latter is maintained by means of a quartz Leyden jar at a positive potential which gives a convenient deflection when the gold leaf is earthed; about 60 volts is generally convenient. If the potential of the inner case is called V, then the instrument is suitable for measuring potentials, positive or negative, in the neighbourhood of zero, and also positive potentials differing by not more than a few volts from 2V. The displacement of the leaf for a change of potential of 1 volt is the same in either case. For convenience in charging the gold leaf to any desired potential, and for other purposes, there is attached to the instrument a small cylindrical condenser of variable capacity, consisting of a sliding tube kept at a constant negative potential by means of a quartz Leyden jar and a rod concentric with the tube fixed to the terminal of the gold leaf. The instrument may be applied to the study of the atmospheric potential gradient at the earth's surface and the earth-air current.

—Contributions to the knowledge of the tetrazoline group: S. **Ruhemann** and R. W. **Merriman.** The authors have continued the study of tetrazoline (see *Trans. Chem. Soc.*, 1902, lxxxi., 261) especially with the view of determining the constitution of the two compounds (previously described) which are formed by the action of methyl iodide on tetrazoline. They show that the one substance, $C_3H_7N_4I_3$, is the additive compound of the other, $C_3H_7N_4I$, and point out the resemblance between the former compound and the additive product of diazobenzene chloride with iodine.—The action of radium and other salts on gelatin: W. A. D. **Rudge.** The author has made experiments with various metallic salts, and finds that those of barium, lead, and strontium produce effects upon sterilised gelatin exactly similar to that caused by radium preparations, and comes to the conclusion that the "growth" observed is not of vital origin, and that the effect obtained by the radium salt is probably due to the large proportion of barium which it usually contains.—A suggestion as to the nature of the "walnut" comb in fowls: W. **Bateson** and R. C. **Punnett.**—The absence of isomerism in substituted ammonium compounds: H. O. **Jones.**

EDINBURGH.

Royal Society, November 6.—Prof. Crum Brown, vice-president, in the chair.—The conductivity of concentrated aqueous solutions of electrolytes, part i.: Prof. J. **Gibson.** When the ratio of the specific conductivity to the concentration measured in grams equivalent per cubic centimetre was plotted against the concentration, curves were obtained concave upwards. When, however, the concentration was measured in grams equivalent per gram, the corresponding graphs became in many cases accurate straight lines, and in most others straight lines over a considerable range of concentration. The point of maximum conductivity, when determinable, lay within this straight line portion. There were a few exceptions to the rules just stated. For example, the graph for zinc chloride was nowhere straight, but was concave upward.—The Tarpan and its relationship with wild and domestic horses: Prof. **Ewart.** The paper was a contribution to the important and difficult question of the ancestry of our domestic breeds of horses. The Tarpan, first described by Gmelin about 1740, had usually been considered as the wild ancestor of the horses of Europe; Dr. Nehring regarded it as the last survivor of the prehistoric European horse, modified by infusion of domestic blood, while Pallas and others thought it might very well be the offspring of escaped domestic horses. After a comparison of the characteristics as to hair, tail, mane, and skeleton of Tarpan and other breeds, Prof. Ewart proceeded to describe the result of his recent experiments on cross-breeding. Bearing in mind the fact established by previous experiments, that the crossing of carefully selected forms sometimes reproduced remote types in all their original purity, he selected a Shetland pony mare which seemed to be a blend of at least three varieties, resembling the wild horse of the Gobi Desert in the head, the forest variety in the mane, tail, and trunk, and the Celtic pony in the limbs and hoofs. This mare was crossed with a black Welsh pony. The first foal failed to throw any light on the question, but the second foal had developed into an animal, now three years old, which was as typical a Tarpan as ever roamed the Russian steppes. The general conclusion was that the Tarpan, once so common in the east of Europe, could not be considered as a true wild species, but was very probably derived from at least three sources:—(1) from a variety of Celtic pony; (2) from a variety resembling the forest horse (*Equus caballus typicus*); (3) from a variety identical with, or closely related to, the wild horse of Central Asia (*E. caballus prjevalskii*).—The horse in Norway: Dr. F. H. A. **Marshall.** The horses in Norway belonged to two distinct types, represented by the pure fjord horse and the Gudbrandsdal horse. The former was probably by origin identical with Prof. Ewart's "Celtic pony," while the latter belonged to the forest or cart-horse type. The fjord horse was now, as formerly, typically light dun in colour. The Gudbrandsdal was formerly of almost the same colour, but it was now generally dark brown or black, owing to an infusion of Danish and other foreign blood. The two types of Icelandic horses were derived respectively from the ancestors of the fjord horse and of the Gudbrandsdal horse.—Elimination in the case of equality of fractions whose numerators and denominators are linear functions of the variables: Dr. Thomas **Muir.** The investigation led with great ease to an interesting identity between a determinant of the $(n+1)$th order the constituents of which were determinants of the nth order and one of the nth order the constituents of which were of the $(n+1)$th order, an identity which would be difficult to establish directly.

PARIS.

Academy of Sciences, November 20.—M. Troost in the chair.—Researches on the insoluble alkaline compounds contained in living plant tissues: M. **Berthelot.**—On the Thalassinidæ collected by the *Blake* in the Gulf of Mexico: E. L. **Bouvier.** This group of crustaceans occupies an important place in the deep-sea collections made by the *Blake* expedition. Several new species are described.—On the attitudes of some Tertiary animals of Patagonia: Albert **Gaudry.**—The evolution of terrestrial relief: A. **de Lapparent.**—On the impossibility of negative waves of shock in gases: P. **Duhem.** Remarks on a paper on the same subject by M. G. Zemplén.—On the grains of Sphenopteris: M. **Grand'Eury.**—On the observation of the total eclipse of the sun of August 30, 1905, at Alcosebre, Spain: G. **Millochau.** A *résumé* of results obtained with the telespectrograph.—Interpolation formulæ for continuous periodic functions: Maurice **Fréchet.**—On the development in continued fractions of the function $(F(h, 1, h', u)$, and the generalisation of the theory of spherical functions: H. **Padé.**—On a theorem of M. Poincaré relating to the motion of a heavy solid: Édouard **Husson.** A new demonstration of this theorem is given.—On the application of the partial liquefaction of air with a view to the complete separation of the air into pure oxygen and nitrogen: Georges **Claude.** Details are given of a system of fractional distillation of liquid air. From 100 parts of air, about 14 parts of pure oxygen are obtained by the process originally described by the author. The improvements in the apparatus now described permit of a practically complete separation of the two gases.—The density of nitric oxide; the atomic weight of nitrogen: P. A. **Guye** and Ch. **Davila.** The nitric oxide used in these experiments was prepared by three methods, the action of mercury upon sulphuric acid containing nitrous fumes, the reduction of nitric acid by ferrous sulphate, and the decomposition of sodium nitrite by sulphuric acid in dilute solution. The gas was dried by sulphuric acid and phosphoric anhydride, solidified in liquid air, and purified by fractional distillation. The mean density found was 1·3402 grams per litre, practically identical with the value recently found by Gray—1·3402. This leads to a value for the atomic weight of nitrogen between the limits 14·006 and 14·010, a confirmation of the number 14·009 found in previous researches.—The action of chloride of silicon on iron: Em. **Vigouroux.** Silicon chloride is decomposed by iron a little below a red heat. No lower chloride of silicon appears to be formed, the silicon set free forming an alloy with the iron containing about 20 per cent. of Si, corresponding to the formation of the well known compound Fe_2Si.—On the preparation of racemic amyl alcohol: P. **Freundler** and E. **Damond.** The alcohol is prepared by the interaction of trioxymethylene with the magnesium compound of secondary butyl bromide, details being given of the precautions necessary to obtain a good yield.—The diffusion of barium and strontium in the sedimentary strata: L. **Collot.**—On the increase in the dry weight of green plants developed in the light, in the absence of carbon dioxide, in a soil to which amides have been added: Jules **Lefèvre.** It has been shown experimentally that the growth of green plants in a soil containing amides, and in the absence of carbon dioxide, is accompanied by a rapid increase in the dry weight. The growth under these conditions is therefore real, and not merely a phenomenon of hydration.—On the structure and evolution of *Rhacodium cellare*: F. **Guéguen.**—On juglone: M. **Brissemoret** and R. **Combes.** Contrary to the usually accepted view, it is shown that juglone exists already formed in all the green organs of the walnut (leaves, stem, nut). The method used for the extraction is given in detail.—Rheotropism in some hydroids and Bugula: Paul

