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BERZELIUS AND WÖHLER.

Briefwechsel zwischen J. Berzelius und F. Wöhler. Im Auftrage der Konigl. Gesellschaft der Wissenschaften zu Göttingen. Mit einem Commentar von J. von Braun. Herausgegeben von O. Wallach. Two vols. Pp. xxii + 717 and pp. 743. (Leipzig : Wilhelm Engelmann, 1901.) Price 2*l.* net.

THE story of the origin of Wöhler's association with Berzelius has been told by Wöhler himself in the *Berichte* of the German Chemical Society in one of the most charming autobiographical sketches which have ever enlivened the formal pages of a scientific periodical. Readers of the *Berichte*—and their number is legion—will recall the picture of the young graduate of twenty-three who, with the ardour of the zealous neophyte, had journeyed from the cloisters at Heidelberg to seek light and leading from the great high priest at Stockholm. How with a beating heart he stood before Berzelius's door and rang the bell. How it was opened by a well-clad, portly, vigorous-looking man—none other than Berzelius himself; and how he was led into the laboratory as in a dream, doubting if he was really in the classical place which was the object of his aspirations.

From that memorable meeting sprang a friendship which ended only with Wöhler's death. Berzelius died in 1848, but to the end of his days Wöhler continued to cherish the most affectionate feeling towards his teacher, exhibiting an almost filial piety in regard to his name and fame. He remained to the last what he was wont to sign himself—"Unveränderlich Ihr Wöhler."

Berzelius was an indefatigable letter-writer, and his correspondents were to be found in every country in which chemistry was cultivated. But to none did he unburden himself as he did to Wöhler. For nearly a quarter of a century—that is from 1824 to 1848—scarcely a month passed without an exchange of letters. Those from Berzelius were carefully preserved by Wöhler, who subsequently presented them, some hundreds in number, to the Swedish Academy of Sciences.

It is this correspondence which forms the subject-matter of the volumes before us. Its publication is due to the action of the Royal Society of Sciences of Göttingen, which has desired thereby to commemorate, in connection with the centenary of his birth, the long and valuable service which Wöhler rendered to that body as its secretary. Wöhler had stipulated that the letters from Berzelius which he deposited with the Swedish Academy should not be published before January 1, 1900. This injunction was, no doubt, expedient in view of the character of the letters. The period over which the correspondence extended was a time of stress and strain, not only in politics, but also in science and especially in the science of chemistry. When it began, the influence of Berzelius in the world of chemistry was supreme. Davy, it is true, still lived, but his intellectual activity was well-nigh spent and he was already showing signs of the obscure malady which occasioned his death in 1829. As the years flowed on, Berzelius was made conscious that his influence was waning—steadily undermined by the leaders of chemical thought in Germany and in France, by Liebig and Dumas and their respective followers, who, continually at war with one another, agreed only in disagreeing with Berzelius.

The secretary of the Swedish Academy was, however, a doughty antagonist; very tenacious of his convictions and somewhat insistent in his expression of them, as the pages of his *Jahresberichte* frequently testify. As might be expected, his letters to Wöhler give even more emphatic expression of his opinions, and when his feud with Liebeg culminated in an open breach, he is at no pains to conceal his sense of resentment and irritation. It is this circumstance that determined Wöhler to fix the end of the century as the time that the letters should first be made public—a time so remote from the period to which they relate as to render it reasonably certain that no pain would be occasioned by their publication. In this respect Wöhler was true to himself. He hated contention and was always ready to advise the lion to eat sugar, as he once said to Liebig. His own letters abundantly illustrate this disposition. They are delightful in their spontaneity and directness, in their sobriety of statement, their unfailing charity and the quiet, delicate humour by which they are constantly illumined. Berzelius evidently set considerable store by them, and they were preserved with no less care than his own. They were ultimately given by the Baroness Berzelius to the Stockholm Academy, and were by it placed at the disposal of the Göttingen Society. With a few exceptions, Berzelius's letters were written in Swedish, and have been rendered into German for the purpose of this work by Frau Prof. Schering, of Göttingen, the daughter of the Swedish Prof. Malmsten. Those from Wöhler have been arranged for publication by his daughter, Frl. Emilie Wöhler.

To the historian of chemistry, this correspondence is of singular value and interest, inasmuch as it stretches over the period which saw the rise of modern chemical theory. Throughout it are constant references to the ideas and hypotheses which gradually developed into the chemical doctrine of the middle part of the nineteenth century—of the period we associate with the names of Liebig and Wöhler, Magnus, Mitscherlich, Rose and Dumas. In some of the letters, we have accounts of discoveries and inventions which mark epochs, or points of departure, in chemical progress. Thus in one of the letters Wöhler describes in detail Liebig's newly-invented method of organic analysis, with sketches of the potash-bulbs, of the mode of making the india-rubber joints and of the charcoal furnace or chauffer. Berzelius was, as is evident from his reply, greatly impressed with the value and importance of the new method, and his genius for manipulative chemistry was immediately exercised in suggestions which he trusts may be improvements. Wöhler also sent to Stockholm one of the earliest accounts of Will and Varrentrapp's method of determining nitrogen. Indeed, we frequently meet with accounts, occasionally illustrated by rough sketches, of manipulative methods and pieces of apparatus which are nowadays to be met with in all laboratories. We have accounts sometimes from the discoverers themselves of metaphosphoric acid, thoria, hippuric acid, vanadium, tellurium, chloroform, chloral; of the isolation of

aluminium; of the synthesis of urea and the mode of preparation of a host of substances, organic and inorganic, of which the times were fertile. Very interesting and instructive, too, are the references made by the correspondents to the work of their contemporaries. Thus Berzelius keeps Wöhler informed of what Mosander is doing, and of the researches of his pupils Dahlström, Sefström, Mitscherlich, Magnus and Johnston; whilst Wöhler in his turn tells, for example, what he knows of Liebig's work, of the progress of Bunsen's investigation of the fuming liquor of Cadet, or sends short notices of what the Göttingen students, under the stimulus of his direction, are turning out.

Wöhler was an excellent draughtsman. Some of his drawings are as amusing as they are clever. Not less excellent are his verbal sketches, as may be seen in the admirable descriptions he sends Berzelius of his experiences of Paris and of the French chemists of the day—what Berzelius styles "die amüsanten Plaudereien ueber die Babylonischen Chemiker"—Gay-Lussac, Thénard, Dulong, Ampère, Chevreul, Robiquet, Bussy, Boussingault, Dumas, Pelouze. He thus, for example, describes Ampère:—

"Ampère. Ein Original wie es wohl wenige mehr gibt. Ein ziemlich grosser alter Mann, vom Alter etwas gebückt mit dicker hängender Unterlippe, ziemlich zahnlos, mit hervorstehenden, stier blickenden Augen, eine Perrücke, die hier und da den Kahlkopf durchblicken lässt, gekleidet in schwarzem Frack, der sehr alt und abgeschabt ist, und die Wäsche stets braun von Schnupftabak, den er in zwei Dosen mit sich führt. Dessen ungeachtet war mir dieser Mann einer der merkwürdigsten und respectabelsten. Den Neckereien und Witzen, die er von den anderen alten, namentlich von Arago und Thénard, zu erdulden hat, entgegnet er mit einer grossen Gutmüthigkeit und nicht selten mit komischem Witz. Nichts verdriest ihn, und er bleibt stets in demselben guten Humor. Er ist ohne Zweifel einer der tiefsten speculativen Köpfe und scheint eine ungeheuere allgemeine Gelehrsamkeit zu besitzen. Er ist selbst in den neuesten chemischen Entdeckungen ganz im Detail zu Haus."

Equally interesting, and no less characteristic, is his account of Dumas, whom he styles "der fleissigste und geistvollste der jüngeren franz. Chemiker." His description of the "kleiner, magerer Kerl" is too long to quote here, but it caused Berzelius to say in reply, "Ich möchte unendlich gern Dumas Bekanntschaft machen."

Had space permitted, we should have liked to have given a number of extracts in order to illustrate the wealth of information of historical value which is scattered throughout this correspondence. There is not a dull page in the two volumes. At times, indeed, the letters are of the greatest interest, and not unfrequently they are most amusing.