Hallez.—The influence of high altitudes on the general nutrition: H. **Guillemard** and R. **Moog.** The observations were carried out at Paris, at the Grand Mulets (3050 metres), and the summit of Mt. Blanc (4810 metres), the changes in the urine being more specially examined. It was found that the effect of high altitudes on nutrition was to produce a diminution of the oxidation processes, diminution of diuresis, and retention of the fixed elements. —The spleen and the biliary secretion: N. C. **Paulesco.** Experiments on dogs leads to the conclusion that the spleen exercises no apparent influence on the formation of bile. —Researches on the formation of hæmoglobin in the embryo: L. **Hugounenq** and Albert **Morel.**—The aurora borealis of November 15 and the magnetic disturbances of November 12 and 15: Th. **Moureaux.** The appearance of the aurora corresponded to strong magnetic disturbances. —Observations on atmospheric electricity in Grahamsland: J. **Rey.**

DIARY OF SOCIETIES.

FRIDAY, DECEMBER 1.

INSTITUTION OF CIVIL ENGINEERS, at 8.—An Installation for the Bacterial Treatment of Sewage, at Neath: W. L. Jenkins.

GEOLOGISTS' ASSOCIATION, at 8.—*Gazella Daviesii*—A New Antelope from the Norwich Crag of Bramerton: M. A. C. Hinton.—On Sections of the Holocene Alluvium of the Thames at Staines and Wargrave: A. S. Kennard and B. B. Woodward.

MONDAY, DECEMBER 4.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Exploration in the Abai Basin, Abyssinia: H. Weld Blundell.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Notes on Gutta Percha and Balata: Dr. W. A. Caspari—The Determination of Zinc in Zinc-Aluminium Alloys: Dr. R. Seligman and F. J. Willott.—Distilled Water Supply for "Works" Laboratories: Dr. R. Seligman.—The Estimation of Naphthalene in Coal Gas: C. J. Dickinson-Gair.—Salts of the Alkaloid Cinchonamine: B. F. Howard and F. Perry.

SOCIETY OF ARTS, at 8.—The Measurement of High Frequency Currents and Electric Waves: Prof. J. A. Fleming, F.R.S.

TUESDAY, DECEMBER 5.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Steam-Turbine: Hon. C. A. Parsons, C.B., F.R.S., and G. G. Stoney.

WEDNESDAY, DECEMBER 6.

GEOLOGICAL SOCIETY, at 8.—The Physical History of the Great Pleistocene Lake of Portugal: Prof. E. Hull, F.R.S.—The Geological Structure of the Sgurr of Eigg: A. Harker, F.R.S.—The Buttermere and Ennerdale Granophyre: R. H. Rastall.

ENTOMOLOGICAL SOCIETY, at 8.—Descriptions of new Genera and Species of African Galerucidæ and Halticidæ: M. Jacoby.

SOCIETY OF ARTS, at 8.—The Manufacture of Sugar from British-grown Beet: Sigmund Stein.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Reducing Action of Hydrogen, II., The Estimation of Traces of Arsenic by the Marsh-Berzelius Method, and the "Insensitiveness" of Zinc: A. C. Chapman and H. D. Law.—Note on the Removal of Arsenic from Hydrochloric Acid for Use in the Marsh-Berzelius Method: A. R. Ling and T. Rendle.—Note on Dutch Cheese: C. H. Cribb.—Improved Arrangement of Lenses for Reading Balance Graduations: G. T. Holloway.

THURSDAY, DECEMBER 7.

ROYAL SOCIETY, at 4.30.—The Periodogram and its Optical Analogy; with an Illustration from a Discussion of Observations of Sun-spots: Prof. A. Schuster, F.R.S.—(1) On a Property which holds good for all Groupings of a Normal Distribution of Frequency for two Variables, with Applications to the Study of Contingency-tables for the Inheritance of Unmeasured Qualities; (2) On the Influence of Bias and of Personal Equation in Statistics of Ill-defined Qualities: an Experimental Study: G. Udny Yule.—On the Inheritance of Coat-colour in Horses: C. C. Hurst.—A Biometrical Study of Conjugation in Paramæcium: Dr. Raymond Pearl.—On Mathematical Concepts of the Material World: A. N. Whitehead, F.R.S.—The Determination of the Osmotic Pressure of Solutions by the Measurement of their Vapour Pressures: The Earl of Berkeley and E. G. Hartley.—The Vertical Temperature Gradients on the West Coast of Scotland and at Oxshott, Surrey: W. H. Dines, F.R.S. —The Combination of Hydrogen and Oxygen in contact with Hot Surfaces: Dr. W. A. Bone, F.R.S., and R. V. Wheeler.

SOCIETY OF ARTS, at 4.30.—The Partition of Bengal: Sir James A. Bourdillon, K.C.S.I.