They have been carefully edited, and the commentary and foot-notes supplied by Dr. von Braun serve to elucidate many points which would otherwise be obscure. We congratulate Prof. Wallach on the production of a work which is a striking monument to the genius of two men of whom it may be said, as Liebig said of his own friendship with one of them, that now they are dead and mouldering, the ties which united them in life still hold them together in the memory of men as faithful workers who zealously laboured in the same field, linked together in the closest friendship. T. E. T.

A BIOLOGICAL PHILOSOPHER.

Die organischen Regulationen. Vorbereitungen zu einer Theorie des Lebens. Von Hans Driesch. Pp. xv+228. (Leipzig: Engelmann, 1901.) Price 3*s.* 6*d.* net.

DR. HANS DRIESCH is well known for his experimental contributions to "developmental mechanics" and as a man of strenuous "begriffskritische Thätigkeit." He is the author of a number of essays which give their readers good exercise in intellectual mastication, and the book before us is another hard nut. We are in entire sympathy with his endeavour after an exact criticism of biological categories and with his ideal of a "truly scientific biology" with thought-out and unified formulæ; we suspect there is some justification for his reproach that there is far too little "reines Nachdenken" in the tents of the biologists; and we share his hope that "in the future the naturalist will be more of a philosopher and the philosopher more of a naturalist"; but, to be frank, we wish that the author, who writes much, could see his way to write a little more clearly. We do not, of course, expect a philosophical criticism of biological categories to read like a novel, but we object to a book where the difficulty of individual sentences intermittently inhibits us in our effort to appreciate the general argument. It may be that biologists do not quite realise how much they are losing by not reading Driesch's essays; but does Driesch realise how much he is losing by ignoring the limitations of human faculty and of a busy biologist's leisure? We have to rub up our mathematics to understand Karl Pearson, we have to learn statistical methods, we are reminded that "nemo physiologus nisi psychologus," we have perforce to be palæontological, our attention to chemistry and physics is essential, we are told that some acquaintance with crystallography, mechanics and meteorology will not be amiss, and so on. Thus a book which demands for its due appreciation no small amount of familiarity with philosophical terms and methods comes almost as the last straw to break the back which mis-education has weakened. We remember, however, that Driesch's essay is intended for philosophers as well as for biologists, and we hope that the former will discover a limpid stream in what seems to us a rather turbid flow, broken here and there by luminous rapid rushes.

The work before us is one of a series of "studies" ("Vorbereitungen") for a theory of life. It deals with "organic regulations," *i.e.* with those vital phenomena which may be roughly compared to the action of a safety-valve in a steam-engine—a compensatory action annulling the disturbing factor and restoring equilibrium. It does not, however, include those coordinated locomotor regulations which we call instinctive adjustments, or those which occur after extirpation-experiments on central nerve-organs. The author has abundant material without these. In studying "organic regulations," which he does with abundance of concrete instances, the author has had a two-fold aim—(*a*) that of giving impulse to research by showing in the strong light of his criticism the gaps in the scientific structure, and (*b*) of advancing a step or two towards "a truly scientific biology." This improved biology will have its dominant concepts more thoroughly thought out and more adequately harmonised,

and it will give prominence to what is, after all, the essential feature in life, the feature studied in Driesch's "Regulatorik"—a supplement to "Organisatorik"! As this scientific biology progresses, a recognition of the need for a "dynamic teleology" will become plain, and everything will become clearer before the open secret of "the autonomy of vital processes." The plan of the book is clear. Part A. is devoted to a descriptive and critical exposition of facts, based especially on the work of Pfeffer and Goebel, Dieudonné and Herbst, and dealing with phenomena like those of immunity, functional and structural adaptations, regeneration, and so on. Part B. includes a definition of the concept of "regulation," a classification of "regulations," an analysis of the process of regulation and an exposition of the two lines of argument which lead to a recognition of the autonomy of vital processes. Part iii. is more technically philosophical, dealing with "Denknothwendigkeit," "Causalität," &c. —"den reinen Erkenntnisskritikern empfohlen."

Let us try in more detail to illustrate the drift of this difficult book. Pfeffer has shown that certain fungi, supplied simultaneously with several organic substances, almost always assimilate first that which has the greatest nutritive value, and go on to the second best only after they have exhausted the optimum. In scarcity of food and of oxygen, many living creatures illustrate an adaptive regulation of their metabolism. There is strong evidence in support of the conclusion that various living creatures can by the production of a specific antitoxin render themselves relatively immune to a specific poison. We have given three examples which may hint at what Driesch means by regulations in metabolism ("*Stoffwechselregulationen*").

Similarly, we all know that the CO_2-content of the blood has a regulative effect on the blood-pressure and on the respiratory movements, that cold weather has a regulative influence on the peripheral circulation which lessens the loss of heat, that plants show a regulative transpiratory response to altered conditions of humidity, that a fungus-cell will save itself from plasmolysis in a too-concentrated solution by the increased production of osmotically-active substances (acids), that our intestinal and renal cells behave not less effectively, and that, altogether apart from brain or eyes, as in the case of a decapitated Planarian, there are adaptive responses to light and other stimuli. These examples may serve to suggest what Driesch means by functional regulations ("*Energetische regulationen*").

It is well known that the leaves of the same kind of plant may have different mesophyll arrangement in different conditions, and that the new circumstances may be said to evoke their own corrective; that the structural adjustments of the same amphibious plant to thoroughly aquatic or to mainly terrestrial life are effective in both instances; and that many kinds of creatures, both animal and vegetable, adapt themselves to conditions of desiccation. These are a few simple examples of what Driesch means by regulative structural adaptations ("*Morphologische Anpassungen an Aüsseres*").

If the top of a conifer be destroyed, a dorso-ventrally disposed side branch may rise upright; if a crab's leg or a lizard's tail is lost, another may be made; a fragment of an animal, even of an embryo, may regrow the whole; a Hydra's tentacles may, in case of need, be, as it were, resmelted into body-substance; the lost lens of a newt may be replaced by adventitious growth from the iris. In short, the author discusses the whole subject of regeneration (recrescence and reparation), and finds therein abundant evidence of "regulation" ("*Restitutionen oder Wiederherstellungsregulationen*").

The four German phrases noted above in italics are the titles of the first four chapters of the book, but we have not been able to give more than a hint of the breadth of the author's survey of facts. We would in particular direct attention to the valuable essay on regeneration included in chapter iv.

Part A. is relatively plain sailing, for there we are dealing with more or less familiar facts, but in Part B.—the theoretischer Theil—we soon get into rough water. There are many sentences which we cannot even pretend to understand. We are first supplied with a definition of the concept "regulation."

"A regulation is a process, or a change in a process, occurring in a living organism whereby some disturbance of its previous 'normal' condition is wholly or partially, directly or indirectly, compensated, and the 'normal' condition, or at least an approximation to it, restored."

By an abstraction, which, if we understand it aright, seems only verbal, Driesch distinguishes two chief kinds of regulations—organisational and adaptive; the former restore disturbed organisation, the latter restore disturbed adaptiveness. The author restores our confidence, however, by admitting that organisation and adaptation interpenetrate one another ("durchdringen sich"). Then follows an elaborate classified catalogue of "regulations."

We have read with interest and instruction the chapter on the course of a regulative process.

"The primary stimulus in regulations consists in a removal of parts or in a disturbance of function. It may coincide locally with the effect, or it may affect the organism quite generally, in which case the localisation of the effect in relation to that of the stimulus is 'specificirt,' or it may have a localisation other than that of the effect. In the last case, mediations ('Vermittelungen') of the primary stimulus become necessary, which sometimes perhaps express themselves materially ('stofflich'), but usually operate in a quite unknown manner. They thus produce the secondary or true stimulus, while in the other cases of relation between localisation of stimulus and localisation of regulation the primary stimulus was also the true one. Regulations, whether functional or formative, presuppose secondary prospective potencies, in contrast to the primary potencies, which form the basis of the normal series of occurrences ('Geschehen'). In the diversity of the specific distribution and specific content of these potencies, we find, at the same time, the limitations of the regulative process ('Geschehen'); since every regulative process is at the same time a reaction-process, its 'specificity' has at the same time the general physiological and morphological characteristics of a reaction-process; but it has besides special teleological characteristics always of a particular kind. The time at which a regulation begins to operate we call the 'Regulationsmoment.'"