CHEMICAL SOCIETY, at 8.30.—The Constitution of Nitrites, Part I., Two Varieties of Silver Nitrite: P. C. Rây and A. C. Ganguli.—The Products of Heating Silver Nitrite: E. Divers.—Ethyl Piperonylacetate: W. H. Perkin, Jun., and R. Robinson.—A Contribution to the Chemistry of Saccharin: F. D. Chattaway.—The Action of Heat on α-Hydrocarboxylic Acids, Part II.: H. R. Le Sueur.—Studies on Optically Active Carbimides, Part II., The Reactions between 1-Menthylcarbimide and Alcohols: R. H. Pickard, W. O Littlebury, and A. Neville.—The Action of Ultra-violet Light on Moist and Dried Mixtures of Carbon Monoxide and Oxygen: S. Chadwick, J. E. Ramsbottom and D. L. Chapman.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Charing Cross Company's City of London Works: W. H. Patchell.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY, at 8.—Concrete Mixers: Dr. J. S. Owens.

LINNEAN SOCIETY, at 8.—On the Ætiology of Leprosy: Dr. Jonathan Hutchinson, F.R.S.—Some Notes on the Life-history of *Margaritifera Panesene*: A. W. Allen.—*Exhibition*: Photographs of a Luxuriant Specimen of *Shortia uniflora*, in the Rock-garden of Mr. W. T. Hindmarsh, at Alnwick.

FRIDAY, DECEMBER 8.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY, at 8.

MALACOLOGICAL SOCIETY, at 8.—(1) A Revision of the Species of Cyclostomatidæ and Liotiidæ occurring in the Persian Gulf and North Arabian Sea; (2) Description of Two Species of Marine Shells from Ceylon: J. Cosmo Melvill.—A Pteropod Alias: (*a*) C. Hedley. (*b*) E. R. Sykes.—(1) Descriptions of Four new Species of Marine Shells from Ceylon; (2) Description of a new Species of Physa from N.W. Australia: H. B. Preston.—Notes (1) on the Dates of Publication of J. D. Wilhelm Hartmann's "Erd- und Süsswasser-Gasteropoden," 8vo, St. Gallen, 1840; (2) On Some "Feeding Tracks" of Gastropods: (3) On Cement as a Slug-killer: B. B. Woodward.

CONTENTS.

SUPPLEMENT

SUPPLEMENT TO "NATURE."

THE MILLAIS BRITISH MAMMALS.

The Mammals of Great Britain and Ireland. By J. G. Millais. Vol. ii. Pp. xi+299; illustrated. (London: Longmans, Green and Co., 1905.) Price 6*l.* 6*s.* net.

IN our notice of the first volume of this sumptuous work we bore testimony to its preeminent excellence and superiority over all other works on the same subject in two most important particulars. First, in regard to the illustrations, both coloured and in black and white, and, secondly, in respect to the full details given of the habits and local distribution of the different species. In these respects we are fully able to endorse and emphasise the praise bestowed on the first volume now that we have before us its successor. Of the nineteen coloured plates in the second volume, all but one, which is by Mr. G. E. Lodge, are from the pencil of that incomparable animal artist Mr. Archibald Thorburn, and when this is said there is practically nothing to add, except to mention that they are the best of their kind. Our only regrets in connection with these admirable works of art are, firstly, that we are unable to reproduce one or two of them for the benefit of our readers, and, secondly, that they have been lithographed and printed in Berlin.

In a work on British mammals it does indeed seem a pity that the illustrations could not have been executed in London, and if their relegation to foreign workmanship has been rendered imperative by financial considerations, all we can say is the more the pity from the point of view of British trade and enterprise.

As regards the illustrations in black and white, all save one are by Mr. Millais himself, and we venture to think that their originality and truthfulness to nature will, if possible, enhance the already high reputation of a great artist. The one plate not by the hand of Mr. Millais is an exquisite picture of an otter and herons by the late Mr. J. Wolf.

There is one other point in which the author deserves special commendation and praise. Mr. Millais has not been content to follow blindly in the track of his predecessors and to take it for granted that when he commenced his work the list of British mammals was complete. On the contrary, he has investigated the animals in their haunts—even in the most remote parts of the United Kingdom—with the result that he has been fortunate enough to add an entirely new and most interesting form of field-mouse, or "vole," to the British list, and likewise an apparently hitherto undescribed form of black rat.

Here it may be mentioned that the present volume includes the descriptions of the British rodents and of the musteline section of the Carnivora.

Having said thus much in commendation of the volume before us, it must be added that in a work of such pretensions, published at a price which places it only within reach of the comparatively affluent, the public expects something more than superlative excellence in the matter of illustrations and full details as regards the habits and distribution of the animals described. It expects—and rightly expects—accuracy and consistency in regard to matters of nomenclature and other scientific details, and likewise freedom from grammatical errors and faults of style in the text. If we ask ourselves candidly and fairly whether the author has fully realised these expectations, we are afraid that the answer must be in the negative, and we fear that in our notice of the first volume we were a little hasty in stating that the work would form one of the standard authorities on the subject of which it treats; but on these points we must leave our readers to form their own conclusions from the criticisms which follow.

As regards the minor matter of defects in the author's style, we may cite a passage on p. 139, where it is stated that "White weasels are not very rare. . . . They seem to be prone to albinism." Other somewhat similar examples might be cited, but we pass them by to refer to the inelegance of commencing (pp. 133 and 134) five paragraphs, which with one exception are consecutive, with the word "weasels." As an example of another, and much more serious, type of error, we may refer to the very first page of the text, where we find it stated that "The Otters, with the exception of the Sea-Otter (Latax) which has flipper-like hind feet analogous but not homologous to those of the seals, have short and rounded feet." Here it was surely quite unnecessary to drag in the subject of analogy and homology—terms which the majority of readers Mr. Millais is likely to attract will probably not understand at all; but, apart from this, the statement is utterly wrong and misleading, and implies that the hind-limbs of the sea-otter represent a structure not found in seals!

Another matter for regret is that in certain instances the scientific names on the coloured plates do not accord with those given in the text as the proper titles for the various species. For instance, on plate xxii. we have the polecat described as *Mustela putorius,* and in the text as *Putorius putorius*; on plate xxiii. we have the stoat figuring as *Mustela erminea,* and in the text as *Putorius ermineus*; while on plate xxiv. the weasel is named *Mustela vulgaris,* whereas in the text it is called *Putorius nivalis.* Whether such confusing inconsistencies are due to the plates having been "made in Germany" is no concern of ours or of the reader, but in a work published at the price asked for Mr. Millais's volume they should not have been allowed to appear, even if it involved reprinting or re-lithographing the plates.