We have tried to translate this "Rückblick" on the analysis of regulation-processes, and we must apologise for the awkwardness of our translation. We hope, however, that it will suggest the luminosity of Hans Driesch's

writings and the absurdly easy-going way in which many physiologists deal with that adaptiveness of response which is the very essence of life.

The kernel of the book is to be found in chapters vi. and vii. of the second part, but the kernel is surrounded by a hard stone. These two chapters (which Driesch says "ich ganz besonders als mein Eigenthum ansehe") contain an analytic discussion of "form-regulations," an excursus on the problem of heredity and an exposition of the two proofs of the autonomy of vital processes Evidences of the falsity of Weismann's theory of development and theory of heredity—both of which Driesch condemns as hopelessly materialistic—are thrown in. The differentiation of harmoniously-equipotential systems is the one foundation of "vitalism"; the existence and genesis of equipotential systems with complex potencies is the other. Whether we study the development of a sea-urchin ovum or the growth of a Tubularian fragment, or regeneration in Planarians, or the potencies of cambium, we are brought face to face with regulative phenomena which put the most elaborate "machine-theory" of life out of court and lead us to recognise "the autonomy of vital processes." So far as we understand, it simply comes to this, that the formulæ of chemistry and physics, as at present conceived, seem quite inadequate for the scientific interpretation of the facts of life.

J. ARTHUR THOMSON.

AN INDIAN POCKET-FLORA.

Forest Flora of the School Circle, N.-W.P. Being a Descriptive List of the Indigenous Woody Plants of the Saharanpur and Dehra Dún Districts and the Adjoining Portion of the Tehri-Garhwal State in the North-Western Provinces, with Analyses. Compiled for the Use of the Students of the Imperial Forest School, Dehra Dún, by Upendranath Kanjilal, Extra-Assistant Conservator of Forests. (Calcutta: Office of the Superintendent of Government Printing, India, 1901.) Price 2*s*.

"I BELIEVE this to be the first botanical work of any importance which has ever been prepared by a native of India, and the Imperial Forest School may well be proud of having educated at least one native gentleman who has taken up botany as a study and botanical work as a labour of love." So writes Mr. J. S. Gamble in his introduction to this useful pocket-flora, which is designed for the use of Indian students of forestry.

Following upon this introduction, in succession are the author's preface, a brief glossary of botanical terms, a general analytical table of the Phanerogamia, an analytical key to the natural orders, accounts of the natural orders, with analytical keys to the genera and species, and descriptions of the latter, and, finally, indices to the European, vernacular and botanical names.

Even with the great aid of Sir Joseph Hooker's "Flora of British India" and Sir Dietrich Brandis's "Forest Flora of the North-West Province," it was no light undertaking to prepare a pocket-flora containing the required information. The author may, however, be congratulated upon his execution of the task.

The greatest difficulty in compiling this work was, doubtless, to select the subject-matter in such a manner as to keep the book small in size, yet devoid of vagueness. The author has elected to give rather full descriptions of the species, even including their vernacular names, habitats, habits, timber structure, uses, times of flowering, fruiting and leaf-shedding. The compression, and hence uncertainty, has therefore fallen upon the steps leading to the determination of the species, and particularly upon the glossary and analytical keys. The result is that the work, though extremely useful as a pocket reminder and aid to students (for whom it is intended), and for others possessing other guides, could not be easily employed by a novice or amateur for the determination of species.

The glossary, in addition to being somewhat too compressed, is occasionally somewhat obsolete, so that some of the definitions, for instance "cone," "endosperm," "lenticel," "moniliform," "prickle," "symmetrical," are scarcely satisfactory. The term "gregarious," though frequently used in the book, is not explained. In regard to this term, its continued use in botanical works is somewhat unfortunate when the more accurate term "social" is available.

The very compressed table showing the general scheme of classification is disfigured by one unnecessary and serious error; it divides flowering plants into Monocotyledons and Dicotyledons, and the latter again into Angiosperms and Gymnosperms!

In the key to the natural orders, the diagnostic characters given evidently refer in particular to the representatives in the flora described; for instance, the features given in reference to the Dipterocarpaceæ are, that they belong to the Polypetalæ, Thalamifloræ, and possess a valvate, irregular calyx adnate to the ovary and enlarged in the fruit; again, the Tiliaceæ are distinguished from the Sterculiaceæ by the free condition of their calyx. It is in this analytical table that some additions would be especially useful, especially such as facilitate identification in the absence of fruits.

Similar additions might be made in the analytical keys to genera and species. To take a specific case, the seven genera of Coniferæ—Taxus, Cupressus, Juniperus, Pinus, Cedrus, Picea, Abies—are distinguished from one another in this book primarily by the structure of their fruits. A novice having a specimen without fruits consequently could not take the first step towards identifying his plant. Yet it is very easy to give a brief key showing how to distinguish these seven genera by the arrangement and form of their leaves. In this particular instance, too, an especially good observer might well be puzzled by the distinction in the analytical key between Picea and Abies, the leaves of the former being described as acicular and multifarious, whilst those of the latter are said to be flat and bifarious.

As regards the get-up and printing of the book, great carelessness has been exhibited in the printing and possibly in the revision of proof; ugly curved lines of words and displaced letters occur, but misprints abound in glossary, tables, text, and in names of all kinds.

The defects of the book, therefore, are for the most part minor or matters of opinion, whereas its merits are great; and, as Mr. Gamble writes, "I am confident

that . . . this Flora will prove valuable to many successive classes of forest students and many successive forest officers whose duties may call them to the beautiful forests of the Dún and the splendid scenery of the adjoining Himalayan Mountains."

THE LAWS OF GEOGRAPHY.

Les Lois de la Géographie. 1er. Étude. Par Carlos de Mello. Pp. viii + 360. (Berlin: R. Friedländer und Sohn, 1902.) Price 10 marks.

SENHOR CARLOS DE MELLO, professor of geography at San Paulo, wields the pen of a ready and fearless writer, for he prefaces his volume of 360 pages on the laws of geography with the statement that it was written in two months, and the regret that it is consequently neither so clear nor so full as it might otherwise have been. "A short bibliography," he says, "concludes the work"; but since the bibliography occupies 224 pp. and the rest of the work only 136, we are inclined to think that the fact could be better expressed otherwise. Dedicated in Portuguese, written in French, printed and published in Germany, it is evident that the "laws of geography" are superior to the trammels of nationality or language. We were, in fact, unfavourably impressed by the preface, and it required some effort to approach the text with an open mind. On reading the chapters it soon became apparent that, however hastily the book was written, its preparation had required and had received years of thought, and study and wide reading. Even in the minor details of correct transcription of foreign names and the titles of publications, quite exceptional care must have been taken, for we have rarely seen a book so full of detail equally free from typographical errors.

The first of the "laws of geography" to be discussed is the law of asymmetry. It is pointed out how rarely parallelism is found in the larger features of the globe, how invariably (except in the case of Africa) a continent occupies a non-central position on its continental block, and how the relief of the continent itself displays a conspicuous dissymmetry, as in the position of the great plateaus of America. From this principle a series of laws of contrasts and harmonies is deduced with much ingenuity and confirmed to a considerable extent by the citation of examples. But even by the device of adopting asymmetry instead of symmetry as the standard of reference, it is impossible to avoid exceptions and contradictions. For example, in the "law of contrasts" which declares that the northern continents extend in the direction of the parallels and the southern continents in the direction of the meridians, the anomalous case of Australia is passed over without remark. We cannot help feeling that the author may possibly hold too precise and mathematical a view of symmetry in regard to the great features of the Earth's crust. It seems to us that broad features should be looked at broadly, and that on doing so the Earth's surface exhibits a rough symmetry in the alternation of height and hollow and the interlocking of ocean and continent. To a closer view, of course, the roughness appears more remarkable than the symmetry, but we have a suspicion that the symmetry is there as a dominant fact and the asymmetry only as a detail. We are by no means sure, however, that the author has not started with the idea of the symmetry of terrestrial features as self-evident, and therefore devotes his whole attention to the rectification of the broad principle in details.