But this comprises only a small portion of the sins of the author in the matter of nomenclature. Apparently Mr. Millais has endeavoured in most cases to follow—whether well advised in this respect or not we need not pause to inquire—the more advanced authorities on this subject, with the result that he has fallen

into some terrible traps. For instance, we are informed on p. 238 that he concluded to retain for the bank-vole the name *Evotomys glareolus* in place of *E. hercynicus britannicus*. Well and good! But why do we find the Skomer vole, which is regarded as a subspecies of the former, designated *E. hercynicus skomerensis*? This, however, is not all, for the latter, which was named by Captain Barrett-Hamilton in 1903, figures as "*sub-spec. nov.*"! apparently on the notion that if an animal is relegated from specific to subspecific rank it is to appear as a new form! The truth, we are afraid, is that the author does not understand even the rudiments of nomenclatural rules.

Another blunder occurs in the case of the so-called water-vole. On p. 231 we are told that the British voles are divisible into the two genera Evotomys and Microtus, the latter being represented by three species. When, however, we come to p. 287 we find the water-vole described as *Arvicola amphibius*, the author apparently not understanding that, as the representative of a subgenus, it should have been called *Microtus* (*Arvicola*) *amphibius*, if he declines to accept the alternative specific title *terrestris* used by advanced writers. In consequence of this blunder the uninitiated reader may enter a kind of puzzle-competition to discover the third species of Microtus referred to on p. 231.

Here we may make a short digression to express the wish that the author had given his opinion on the use of the term "Vole." The proper English name of *Microtus amphibius* is undoubtedly "water-rat," just as "hedge-sparrow" is the indefeasible title of the bird ornithologists are pleased to miscall "hedge-accentor." In order to distinguish the water-rat and the short-tailed field-mice from the true rats and mice they have, however, for many years been termed "voles" by naturalists. Now Macgillivray tells us ("Brit. Mammals," Naturalists' Library, p. 260) that the name "vole" is a meaningless term introduced by Dr. Fleming to replace the French campagnol, then in use among naturalists. If this be true, the word ought to be expunged from nomenclature altogether as a "bogus" term; and from no point of view is its use justifiable for the British water-rat and short-tailed field-mice, which have vernacular names of their own. It may be added that the word vole does not appear to be derived from the German *Wühlmaus* (burrowing mouse), *Veltmaus* (field-mouse), or *Waldmaus* (wood-mouse).

To revert to our criticisms on nomenclature, we may conclude by mentioning that we are at a loss to understand why, from the point of view of the advanced side of the subject, the author calls the brown rat *Mus decumanus* in place of *M. norvegicus*; and that in the case of the black rat his English names for the local races are open to strong objection, as, for instance, northern Alexandrine rat in place of the northern or typical black for the type form.

Another point of some importance strikes us on looking through the volume. Among the list of photographic illustrations (which are in addition to the plates already referred to) we note some very interesting plates of the skulls and dentition of the weasel group, rats, dormice, "voles," &c., reproduced from drawings by Mr. H. Grönvold. Curiously enough, there appears no reference in the text to these beautiful figures, nor is there any index pointing out the details of the enlarged figures of teeth.

This is a great pity, as the figures of molar teeth are of much interest, and exhibit details not shown in any other work with which we are acquainted. How the author could have given so much time to the selection and arrangement of such beautiful figures (and from the absence of any reference to the name of any friend who may have assisted the reader is left in the belief that this selection is the work of the author) without describing the structures thus portrayed it is difficult to understand. It may be pointed out that it would have been better had all the teeth selected for illustration been in the same state of wear; and we note some little errors, due to the lack of skilled supervision, in the figures of the molars of the voles; while in the plate forming the frontispiece the skull of the badger is not, as it purports to be, represented anything like the natural size.

While there is much to admire in this volume, the foregoing criticisms (which by no means exhaust all that might be said) show that it is a long way short of perfection. The truth, we venture to think, is that the author, although an enthusiastic and excellent field-naturalist, lacks the scientific training necessary for success in a work of this nature, and, as we have had occasion to remark when reviewing the works of other amateur naturalists, it would have been better had the assistance of one of his professional brethren been secured for the revision of the nomenclature and other technical aspects of the subject. Such a magnificent undertaking ought not to be marred by any feeling on the part of its author that it is beneath his dignity to claim such assistance in regard to details and technicalities with which the amateur field-naturalist can scarcely be expected to be acquainted. R. L.

THE ORIGIN OF KINGSHIP.

Lectures on the Early History of the Kingship. By Dr. J. G. Frazer. Pp. viii+309. (London: Macmillan and Co., Ltd., 1905.) Price 8*s*. 6*d*. net.

WE learn from the preface to this work that it consists substantially of a series of extracts from the forthcoming third edition of the "Golden Bough." Few, however, will feel called upon to quarrel with the author for this somewhat unusual procedure, for the "Golden Bough" is, to use a mixed metaphor, a work of many diverse threads, and the lay reader will be grateful for the chance here given him of following up one line of argument, itself far from simple, without the necessity of disentangling it from a mass of material and hypothesis linked together by the general theory there set forth.

Dr. Frazer warns his readers at the outset that they must not expect him to deal exclusively with

royal personages; in order to make the sacred and magical functions of kings intelligible, a sketch of those superstitions is needed of which the beliefs connected with kingship are a specialised form. Accordingly, after a brief survey of the facts which have already served as a text to the "Golden Bough," with, however, an important modification as regards Virbius, the first priest of the Grove of Nemi, we plunge into the question of magic, its classification and explanation. Here we are met with an important modification in terminology; sympathetic magic is divided into two classes:—(1) homœopathic, otherwise termed mimetic; (2) contagious, previously called sympathetic. After exemplifying these forms of magic by illustrations covering some fifty pages, Dr. Frazer grapples with his real subject, and shows how the magician in many savage tribes develops into the chief or king. Then, returning to the Grove of Nemi, he takes up the new point as to Virbius—that he was the husband of Diana, the goddess of the grove, and illustrates at length the custom of marrying gods, especially tree and water gods, to human beings. This is followed by a discussion of these customs in Rome in particular, in the course of which are made the suggestions that the union of Numa and Egeria was of this type, that Roman kings were regarded as the sons of the fire god by the vestal virgins, and that the succession in the kingship among the Latins was through the female line. Dr. Frazer then proceeds to deal with various features of the Roman customs relating to the king, such as the Saturnalia, the *Regifugium*, and the violent death suffered by so many of the royal line, and finally concludes that the king of the wood, Virbius, represented Jupiter; with Jupiter, on grounds which seem convincing, he equates Janus or Dianus; holding that Jupiter, and consequently also his double, Janus, was an oak god, Dr. Frazer finds it extremely natural that Virbius should mate with an oak goddess; regarding the union of Numa and Egeria as a variant of the marriage of the priest of Nemi, he shows good grounds for holding that Egeria was an oak nymph and identical with Diana, whose name is a variant form of Jana; and, finally, he briefly expounds his explanation of why the priest of the grove had to do battle for his title, quoting an Indian parallel observed, though in very different form, in the kingdom of Calicut down to 1743.