Part ii. deals with the laws of mutual dependence of terrestrial forms, and considers the cases of the relation of rivers to valleys and of continents to oceans. It presents a number of relationships arrived at by many authors whose works were often separated by considerable intervals of time. Some of these have been accepted and incorporated in current views, others have been passed over and forgotten. We have not space to refer critically to these, or to inquire how far they agree with or contradict the recent systematic discussion of the relation of rivers to their valleys which has culminated in the geographical cycle of Prof. Davis; but we cannot let pass the opportunity of reviewing this thoughtful summary of a part of geographical theory without inquiring why it is that so much of the work of geographical theorists has passed unproductively into oblivion. The reason may perhaps be that an original mind devoted to purely geographical questions has only arisen at long intervals; the work of the predecessor has been forgotten or absorbed as a detail in other sciences before the successor has made himself heard. It may be that this is due to the absence from geography of the numerous less original workers who are attracted to the study of other sciences by prospects of gain, and, while unable to advance the science themselves, at least hand on the torch without extinction.

Whether this be so or not, the fact is beyond dispute that geography has not made the progress that it should have done; and, more particularly in this country, the geographer as such is scarcely recognised. Geographical questions have so frequently been treated as incidents in the course of geological, botanical, zoological or historical investigations that even the scientific world hesitates to accept geography as a subject deserving of the whole attention of a competent man. There are signs of improvement in this respect, it is true, and any improvement is matter for satisfaction. There is room for many books of the type of Prof. de Mello's, and it would be well if such books commanded many readers. The sympathetic attitude of the ancient universities to geography is a gratifying and hopeful circumstance, almost compensating for the inadequate or even retrograde steps of the newer academic centres. H. R. M.

OUR BOOK SHELF.

The Elements of Electrical Engineering. A First Year's Course for Students. By Tyson Sewell, A.I.E.E. Pp. xi + 332. (London: Crosby Lockwood and Son, 1902.) Price 7*s.* 6*d.* net.

THIS book, which is based upon courses of lectures delivered by the author, is primarily designed for students attending evening or other courses at the polytechnics. The course of lectures is more or less complete in itself, the necessary elementary theory being by no means neglected; the author, indeed, advises students to take a concurrent course in the scientific side of the subject, but such as are unfortunately unable to spare the necessary time will not, we think, find much in this book

which is beyond their comprehension. Undoubtedly, for a thorough training in electrical engineering the practical and theoretical sides of the subject must receive equal attention, but not all students can attend institutions where this is to be obtained. Many have of necessity to be satisfied with some sort of compromise, and one welcomes a book which is sound in its treatment and is admirably calculated to give such students the knowledge and information they most require.

Selection of some sort, when dealing with so large a subject, is of course necessary; the author has, we think, made a wise choice in the branches with which he deals and in the manner in which he treats them. These include, in addition to the general principles underlying the subject, batteries, accumulators, measuring instruments and supply meters, arc and incandescent lamps, and the continuous-current dynamo and motor. Particular apparatus is only described when it illustrates the general principles. Perhaps in a few instances there is a little too much detail, as, for example, in the description of the recording mechanisms used in meters. We would gladly see some of this matter omitted, and such branches as telegraphy, telephony and electrochemistry treated on broad lines instead. Mr. Sewell has the power of clear exposition, and has succeeded well in avoiding too mathematical treatment; the illustrations and diagrams are excellent. M. S.

The Force of Mind: or, the Mental Factor in Medicine. By A. T. Schofield, M.D., M.R.C.S., &c. Pp. xiv + 309. (London: J. and A. Churchill, 1902.) Price 5*s.* net.

IN this book, which is written for medical practitioners, Dr. Schofield appeals for a fuller recognition of the influence of the "mind" in causing and in curing disease of the body, and urges medical men to work for the reclamation of those waste and unmapped regions in which the religious fanatic and the quack doctor have hitherto been allowed to reign, occasionally producing, among much that is harmful, remarkable cures. He would have the subject taught and studied in the hospitals and great medical schools as a part of the regular curriculum of every medical student. There can be no doubt that the reforms advocated are much needed and that Dr. Schofield performs a useful service in thus pointing out the weak and neglected side of modern medicine. The author supports his contentions with many quotations from high authorities, both ancient and modern, and by the citation of numerous cases, and gives from his own experience many practical hints that should be valuable to practitioners. From the point of view of the psychologist, the book is vitiated throughout by the insistence upon the part supposed to be played by "the unconscious mind." This seems to be a figment similar in function to von Hartmann's "unconscious," *i.e.* it is a hypothetical agent to the activity of which is assigned all that is obscure and difficult of explanation in the workings of the nervous system. It is a radically vicious hypothesis because it is one that tends to baffle rather than to quicken the impulse to research. We are told that the phrase is not used merely to cover the more complex workings of the nervous system that are not accompanied by consciousness, and no reasons are assigned for rejecting this, which may now be called the generally accepted and intelligible view of the matter. The author seeks to support his position by quoting Dr. Bastian's plea, "Let us make mind include all unconscious nerve actions," and in so doing reveals the dire confusion of his own thoughts on this subject. He good-naturedly pokes fun at those who objectify "Nature" as a healing agent and then commits the same error, replacing "Nature" by the *vis medicatrix naturae*, which he identifies with the unconscious mind, and thus commits himself to the somewhat absurd dogma that such remedial processes as compensatory hypertrophy of the heart and phagocytosis are manifestations of the power of "the unconscious mind." Unless it can be shown, as at present it cannot be, that nervous activities and conscious processes together are inadequate to the explanation of all the facts of our mental life, the assumption of a third mysterious agent, call it "the unconscious mind" or "subconsciousness" or what you will, is much to be deprecated. W. McD.

Introductory Chemistry for Intermediate Schools. By Lionel M. Jones, B.Sc., A.R.C.Sc.(Lond.) Pp. vii + 195. (London: Macmillan and Co., Ltd.) Price 2*s.*

THE standard of this book is suitable for the junior classes of intermediate and secondary schools in which chemistry is used as a form subject, and the matter in it covers almost the same ground as that in the chemical part of Perkin and Lean's "Introduction to Chemistry and Physics." The treatment is rather different, as the historical side is not mentioned. The students are expected to have been taken through some course in physics or experimental science before they begin this course. It is important that they should have done so, as they are supposed to understand the balance, to weigh to milligrammes and to know the meaning of many physical terms.

The book opens with chapters on the description of bodies. Much attention should be given to this, as in a recent examination, when a fragment of Iceland spar was given for description, only a very small percentage of candidates recognised that definite shape was characteristic of the substance. Then follow chapters on simple operations, solution, evaporation, distillation. Afterwards come chapters on rusting, combustion, oxygen, hydrogen, chalk, coal and coal-gas, salt and salt-gas, and finally on acids and bases.

Some of the methods appear to us to be too elaborate for young children. There is, for instance, the complicated aspirator, which experience has taught the present writer is hardly ever clearly grasped. The correction for pressure is always a difficult point. Again, the students should never be allowed to make statements such as "1 litre of hydrogen weighs 0·09 gm." or "density of chalk-gas 0·00198 gm. per c.c." without stating definitely the temperature and pressure at which the weight or density has been ascertained.

We should have liked to have seen more attention given to the indestructibility and conservation of matter. This principle of chemistry cannot be grasped too early. Many of the elementary experiments are conducted with its tacit assumption, and we think it should be pointed out to the student. S. S.

Next to the Ground; Chronicles of a Country Side. By Martha McCullock Williams. Pp. xii + 386. (London: Heinemann, 1902.)

IN this dainty little volume, the author affords English readers a most interesting series of glimpses of the charms and passing events of everyday country life in the United States, after the fashion which so many writers have made familiar in England. A close observer of nature, and evidently imbued with the spirit that everything has an interest of its own, if looked at in the proper light, the author has hit upon a congenial subject, and treated it in a manner which affords an excellent example of the best style of "nature-teaching." The scene is laid in a southern county lying to the westward of the Alleghanies and eastward of the Mississippi, nearly midway between the mountains and the river; and whether describing ploughing with mules or oxen, discoursing of the quail, the partridge or the opossum, discussing shooting and fox-hunting or writing on horses, cows and pigs, the author is equally at home and equally interesting. Some of the information given, such

as the fact that the Derby is a race for three-year-olds (p. 255) and that female foxes are properly called vixens (p. 305) is perhaps somewhat superfluous, for English readers at any rate; and we rather fail to see why pigs are called cousins of opossums (p. 149).

To the naturalist, the most interesting chapters are those on wasps and ants, the "possum," quail and partridge, and insects generally, the account of the habits of the opossum being especially good. In the chapte on fox-hunting, the author confirms the statement of other writers that the so-called red fox (the American representative of the European species) cannot be run down without a relay of dogs, or, as we should say, hounds. Whether, however, this is due to the greater speed of American foxes or the inferior pace of American hounds remains to be told. In teaching people how much is to be learnt from the intelligent observation of ordinary surroundings, the book before us is clearly a step in the right direction. R. L.

L'Age de la Pierre. By G. Rivière. "Bibliothèque d'Histoire et de Géographie universelles." Pp. 183. (Paris: Schleicher Frères.) Price 2 francs.

IN this book we have a popular account of the Stone age following the traditional lines of French archæology. The author does not pay much attention to any discoveries out of France, but the French evidence being so complete this does not matter very much, especially as the book is not intended for students. The transition between the Palæolithic and Neolithic ages is recognised, and the author brings out clearly the culture of the immigrant Neolithic brachycephals. The statement on p. 136 that "certain peoples of Oceania still use very similar sticks [to the curved throw-stick of Egypt] which they call boomerang" is inexcusably vague. A description of megalithic monuments closes the account of the Neolithic age. The last chapter deals briefly with trepanation as a surgical method in Neolithic times. The author still employs the absurd term "bâtons de commandement" for the carved perforated antlers found in the caves; surely he must have known of the conclusive paper read by O. Schoetensack before the Congrès International d'Anthropologie et d'Archéologie at Paris in 1900, in which the author demonstrated their similarity to the bone dress fasteners of the Eskimo. In addition to twenty-six figures in the text, there are four half-tone plates, three from the paintings of Jamin and one from Cormon, which illustrate in a dramatic manner various incidents in the life of the men of the Stone age.

Flora of the Liverpool District. By C. T. Green. Pp. xii + 207. (Liverpool: D. Marples and Co., 1902.) Price 5*s.* net.

THE present work replaces a previous "Flora of Liverpool," which was originally published in 1872 and to which, later on, appendices were added. The revision of previous records and the compilation of recent data have been undertaken by members of the Liverpool Naturalists' Field Club, under the direction of Dr. Green. An original feature of the book consists of illustrations specially drawn by Miss E. M. Wood. These are for the most part characteristic and lifelike, and the figures of certain less common species such as *Ranunculus Lenormandi*, *Viola carpatica*, *Juncus supinus* and others are very useful, but in many instances the important features of the plant are omitted, or at any rate not emphasised, *e.g.* the root of *Lathyrus macrorhizus*. In the case of localities where plants are now extinct, as, for instance, Oxton Heath, it would have been well to notify this more definitely. It will be observed that comparatively recent strangers are being admitted, notably *Lycium barbarum*, while *Solanum rostratum* represents a quite modern American invasion. The geological chapter does not serve to dispel the impression that the book is too much of a dry catalogue, and even the submerged forest at Leasowe receives but a brief mention.

Examples in Algebra. By C. O. Tuckey, B.A. Pp. viii + 178. (London: Bell and Sons.)

IN making this collection, Mr. Tuckey has kept in mind the recommendations of the committee on the teaching of mathematics appointed by the Mathematical Association, and the result is seen in various welcome innovations. Thus, for instance, exercises on the use of graphs are given, some at quite an early stage; there are problems to show the application of algebra to geometry, mensuration and elementary physics, and so on. Checks on accuracy are frequently suggested, and there are numerous questions to be answered orally. Particularly good sets of questions are those on "Formulæ" (p. 23) and "On the Use of Theory of Form as Check" (p. 93). Merely artificial conundrums are happily rare; the worst we have noticed is "Simplify $\sum_{abc} \frac{1}{1 + x^{a-b} + x^{a-c}}$." Undoubtedly this is a very good collection, which may be recommended without reservation.

Children's Gardens. By the Hon. Mrs. Evelyn Cecil (Alicia Amherst). Pp. xv + 212; with illustrations (London: Macmillan and Co., Ltd., 1902.) Price 6*s.*

THE object of this daintily produced volume, with its profusion of beautiful illustrations, is to teach children enough about gardening to enable them to find pleasure and profit in the study and cultivation of plants. The book is written in a simple, practical way, and should be of real assistance to those who are able to indulge their taste for horticulture without too much attention to expense. Judging from the style of the book, we should say that the author will succeed in winning and retaining the interest of young children, who will, by the way, find occupation for the winter months as well as for the brighter seasons of the year. Directions are given as to how to utilise the leisure hours of winter in reading about the plants, in manufacturing garden seats and so on, for use in the garden during the days of summer. Altogether a pretty gift book.

School of the Woods: some Life Studies of Animal Instincts and Animal Training. By William J. Long. Illustrated by Charles Copeland. Pp. xiii + 364. (Boston, U.S.A., and London: Ginn and Co., 1902.) Price 7*s.* 6*d.*

MR. LONG believes that an animal's success or failure in the ceaseless struggle for life depends, not upon instinct, but upon the kind of training which the animal receives from its mother. He has written most of the sketches contained in this attractive volume in the woods, with the subjects themselves living just outside his tent door. The result is that we are provided with an interesting book which will go a long way to make all who read it lovers of nature and sympathetic, intelligent observers of animal life. Mr. Copeland's excellent pictures will help very much to make the book a favourite with children.

Macmillan's Short Geography of the World. A New Handbook for Teachers and Students. By George F. Bosworth. Pp. vi + 197; with maps. (London: Macmillan and Co., Ltd., 1902.) Price 1*s.* 6*d.*

THIS little book deals in a brief manner with the chief facts in the physical and political geography of the countries of the world. Numerous clear maps will enable the beginner to find many of the places mentioned in the text without the aid of a separate atlas. There is scarcely enough information about the many subjects included in the book to make the geography lesson interesting to children, but as a summary the book may be useful

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.*]

Note on the Discovery of the Human Trypanosome.

WE have recently seen in the medical Press several very inaccurate accounts regarding the authorship of the important new discovery of trypanosomes in human blood, and of the disease caused by them. For instance, the *Journal of Tropical Medicine* for November 1 (in giving an anonymous description, supported by an editorial, of a case just observed by Drs. Daniels and Manson) attributes the original discovery to Dr. R. M. Forde. It does not mention even the name of Dr. J. Everett Dutton. Dr. Dutton is an old student and assistant in this Laboratory, and is now away on the West African Coast; and we are of opinion that he has a claim to be considered in the matter of this discovery. Another periodical, *The Hospital* for November 8, while also omitting Dr. Dutton's name, states that the discovery was made "within the last few days" by the London School of Tropical Medicine. We believe that such statements are calculated to distort the history of the discovery, and should therefore like to have an opportunity for correcting them promptly in your pages.

The facts regarding the history of the discovery—which was made nearly a year ago—have already been publicly and adequately stated both by Dr. Forde[1] and by Dr. Dutton.[2] Dr. Forde, Colonial Surgeon, British Gambia, tells us that the case in which the parasites were first observed came under his notice in May, 1901; that he found in the blood "small worm-like, extremely active bodies, which I prematurely pronounced a species of filaria," although this conclusion "became doubtful after repeated observations of the parasite"; and that he showed the case in December, 1901, to Dr. J. Everett Dutton, then upon a mission of the Liverpool School of Tropical Medicine to the Gambia, and that Dr. Dutton "at once recognised" the parasite "as a species of Trypanosoma." Dr. Dutton's two papers corroborate these statements of Dr. Forde. After the recognition of the new organism, Dr. Forde gave the first records of the case to Dr Dutton. Dr. Dutton it was, as Dr. Forde says, who recognised that the fever was of a peculiar undulant type; Dr. Dutton it was who positively excluded malaria as the cause of the symptoms; it was he who saw that those symptoms roughly resemble those of tsetse-fly disease and surra; it is he who has published accurate and able descriptions, drawings and charts of the parasites and of the case; and it is he who is now, with Dr. Todd, investigating the subject in West Africa for the Liverpool School of Tropical Medicine.