Broadly speaking, the book falls into three parts, distinguished by the subject-matter and, to some extent, by their relative completeness. The first part, introductory and illustrative of savage beliefs in general, is naturally no more than a selection; the third part, dealing with the classical evidence, seems very exhaustive, far more so than the first two editions of the "Golden Bough," a result due in part to the contributions of Mr. A. B. Cook, whose services Dr. Frazer acknowledges; the second part, on the other hand, should, on strictly inductive principles, contain a survey of the whole field of savage chieftainship, if possible on a statistical basis; and this is the more necessary as, to judge by the title, this part should contain the kernel of the book. Dr. Frazer disarms criticism by affirming that his thesis of the magical origin of kingship is of general application only; in fact, he expressly abstains from claiming more than that it is broadly true that we owe to the magician the rise of despotism, in which, paradoxically but truly, he sees the germ of human liberty. His examples of savage magicians are taken almost exclusively from Australia, Melanesia, and Africa. But as regards Australia, it seems far from being generally true that the head of a totem kin is also head of the local group; and if this is so Dr. Frazer's argument that the head of a totem kin is a magician *par excellence* does not advance his general argument that the head of a local group, or of the whole tribe, tends to be a magician; then, again, we find in many cases that the head of the tribe is a specially gifted orator or hunter, but of his magical qualifications we hear nothing or next to nothing; finally, in a society where all old men are magicians, it is a natural thing for the chief to be a magician also; but this is not equivalent to saying that he owes his position as chief to his magical powers. The general impression gathered from Dr. Howitt's work, on which Dr. Frazer relies for Australia, is, in fact, that magical powers are only one among several causes which help a man to the chieftainship. The Melanesian facts, it may be granted, tell in Dr. Frazer's favour; but Melanesia is a comparatively small area. For Africa, as for Australia, we should have been better able to judge of the magician theory if we had before us something like a conspectus of the material or even a statement of the proportion of cases in which this theory holds good.

Africa, Melanesia, and Australia are the areas from which Dr. Frazer takes his examples of magician-chiefs. Where his object is simply, as in the "Golden Bough," to justify a theory by a collection of examples, it would be unreasonable to complain that the author fails to exhaust his material. But in the work before us it is different. Europe and parts of Asia are, no doubt, too advanced for any certain conclusions to be based on the facts; but in elaborating his argument as to the origin of chieftainship Dr. Frazer has almost entirely neglected the New World. After the opening eulogy of the inductive method, it is not a little remarkable that Dr. Frazer should be content to rest his case on so partial a statement of facts, whether the American facts tell for him, or, as is more probable, against him. In any case mention should have been made of the war-chief as one of the forerunners of royalty; the war-chief is found, not in America alone, but also in Australia and Africa.

It is naturally impossible to deal with all the points which invite criticism; it must suffice to mention a few in passing. Although Dr. Frazer deals largely with magic, and re-asserts its priority over religion, we nowhere find a definition of either; we are left in the dark as to whether, in Dr. Frazer's view, the two classes of magic mentioned above cover the whole field or whether other kinds of magic exist. In the explanation of the origin of magic more stress is

laid on the association of ideas as a starting point, not merely an *ex post facto* explanation, than modern psychologists would be prepared to grant to it. The savage examples of inheritance through females are far from being parallel to the rule of succession by marriage, assumed to be the Latin rule.

Of Dr. Frazer's charm of style and literary skill in arranging his material it is needless to speak, and the points noted above detract in no way from the interest of the book, which, indeed, might rest its reputation on the classical material alone. An adequate index is provided. N. W. T.

A COMPENDIUM OF NATURAL KNOWLEDGE.

Landolt-Börnstein—Physikalisch-chemische Tabellen. Dritte Umgearbeitete und vermehrte Auflage. By Drs. Börnstein and Meyerhoffer. Pp. xvi+861. (Berlin: Julius Springer, 1905.) Price 36 marks.

THE promised new edition of Profs. Landolt and Börnstein's well-known tables of constants, a work which has long been familiar in the laboratories of physicists and chemists throughout the world, has at length appeared after being in the press nearly three years.

As regards the number of pages, the book contains about half as many again as the second edition published in 1894, and three times as many as the first edition of 1883.

A book such as the present volume may be compiled on several different plans. An attempt may be made to give a complete list of all determinations of any physical constant, with references in each case. This method, however, would entail enormous labour and make the resulting volume very ponderous without conferring any additional advantage on the user, except, perhaps, the specialist interested in the history rather than the present accepted value of any physical constant. A second plan would be to collect from the whole literature only the more recent references, and a third to give, as is usual in the various pocket-books, a single value for each constant. In the compilation of the present work no one of these systems has been followed throughout, although the rule of giving a reference to the source of information has been rigidly followed in each case. The result is undoubtedly the most complete work of reference of its kind in any language, if we except the treatise on physical constants now being brought out by the French Physical Society, which will require many volumes for its completion. The original compilers have called to their aid about forty specialists, and in all cases the name of the person responsible appears at the foot of each table.

To criticise a work of this kind is no easy task; indeed, to do it at all adequately the editor would be obliged to call in the services of a number of reviewers rather than a single individual. In the writer's opinion, however, the object of a reviewer should be rather to attempt to appreciate the book in question at its true value, and to indicate whether in his opinion it is likely to serve the purpose for which it is intended, rather than to put together a long list of grammatical slips and printer's errors, though this side of the question need not go wholly without attention.

A cursory comparison of the book with the earlier editions of 1883 and 1894 will convince everyone of the substantial advance that has been made both in our knowledge and in the completeness of the work in question. Indeed, this very completeness in certain directions appears at times almost appalling. For every person who wishes to look up the index of refraction for the green thallium line of "Camphocarbonsaürekohlensaürediethylester," which is given, there would probably be a hundred who would be glad to be informed as to the electrical properties of Acheson graphite, which is not mentioned, and a thousand who would like some more precise indication as to the melting point of common salt than simply a catalogue of values varying from 776° to 820° C.

Indeed, the character of the information excluded from the book at once proclaims the preeminently academic rather than practical tastes of the majority of its compilers. For example, no word is to be found as to the electrochemical equivalents of the metals, or as to the flash and firing points of the various oils used in industry. A mixture such as petrol has properties as definite as many single substances, and is vastly more important than many out-of-the-way bodies the properties of which are here detailed. The work is a monument to the industry and book-learning of the German professor, but if it had to be translated into English many changes might be introduced with advantage. One can picture the trained electrochemist of an up-to-date American works expressing his disappointment when he finds that, though he could revel in pages of "Ueberführungszahlen," yet important bodies like carborundum and siloxicon are not even mentioned, and he would appeal in vain to the book if he wished to ascertain whether magnesia or alumina had the lower melting point.

The following may serve as an example of the somewhat irritating way in which some of the data are expressed. We conventionally divide all substances into electrical insulators and conductors, and again we divide the metals and alloys into those used for *current-carrying* and those employed as *resistances*. It may be *academically* correct to lump all these together and tabulate their conductivity as a number multiplied by a factor varying from 10^{4} to 10^{-18}, but there is no question as to the superior *utility* of giving the resistivity of the usual insulators in megohms or millions of megohms per centimetre cube and that of the other materials both in microhms and in terms of copper.

We are glad to notice that in the matter of units many improvements have been made on the old edition. The three confusing brands of calories met with in thermochemistry have been unified, and in the section on thermal conductivity the C.G.S. system has displaced the inconvenient units formerly employed.

The information given in the book is on the whole accurately compiled,[1] yet we regret to find that misprints, which have been corrected by their authors,

[1] A list of a few errors discovered has been sent to the authors.

should be repeated in a work of this kind. For example, Violle's value for the melting point of gold is given as it was printed in his original paper in 1879—namely, 1035° C. Two years later (*C.R.*, xcii. p. 866) he stated that this was a printer's error for 1045° C. Still later he admitted that the value 1045° needed raising 15° or 20°, thus bringing his figure into complete accord with the results of modern observers. Yet no mention of these facts is made in the book, nor is any account taken of the influence of this raising of the melting point of gold on the results obtained for numerous other substances, using pyrometers standardised by this melting point.

Again, several papers by American physicists have been written on the correction of Rowland's classic experiments on the mechanical equivalent of heat to bring his temperature-scale into agreement with modern standards; yet we find the values of Rowland's original paper given on p. 810 without comment.

In the table of dielectric constants the duration of the charge should have been specified, and the same applies to the table giving the resistance of insulators, where both the testing voltage and time of electrification are vital in determining the value obtained. In spite of many omissions, the book is the most complete and best of its kind, is well bound and printed, and should be found in every well-equipped laboratory of physics or chemistry. J. A. Harker.

THE PRINCIPLES OF SCIENCE.

Erkenntnis und Irrtum. By Prof. Ernst Mach. Pp. 461. (Leipzig: J. A. Barth, 1905.) Price 10 marks.

PROF. MACH is best known to English readers by the translation of his "Die Mechanik in ihrer Entwickelung." Those who have read that admirable book and know its interest will probably hasten to learn more of that philosophy of science which is only dimly indicated therein in a few casual but suggestive remarks. Perhaps they will be disappointed.

For Prof. Mach is no philosopher; he is a "Naturforscher"; he assures us of it at every opportunity; the mere name of philosophy fills him with horror. But unfortunately a hatred of other metaphysicians is not unknown among those included under the same name; it is just as metaphysical to condemn metaphysics as it is superstitious to belong to the "13 Club." A new answer to the problems of metaphysics does not exclude us from the circle of students of that subject, for only by ignoring those questions can we place ourselves outside it; whoever deals with such problems must be treated as a philosopher.

Prof. Mach's views on the philosophy of science are very similar to those which Prof. Pearson expresses in his "Grammar of Science"; his attitude approaches more nearly to sensationalism than to any other recognised system. Our sense impressions are for each of us the only ultimate facts and the only source whence knowledge can be derived. Science consists in the adaptation of our thoughts to one another, a process in which an essential part is played by the conceptions which we form by generalising our perceptions. Knowledge, therefore, is attained in the simplification of our conceptions and in their harmony with our perceptions. No knowledge exists which is not scientific; we can deal with nothing but phenomena; "things in themselves" are meaningless, they are "monströse, unerkennbare." Causality is a conception derived from the constancy of association of some of our perceptions, and is nothing but a functional relation between phenomena. Geometry and other branches of pure mathematics consist of the study of the conceptions of space, time, number, and so on, to which we have been led by a study of phenomena and a consequent idealisation of our perceptions; the possibility of intuitional knowledge must be absolutely rejected. Such are the chief propositions which the author is concerned to establish.

It is clear that these propositions were designed to meet the needs of a student of natural science, and that only those assumptions have been made which are considered necessary and sufficient to prove them. Of course, this would be perfectly legitimate; it is not only logical, but in many ways advantageous, to decide definitely what assumptions must be made in order that science may be possible, to make those assumptions and to leave to others the discussion of their validity and their source. But our author has been in such a hurry to get within the fortress of science and to shut out the hostile metaphysician that he has left some of his necessary baggage outside; his assumptions are not sufficient for his purpose. Knowledge, he says, consists in the perfect harmony of our conceptions and perceptions; that is simply a matter of definition; but then he tells us that this knowledge can give us an expectation (Erwartung). Now our conceptions are derived from past perceptions, and if they are to give us any information about future perceptions it must be on the grounds that future sequences are likely to resemble past sequences. But this is a new proposition; we cannot prove it from "Naturforschung," for Prof. Mach admits that the only method which is available for the attainment of new knowledge by such a process is "incomplete induction," which involves the truth of this very proposition. We must either assume it or deduce it from some other source; for instance, we might deduce it from the uniformity of the observing self and plunge into Solipsism, or from the uniformity of some external agent and be forced to dispute with the metaphysician the questions of reality and existence.

The most satisfactory portion of the book is that in which the methods by which science has been advanced are analysed in detail and illustrated by some apt examples. The chapter on hypotheses directs attention to a sadly neglected principle. The cause of the fruitlessness of Baconian induction in the hands of its author and his followers lay in their neglect of hypotheses. Random experiments, however numerous, are always in vain; except by chance, no researches which have not been directed to the examination of some hypothetically suggested theorem have yielded any useful knowledge.

On the other hand, the psychological investigation into our reasoning powers does not seem very interesting or convincing. Prof. Mach's treatment is genetic, and must always be open to the objection that it is not necessary in intellectual development that the growth of the individual should repeat the history of the growth of the race. Indeed, the influence exerted on our present thought by the few men of real genius is so great as to preclude at once the biological analogy. We regret to see that Prof. Mach in his treatment of time and space makes no mention of the work of Poincaré; he seems to be struggling with difficulties that have been solved already by that brilliant author. Much of the last few chapters would become superfluous if it were recognised that changes in time and space are only phenomenal changes to which we are led to attribute special importance because of their relation to other classes of mental facts which are summed up as "will" and "memory."

Any judgment of a philosophical treatise must depend on the opinions of the reader. The author's exposition is lucid, though all writings in German tend naturally to cumbrousness. It is probable that some will find in this volume valuable ideas which are new to them and suggestive illustrations of those with which they are familiar; but others will prefer Prof. Mach the mathematician to Prof. Mach the philosopher. N. R. C.

MATHEMATICS FOR SCHOOLS.

The Winchester Arithmetic. By C. Godfrey and G. M. Bell. Pp. ix+199. (Cambridge: University Press, 1905.) Price 3*s*.