Dr. Forde is undoubtedly deserving of great credit for his part in the matter, and we think his name should be associated with the discovery. But, until Dr. Dutton was called in, he published no account of the case and did not recognise the nature of the parasite, or the peculiarity of the symptoms. In order to make a discovery, it is not sufficient merely to see an object; it is necessary also to recognise the nature of the object seen and to publish accurate and adequate descriptions of it. For example, Virchow and others long ago saw the parasites of malaria without recognising their parasitic nature; but it is to Laveran, who did recognise their nature, that science gives the credit for the discovery of them. It is certain that Dr. Dutton was the first clearly to observe and to signal the existence of trypanosomes in human blood, and the first to give accurate descriptions of the new organism; and it is to him that science will give the principal credit for the new observation.

It seems to us particularly unfortunate that the *Journal of Tropical Medicine* should have so ostentatiously omitted the name of Dr. Dutton at the moment when it was engaged in giving great prominence to a case of Drs. Manson and Daniels, which, after all, would probably have escaped notice but for the previous work of Dutton. We may mention also—and this is another point which the *Journal of Tropical Medicine* appears to have forgotten—that before his departure for Africa, Dr. Dutton gave at this Laboratory a detailed demonstration, both of the parasite and the clinical features of the case, to Drs. Manson and Daniels, and to one of the editors of the periodical referred to. The omission, then, appears to be due rather to want of memory than to want of knowledge. The journal also states that while the first case (namely, that of Dutton and Forde) was regarded only as a "curiosity," the "discovery of a second case" (namely, that of Daniels and Manson) "opens up a new field for investigation and elucidation," and so on. This view of the relative importance of an original discovery and of a mere confirmation of that discovery is somewhat novel. But the case of Drs. Manson and Daniels is not the second case at all. The second case—also discovered by Dr. Dutton—was that of a child in British Gambia.

It is unnecessary, after what has been said, to deal with the statement made in *The Hospital*. It affords, however, an instance of the curiously rapid manner in which such errors are often propagated in the Press.

We should note that Barron and Nepveu have also claimed to have found flagellates in human blood; but, as will be seen from their writings, their descriptions are so inadequate as to fail to convince us of the accuracy or even the nature of their observations.

RUBERT BOYCE,
RONALD ROSS,
CH. S. SHERRINGTON.

Thompson Yates Laboratories,
University College, Liverpool.

[1] *Journal of Tropical Medicine*, September 1.

[2] "Thompson Yates Laboratory Reports," vol. iv. part ii., May; and *British Medical Journal*, September 20.

The Secular Bending of a Marble Slab under its own Weight.

JUST east of the old brick church in the Rock Creek Cemetery near the Soldiers' Home in Washington is a phenomenon which, so far as I know, is unique. A marble slab, originally plane and resting on four posts at the corners, in the course of about half a century has gradually bent under its own weight and a section of it assumed the figure of a catenary. Careful measurement shows the slab to be 2 inches thick, 35 inches wide and 70 inches long; the posts supporting the slab are 7·5 by 6·75 inches in horizontal section, and so placed that the inner edges (which now furnish the support) are 52 inches apart. The stone has bent so much that the ends of the slab are tipped up one inch above the outer edges of the posts on which they formerly rested. At a distance of 12 inches from the ends, the bending is 1·25 inches; at a distance of 24 inches, the bending is 2·50 inches; and at the centre (distant 35 inches from either end), the bending is 3·05 inches. The stone is a little rough from the effects of atmospheric decomposition, and, of course, the hundredth of an inch is hardly to be depended upon in these measures.

Inquiry as to the epoch of erecting the stone did not lead to definite information, but the inscription gave a date of 1853, thus indicating that it has probably been in position approximately half a century. The superintendent of the grounds has been there some twenty years, and he assured us that the bending of the stone had become much more decided in recent years.

The slab is composed of white marble, of about the texture of the material used by sculptors, and appears sufficiently crystalline and homogeneous to take a polish. On the under surface, the stretching of the material has given rise to a number of small cracks, such as develop in plaster where it bends. The chief interest in the phenomenon arises from the evidence it furnishes that *marble is in reality a fluid of enormous viscosity*. This has, of course, some bearing on the question of the rigidity of the rocks composing the crust of the earth and the gradual adjustment of the earth's figure under gravity.

T. J. J. SEE.

Washington, D.C., November 3.

November Swallows.

SINCE the end of October I had not seen a single swallow. This afternoon, however, between four and five o'clock, I saw a party of six, or more, leisurely hawking over the trees and house-tops. It was occasional appearances such as this, after the general exodus, which led Gilbert White to believe that swallows did not all migrate. On seeing some on November 4, near Newhaven, he writes:—

"I am more and more induced to believe that many of the

swallow kind do not depart from this island, but lay themselves up in holes and caverns; and do, insect-like and bat-like, come forth at mild times and then retire to their *latebrae*."

So far as I can make out, November 7 is the latest date on which White records having seen swallows. In 1900 I observed them here throughout the month of November—usually not more than from one to three at a time—up to November 30. In 1901 I never saw one after the end of October.

Recent study of migration seems to show that those individuals of a species which breed farthest north are the last to migrate south. But it is hard to believe that these November swallows are those which have bred in the most northern region visited by the species, say, Iceland and the Faroes. How could they have subsisted in those more boreal climes while ours, "foggy, raw and dull," forced them to flee across the seas? I venture to suggest that they are individuals which had already accomplished a part of their southward retreat. They had reached, perhaps, the south of France or Spain. It would be a small matter for such powerful fliers to pop back for a brief interval, tempted by a spell of mild weather. And there is reason to believe that in retiring to their winter quarters many species perform the journey in a much more leisurely fashion than when they make their great rush to their breeding grounds.

G. W. BULMAN.

13 Vicarage Drive, Eastbourne, November 12.

THE MYCENÆAN DISCOVERIES IN CRETE.

FOR several years past the attention of archæologists has been directed more and more to Crete. The reasons for this access of interest in the antiquities of the great Mediterranean island have already been explained in the two articles on the "Older Civilisation of Greece," which appeared in NATURE, vol. lxiv. p. 11, and vol. lxvi. p. 390. In Crete, revelations of the older culture of the Greek lands are now being made at a very rapid rate, and it is to Mr. Arthur Evans that the palm for these revelations must be awarded. Through many years of greater or less success he has explored the byways of Crete, convinced that the great island would eventually yield results of the greatest importance for the elucidation of the early history of Mediterranean civilisation, and now he has had his reward in the remarkable discoveries which have attended the systematic excavations which he has at last been able to carry out on the site of the ancient Knossos, the city of Minos himself. It is the excavation of Knossos which has directed public attention to the possibilities of Cretan exploration, and there is no doubt that in importance this excavation ranks far higher than any other in Crete. This being so, it is with Knossos that we may fitly commence our survey of these Cretan explorations. Enough has been said in the two articles previously mentioned to give the reader a general idea of the discoveries at Knossos, and of the peculiar characteristics of the earlier Mycenæan age in Crete—which we ought, perhaps, rather to designate, with Mr. Evans, the "Minoan" age—which have been revealed by these discoveries.

Knossos lies about four miles south of the town of Candia, or Herákleion, as the Greeks call it. The walk thither is pleasant; the road (a rarity in Crete) resembles any English country lane. In front rises the curious isolated cone of Iuktas, the fabled burial-place of Zeus, which seems steadily to increase in size as we proceed southwards, and at Knossos dominates the surrounding country. Breasting a hill, Iuktas comes into fuller view; on either hand are rolling downs, backed by mountains; further on, a couple of roadside wine-shops, a house, and a path off to the left across the fields to a white patch with a wooden summer-house in the middle of it, from the top of which floats the Union Jack; this is Knossos, where Minos judged, where Theseus slew the Minotaur.