A Text-book of Algebra. Part i. By A. E. Layng. Pp. viii+176. (London: Blackie and Son, Ltd., 1905.) Price 2*s*. 6*d*.

An Introduction to Algebra. By R. C. Bridgett, F.C.S. Pp. 95. (London: Blackie and Son, Ltd., 1905.) Price 1*s*.

Elementary Modern Geometry. Part i. By H. G. Willis. Pp. viii+236. (Oxford: Clarendon Press, 1905.) Price 2*s*.

Tables and Constants to Four Figures. By William Hall. Pp. ix+60. (Cambridge: University Press, 1905.) Price 3*s*. net.

MESSRS. GODFREY AND BELL'S excellent arithmetic consists mainly of sets of exercises, many of them oral, very carefully graded, and charmingly fresh and varied. A large number of the exercises refer to interesting current events and subjects, and thus incidentally impart quite a fund of general and useful information to the young reader. The metric system is in constant use along with the more important British measures, and by its aid decimals are taken before vulgar fractions. Commercial arithmetic is ably dealt with, but is not allowed an undue monopoly. The needs of the worker in the laboratory are not overlooked, for the course includes approximations, the mensuration of simple plane and solid figures, logarithms, with a chapter on graphs, while symbols and formulæ are introduced from the first, "exhibiting algebra as shorthand arithmetic." The student is not allowed much chance of working unintelligently by rule, and is everywhere encouraged to think for himself, for the rules and processes are left to be given orally by the teacher, who can obtain a special interleaved copy of the book containing model exercises and all the answers. This admirable text-book will rank high amongst its fellows, and it would be difficult to find a school arithmetic more worthy of general use.

In part i. of the algebra by Mr. Layng, the subject is developed in very easy stages, generalising from arithmetic, and is carried up to the solution of simple quadratic equations. In choice of matter the author gives preference to parts which have an immediate practical application, as being specially suitable for young beginners. Graphs are very freely used. The applications include the mensuration of plane geometrical figures.

The algebra by Mr. Bridgett proceeds on somewhat similar lines to that just noticed, but the explanations are briefer, and only simple equations are dealt with. The applications include proportion, profit and loss, simple interest, discount, mixtures, work, averages, areas and volumes. Answers to the exercises are given.

Mr. Willis's volume is the first part of what promises to be an important text-book of elementary pure geometry, representing the present position of the science. The first chapter is experimental and practical, with the object of making the student familiar with the things he is about to study. Chapter ii. deals with first principles. Here the definitions, axioms, and methods of geometrical deduction are fully discussed, and fundamental propositions relating to lines, angles, and triangles are established. In addition to the usual axioms, the author gives axioms of continuity, displacement, and rotation. The next chapter is a short one, containing problems and graphs. The last chapter treats of parallels. Playfair's axiom is introduced as an alternative to the rotation axiom, and reasons are given for not adopting Euclid's criterion of parallelism. Notions about limits, infinity, loci, &c., are introduced and used in the propositions, so that the student acquires these comparatively early in his course. The present part is intended to cover the ground required for ordinary pass examinations, and the forthcoming part, it is hoped, will be suitable for honours. Sets of exercises are given at short intervals, the answers to those which are numerical being collected at the end. The book is one that should be known to all teachers, and is likely to be used by many.

The four-figure tables by Mr. Hall comprise square roots, squares and reciprocals, the ordinary logarithms and anti-logarithms of numbers, and the usual logarithmic and natural functions of angles. In addition, there is a useful three-figure traverse table, occupying eighteen pages, giving the products of all numbers from 10 to 99 into the sines and cosines of angles from 1° to 89°, with intervals of 1°. There are also tables of natural and logarithmic haversines, or half-

versines, these valuable tables being thus now readily accessible. The author also includes short tables of refraction and dip, sufficient for beginners in navigational astronomy. There is a brief description of the use of the tables, and a five-page collection of useful numbers and physical constants. The tables are carefully compiled and skilfully arranged, and seem thoroughly serviceable and trustworthy.

STATICS IN THE MIDDLE AGES.

Les Origines de la Statique. By P. Duhem. Vol. i. Pp. iv+360. (Paris: A. Hermann, 1905.) Price 10 francs.

THIS book is sure to arouse the interest of all who study the history of natural science, and it may cause a certain amount of controversy owing to the nature of its conclusions; but even if some of these have to be modified, enough will remain to shed a new light on the progress of mechanics in the middle ages. The main result, and this is established beyond all reasonable doubt, is that the mechanics of the fifteenth and sixteenth centuries must not be regarded as a sudden achievement, but as a development of ideas current in the thirteenth and fourteenth centuries, many of which were unscrupulously reproduced without acknowledgment.

Who, then, are these predecessors to whom even Galileo and Descartes probably owed more than they ever confessed? In the first place, Jordanus Nemorarius, or more properly Jordanus de Nemore. Nothing is known of his personal history; Moritz Cantor is inclined to identify him with Jordanus Saxo, but Prof. Duhem conjectures that he may have been an Italian, Giordano of Nemi, and this is plausible enough to deserve further investigation. Manuscript evidence tends to show that his works were composed in the twelfth century at latest. Prof. Duhem's researches lead him to the following conclusions about Jordanus and his mediæval successors. Jordanus wrote a treatise of which the proper title seems to have been "Elementa Jordani super demonstrationem ponderis"; of this there is a thirteenth-century fragment and a fifteenth-century text apparently complete. He had studied Aristotle, and the "De ponderoso et levi" attributed to Euclid; but his treatise seems to be original, and not a translation from the Greek. He discusses the equilibrium of the lever by a method which is essentially that of virtual velocities, and even seems to be on the brink of discovering the infinitesimal calculus.

Jordanus's treatise became classical; it was associated with the "De canonio" (attributed to Euclid), and transformed in various ways by commentators without improvement. But there is another work, attributed to Jordanus, "De ratione ponderis," which is of still greater interest and importance. It contains the notion of the moment of a force, the correct theory of a bent lever, and the solution of the statical problem of two weights connected by a string and resting on two different inclined planes. Prof. Duhem is probably right in saying that this was not written by Jordanus, but by an unknown successor whom he calls the "precursor of Leonardo da Vinci." The main argument is that some errors of the "Elementa" are here corrected. It is not impossible that Jordanus wrote it *after* his other treatise, tacitly amending his previous mistakes; however this may be, the author was familiar with Jordanus's "Elementa," and his work is contained in a thirteenth-century MS.

The next great figure to appear on the scene is that of Leonardo da Vinci. It is not very easy to decide how much of theoretical statics Leonardo found out for himself; he had a clear notion of moments, but, on the other hand, his ideas about the composition of forces were vague and incorrect. He does not appear to have added anything essential to what was already known in the thirteenth century; but it is likely enough that his manuscripts suggested valuable ideas to some of those into whose hands they fell.