Coming from the west, one enters first the great western court, which, if one is not a timid Dryasdust, but an archæologist who takes pleasure in repeopling the ground on which he stands with those heroic figures which are associated with it in legend, one may call the Dancing-floor of Ariadne if one will. Crossing to the south-west corner, one reaches the remains of a great gate at this end of the beautiful wall of polished gypsum blocks which separates the court from the rest of the palace, and so round through the corridors which once were adorned with frescoes of tribute-bearers coming in procession, into the long north-and-south gallery out of which open to the left the curious long cupboard-rooms or "magazines" in which were stored the great earthenware *pithoi*, with ornament in relief, containing tablets or other objects of value, which are so characteristic of Minoan palaces. Most of these remain *in situ*, some broken or overturned by falls of masonry, many roughly restored with plaster to keep them together. In the floors open the curious lead-lined safes or receptacles for valuables, called "Kaselllais" by the diggers, made with the greatest care in double tiers, and still almost excavator-proof. Unluckily, most of the golden treasures which they once contained seem to have been removed before the final catastrophe which overwhelmed the palace of Minos. Over one of these magazines stands the "summer-house" already mentioned, which is really a kind of gazebo, built by Mr. Evans for the purpose of obtaining a panoramic view of the excavations. Hence we pass round to the right, to the throne-room, which opens on to the central court. This is now roofed over, in order to protect its contents from the weather, and the curious brightly-coloured modern Mycenæan pillars, tapering from capital to base, which occupy the site of the ancient columns, with the red-painted walls, give us an interesting idea of what the place once looked like. It should be remembered that there is no "restoration" here; it is purely a work of conservation; the form and colour of the modern pillars are supplied from a Knossian fresco, the colour of the modern walls is but a continuation of the colouring of the ancient. The effect is good. Leaving the throne-room of Minos, with its curious throne with back in the form of an oak-leaf and legs carved with Gothic crockets, its stone seats for the councillors, its bath and its great stone bowl, we cross the central court eastwards to the edge of the hill, and then descend part of the wonderful quadruple staircase, which was excavated by Mr. Evans with so much difficulty and is now held in place by wooden arches, to the "Hall of the Colonnades," in which one might fancy oneself in the court of an Italian palace. Above us is an open loggia, which can be attained from half-way up the stairs. The existing palace is just here nearly three stories high, and was originally four or more! As Mr. Evans points out (*Journal of Hellenic Studies*, xxi. p. 335), "even at Pompeii staircases one over the other have not been brought to light." Passing out, we reach the "Hall of the Double-Axes," so called from its pillars and wall-blocks, which are engraved with the mystic sign of the god of Knossos and of Diktê, who was afterwards (?) identified with the Aryan Zeus. Everybody knows the brilliant philological explanation by Mayer and Kretschmer which has made clear the meaning of Λαβύρινθος as "Place of the Double-Axe," and so has converted the guess that the Knossian palace is the Labyrinth itself into a practical certainty.[1] One

[1] In the *Journal of Hellenic Studies*, xxi. part ii. p. 268, Mr. W. H. D. Rouse complains of my having followed Mr. Evans in accepting this explanation of the word "Λαβύρινθος" and having adopted his identification of the Knossian palace with the Labyrinth in my book "The Oldest Civilization of Greece." Mr. Rouse does not accept the explanation, and so will not adopt the identification. I apprehend, however, that his refusal to accept the explanation of the name is due to the fact that he is hardly cognisant of all the arguments for it. For instance, he says that the termination -νθος is not explained! (*loc. cit.* p. 274). He will find it fully explained in

may believe in the existence of the Labyrinth without believing in the existence of an actual Minotaur!

Leaving the Hall of the Double-Axes, we bear round to the left above the little valley of the Kairatos to the ancient northern entrance, where is to be seen a very interesting surface-drain which carried off water from the central court. And now we again stand outside the palace with our faces turned in the direction of Candia.

Looking back, we are at once struck by a feature of Knossos which entirely differentiates it from Tiryns or Mycenæ. It is not fortified. "Bastions" there may be at the northern entrance, but they do not seem to have been of any particular military value. The Labyrinth was not a fortress, it was a peace-time palace, the residence of kings who ruled a settled people and needed not to fear armed attack. But one day war came to Knossos, and the dominion of the proud Minoan thalassocrats disappeared in the smoke of the burning Labyrinth.

This open and unfortified character of the palace testifies to the high state of civilisation of the Minoan Knossians, thus agreeing with all tradition of the great Cretan law-giver who personifies the ancient princes of Knossos. But high civilisation often brings degeneracy in its train, and, as has already been pointed out in these columns (vol. lxvi. p. 393), there are many traits in the culture of Knossos which give the modern observer a decidedly sinister impression.

Of the Mycenæan town of Knossos, excavated by Mr. Hogarth in 1900, which lay to the south-west of the palace, there is not much to be seen. A discovery of Mr. Evans's, made during the present season (1902) and communicated by him to the *Times*, may, however, give us some idea of what the town may have looked like. To quote Mr. Evans:—"This is the remains of a mosaic, consisting of small porcelain plaques, which in its original form seems to have represented scenes disposed in various zones recalling the subjects of Achilles' shield—the walls and houses of a city, a river, a vine and other trees, warriors with bows, spears, and throwing sticks, besiegers and defenders, and various animals. But the most surprising part of all are the houses of which the city is composed. Fragmentary as are their remains, it has been possible to reconstitute about a couple of score of these. The varying character of the structure—stone, timber, and plastered rubble—is accurately reproduced; and the walls, towers, gateways—a whole street of a Minoan city rises before us much as it originally stood. But what is even more surprising than the fact that the elevations of these prehistoric structures should be thus recovered for us intact from the gulfs of time is the altogether modern character of some of their features. Here are three-storeyed houses (some of the semi-detached class showing two contiguous doorways) with windows of four panes, or double windows of three panes each, which seem to show that the inmates of the houses had actually some substitute for glass." Perhaps they had window-glass; why not? It was known to the Romans, and has been found at Pompeii. However this may be, it would indeed seem, as Mr. Evans says, "as if the brilliant and unexpected character of the finds" at Knossos is "likely to maintain itself to the last."

We retrace our steps to Candia and thence start for Phaistos, on horse- or mule-back. We pass Knossos once more, we pass Iuktas, and so on over the watershed between the Ægean and Libyan seas, with snowy Psiloriti (Ida) on the right hand and Lasíthi (Diktê) on the left, into the Messará, the valley of the Ieropotamos, to the acropolis-hill of Gortyna, which stands at the entrance of a remarkable gorge through which flows the Lethaios of the ancients. The site of this once famous city, which supplanted both Knossos and Phaistos as the chief town of Crete, was investigated by the Italians two or three years ago, and again examined by Mr. Taramelli in 1901; he found no traces of occupation in Mycenæan days. Hence we pass down the broad Messará to the triple acropolis of Phaistos at Agia Photiá, first identified by Admiral Spratt.

Phaistos stands upon a triple-peaked hill, which forms the end of the spur which divides the Messará from the maritime plain of Dhibáki, where the Ieropotamos reaches the sea. At its base runs the Ieropotamos. Its situation is therefore much stronger than that of Knossos, and seems to be better adapted for a fortress than the low knoll on which the Minoan metropolis stood. On the third, the lowest, peak, Prof. Halbherr and the Italian expedition have excavated a Mycenæan palace, the architecture of which is entirely Knossian—Minoan—in type; we find here the same corridors, the same magazines, the same pillared halls and open courts as at Knossos. There is no doubt whatever that the palaces of Knossos and Phaistos were built by the same people and approximately at the same period. Legend ascribes the foundation of Phaistos to Minos, and there is no reason to doubt that this legend enshrines forgotten history. If, then, Phaistos was founded by the Knossians, its palace would be expected to show signs of a somewhat later date than Knossos. These signs are quite apparent. Phaistos marks a development of, an improvement on, Knossos. In some ways it must have been much finer; certainly its ruins are much more impressive. The masonry at Knossos is neither so good nor so well preserved as that at Phaistos; the curious triangular *θεάτρον* at Phaistos, with its altar and tiers of stone seats, has no parallel in the mother-palace, nor has the latter now anything to compare with the great and broad stairway which leads up to the pillared hall at Phaistos, although it is possible that some similar stairway may once have existed at Knossos, but has now disappeared. Phaistos, then, makes a finer show than Knossos, but is really far less interesting. In the first place, it has no legendary past to speak of; we know nothing of its ancient dynasts, while Knossos was the city of Minos, the metropolis of the ancient dominion over land and sea which is connected with the name of the great legendary lawgiver, and its palace is in all probability the identical Labyrinth which the legendary Dædalus built for the great king. In the second place, Phaistos is nothing but bare walls, fine though their masonry may be, and has yielded practically none of those minor discoveries which tell us so much more than bare walls can; while Knossos, on the other hand, has, as we know, yielded minor discoveries of the utmost importance, which have revealed to us most of our present knowledge of Minoan civilisation and have told us its date.