The later chapters of the book deal with the facts relating to Galileo, Stevinus, Roberval, and Descartes; this period is better known, and it is needless to go into details here. The main point is that, however much we owe to sixteenth-century mathematicians, it is wrong for us to regard them as the founders of an absolutely novel theory of statics; and although this conclusion may somewhat dim our mental picture of the glories of the Renascence, it will deepen our piety towards those *obscuri viri* who cultivated science and learning when they were most in danger of extinction. It is noteworthy that in other directions, such as the history of painting, the same kind of verdict on the Renascence appears to be forming.

The teaching of mechanics to average students is a very difficult and often ungrateful task. One is often tempted to lose one's temper, and unfairly blame the pupil for his stupidity. It is a wholesome corrective to think of the slow progress of the theory and of the extraordinary mistakes made in connection with it by men of unusual ability. Thus it took years of controversy to establish the fact that a uniform bar, supported at its centre of mass, is in neutral equilibrium; and it was long taken for granted that a two-pound weight fell to the ground twice as fast as a one-pound weight. G. B. M.

SPECTROSCOPY.

Spectroscopy. By E. C. C. Baly. Pp. xi+568; illustrated. (London: Longmans, Green and Co., 1905.) Price 10*s.* 6*d.*

THIS important addition to the well-known series of text-books edited by Sir William Ramsay will be welcomed by all who are interested in the progress of spectroscopy, and especially by students of physics and chemistry who may desire to engage in spectroscopic study and research. The book, indeed, fills a gap in spectroscopic literature which has long existed, providing in a moderate compass a comprehensive guide to modern methods of investigation, the theory of the instruments employed, and the principal results which have been arrived at in the application of spectroscopic methods to chemistry and physics. In each of these departments the explanations are gene

ally characterised by thoroughness in matters of detail, and are seldom lacking in clearness.

On the practical side of the subject there are ample instructions for the adjustment of apparatus, the production of spectra, and the modes of registration by the eye or photographic plate. Particularly useful are the descriptions of a home-made mounting for the prisms and lenses of a powerful spectrograph, of a mounting for a concave grating, and of the construction and use of vacuum tubes. The methods employed for the infra-red and ultra-violet parts of the spectrum are also ably discussed. The explanation of the reduction of photographic spectra is less satisfactory. The tedious and often uncertain process of identifying the comparison lines of iron described on p. 140 may be greatly simplified by the use of Kayser and Runge's wave-length map of the iron spectrum, especially if the lines due to an impurity of copper in the iron which was employed be first eliminated. Again, the Cornu-Hartmann interpolation formula for the determination of wave-lengths from prismatic spectra cannot properly be described as "cumbersome and laborious" (p. 133). The entire computation may be reduced to a very simple form in which a quarter of an hour's work will give all the constants, and the advantages of this method of reduction, which is, in fact, widely employed, should have been indicated.

Almost for the first time in a text-book an attempt is made to give a connected account of the theory of instruments, including the echelon grating and interference methods for the determination of wave-lengths. Such matters as resolving power and efficiency are very fully dealt with, but in view of Schuster's recent criticisms it is unfortunate that so much space has been devoted to Wadsworth's extension of the theory, and in any case the derivation of the formula for the diffraction image of a slit (p. 73) and of Schuster's expression for purity (p. 317) might have been included with advantage.

Among the results of spectroscopic research which are described, absorption spectra in relation to chemical constitution are well explained, and there is an excellent account of spectrum series, in which the relative merits of the formulæ of Rydberg and Kayser and Runge are well brought out. In the latter section, however, there is a complete absence of illustrations, the introduction of which would have made the whole subject clearer and more attractive to beginners.

Actual errors are remarkably few, but one occurring on p. 387 should be corrected. It is there stated that "Lockyer has throughout considered that the passage from the arc to the spark discharge means a great increase of temperature," whereas, as Sir Norman Lockyer has recently pointed out (*Roy. Soc. Proc.*, vol. lxxvi., p. 145), the "action of electricity" has always been included by him in the term "temperature" in relation to dissociating effects.

The illustrations are numerous, but not always well chosen. Mechanical details of such highly specialised apparatus as that of Schumann for the investigation of spectra in the extreme ultra-violet, and of Rowland's engine for ruling gratings, might well have been replaced by illustrations of more direct use to the student. Photographs of spectra are notably deficient and might frequently be introduced with advantage, as, for example, in the explanation of comparison spectra (p. 138) and in illustration of the differences between arc and spark spectra (p. 387).

Notwithstanding the few drawbacks to which attention has been directed, the book reflects the greatest credit on its author, and will doubtless do much to stimulate spectroscopic research.

PRECIOUS STONES.

Precious Stones considered in their Scientific and Artistic Relations. By Prof. A. H. Church, F.R.S. Pp. vii+135. (London: Wyman and Sons, 1905.) Price 1*s.* 6*d.*; in cloth 2*s.* 3*d.*

THIS well-known handbook of the Victoria and Albert Museum has now reached a second edition. It is difficult to say whether the scientific or artistic side of the work is worthy of the higher praise; certain it is that no work on the subject has better combined the two kinds of information. Within the small compass of this little work, Prof. Church has succeeded in giving the most exact and up-to-date account of the best methods of distinguishing the various gem-stones, so often, by design or accident, mistaken for one another.

The work has been revised and enlarged, and some part of it re-written. That it has been fully brought up to date will be seen by anyone who refers to the accounts given of hiddenite, rhodolite, and kunzite.

An important feature of this book is the recognition it gives to the value, for ornamental and artistic purposes, of many substances not popularly regarded as gem-stones. It is to be regretted that fashion, rather than taste and judgment, play so great a part in determining the use and value of many precious stones. Prof. Church's book may serve the purpose of directing attention to the existence of many exquisitely beautiful but almost entirely neglected minerals. His remarks on the selection, arrangement, cutting, and setting of the various stones are especially valuable. There can be no doubt that the beauty of many of the gem-stones is often, to a great extent, lost by inattention to the necessity of artistic treatment in their setting and surroundings. This question has been the subject of much careful study on the part of Prof. Church, and he writes on it with authority. The catalogue of the collection of precious stones made by the late Rev. C. H. Townshend, and left by him to the nation in 1869, is printed at the end of the book. Any student of gems wishing to make himself acquainted with the chief types, and their methods of cutting and mounting, could not do better, after reading Prof. Church's manual, than to visit the Victoria and Albert Museum and examine the specimens, each of which is described in the catalogue. It is not necessary to point out how greatly the value of our national collections is enhanced when the public can obtain so cheaply a convenient and authoritative handbook, dealing with particular classes of objects exhibited in them, like the work before us.

J. W. J.