One difference between Knossos and Phaistos, however, is noticeable, and that a somewhat significant one. Phaistos was more strongly fortified than Knossos, and in many places the palace walls, built of ponderous stones like Mycenæ and Tiryns, are visible. This we should expect in a building which was evidently placed where it is for more or less military reasons, and it confirms the idea that Phaistos was built by the Minoan rulers of Knossos with the direct purpose of controlling

the chapters of Kretschmer's *Einleitung* on the languages of Asia Minor and the pre-Hellenic population of Greece (x., xi., p. 289 *ff.*; *esp.* p. 404). I should also like to refer him to my article in NATURE, November 14, 1901, Suppl. p. vii., where he will find the matter explained to the best of my ability. With regard to another point which has been urged against the correctness of the identification of the Knossian palace with the Labyrinth as being, *par excellence*, the "Place of the Double-Axe," I confess that I do not see that the fact of the Double-Axe sign being cut upon the rough stone blocks of the walls, which were intended to be covered with stucco or with gypsum slabs, is of much weight, as I am inclined to regard these signs as hieroglyphs, intended merely for the guidance of the masons, signifying that such and such a block was intended for a building or room somehow connected with the worship of the god of the Double-Axe. Indeed, the hieroglyphic of their tutelary deity may have been used by the Minoans as a sort of heraldic device to mark "Government stores," exactly like the British "broad arrow." I do not know whether this explanation will commend itself to Mr. Rouse or not, but it appears natural enough to a student of Egyptology.

the mouth of the Ieropotamos and the more southerly haven of Mátala, and so securing the communications of Knossos with the southern sea. Originally founded by the Knossian princes Phaistos probably was not; such a site must always have been occupied from the earliest days of human settlement in the Messará, and, as a matter of fact, primitive pottery of days long anterior to the Mycenæan period has been found at Phaistos, and in the near neighbourhood is Agios Onouphrios, where one of the most important discoveries in Crete, that of burials of the primitive pre-Mycenæan or "Amorgian" period, containing Egyptian scarabs of the twelfth dynasty (*c.* 2200 B.C.), was made in 1887. But its foundation as an important city Phaistos no doubt owed to the conquering rulers of Knossos, and to them the construction of its fortified palace is most probably due.

This season is announced the discovery at Agia Triadha, between Phaistos and the sea, of what is described as a "country residence" of the Phæstian princes, which will no doubt prove of very great interest. Indeed, it appears that a large number of Mycenæan seals, an inscribed tablet of the Knossian type, and other objects of interest, including a portion of a stone vase sculptured with a most realistic representation in relief of a body of men leaping and dancing in a religious procession (apparently a harvest-home, judging from the implements carried by the dancers), have already been found here. The neighbourhood of Phaistos is rich in remains of the older civilisation of Greece. Northwards, at the end of a valley of Ida, lies the cave of Kamárais, where was found the store of that peculiar pottery which has proved to be characteristic of the period of Cretan art which immediately precedes the true "Mycenæan," the period to which the earliest foundation of the palaces both of Knossos and of Phaistos must be assigned, the period, probably, of the earliest Minoan kings. A large store of this ware was discovered by Mr. Hogarth in the town of Knossos, and it has also been found at Phaistos, Zakro and other Minoan sites. Further, and this is most interesting, it was also found by Prof. Petrie at Kahun, in Egypt, and may there be roughly dated to the period between the twelfth and eighteenth dynasties, not earlier than the twelfth, but no doubt earlier than the eighteenth. It was, then, imported into Egypt from Crete between 2000 and 1700 B.C. Here is another piece of evidence as to date which fits in absolutely with the evidence of the alabastron-lid of Khyan and the statuette of Ábnub, found at Knossos.[1] Everything points to *c.* 2000–1500 B.C. as the date to be assigned to the early Minoan period.

The other well-known cave on Mount Ida, the "Idæan Cave" *par excellence*, explored by Messrs. Halbherr and Orsi, contained objects, mostly of post-Mycenæan and early classical date, exhibiting strong traces of Phœnician influence. It lies further north, above the Nida plain.

To the south-east, in the direction of Gortyna, stood once a Mycenæan city on the curious isolated hill of Kourtais, the necropolis of which has yielded interesting Late-Mycenæan and Geometrical finds. Another explored site which may be mentioned is Priniá, to the north; away to the east, in the province of Pediada, where the Omphalian Plain meets the lofty mountains of Lasithi, the ancient Diktê, and the as yet unexplored site of Lyttos awaits the excavator's spade, the necropolis of Erganos has yielded the interesting tombs of a Mycenæan hill-settlement, and the district of Embaros innumerable traces of extensive occupation in Mycenæan times, both early and late. This country must in Minoan days have formed part of the immediate territory of Knossos; the town of Lykastos, which lay within it, was said to have been founded by Minos, and Lyttos is associated with the legends of the Cretan Zeus, who was supposed to have passed his childhood in a cave on the slopes of Diktê. This cave has been identified, and Mr. Hogarth has explored it. It is a "large double cavern situated to south-west of, and about 500 feet higher than Psychro, a village of the upland Lasithi plain," a curious tract which lies in the middle of and surrounded by the Dictæan mountains. Mr. Hogarth's discoveries in the Dictæan Cave have already been noticed in NATURE (vol. lxiv. p. 15); it need only be said here that he has shown that it was probably one of the holiest places of Crete, and the hundreds of Mycenæan votive double-axes which he found are final proof of the identity of the prehistoric God of the Double-Axe with the Cretan Zeus, which again shows the identity of the Cretan with the Karian Zeus, whose emblem was the λάβρυς or Double-Axe and the seat of whose worship was Labraunda, which confirms the equation Λαβραυ-νδα = Λαβυρι-νθος, explains Λαβύρινθος as the "Place of the Double-Axe," and so identifies the Knossian palace as the Labyrinth of Minos. Most interesting is the discovery in the Dictæan Cave of a bronze figure of the Egyptian God Amen-Rā, Amonrasonter, "the King of the Gods," probably dating to about the eleventh or tenth centuries B.C., which was perhaps dedicated by some Egyptian traveller who identified the God of the Double-Axe with his own supreme deity, thus anticipating the later conjunction Zeus-Ammon by many hundred years! From this cave came the well-known inscribed libation-table, now in the Ashmolean Museum. It was no doubt from Diktê that the Cretan mountain-goddess Diktynna, also called Britomartis, took her name, and not from the Greek δίκτυον, "a net."[1]

South-west of Diktê is a district in which many Mycenæan sites still await the spade, as at Rotási (Rhytion) and Viano (Biennos); on the south coast is Arvi, where, a few years ago, an important find of early Mycenæan stone vases was made, and where an ancient cult of Zeus probably points to a direct connection with Knossos.

Rounding the northern slopes of Diktê, we enter the province of Mirabello, where, at Milato on the north coast, an important Mycenæan tomb has been found, and where, further south, the imposing ruins of Goulàs, the ancient Lato, investigated by Messrs. Evans and Myres and afterwards partly excavated by a French explorer, M. de Margne, without much success, no doubt mark the site of a Minoan city and palace. The place-name Minoa preserved in classical days the tradition of Knossian domination hereabouts also. We have now reached another depression in the mountain-system of Crete, the hilly plain which lies between the Gulf of Mirabello and the district of Hierapytna on the south coast. Before us to the east rises another mountain-mass, which stretches from sea to sea and seems to block all further progress eastward. This is the Aphendi Vouno of Kavousi, which bars off from the rest of Crete the extreme eastern portion of the island, the modern province of Sitía, of old the territory of the Eteokretans, who were said to be first cousins of the non-Aryan Lycians, and certainly still spoke an absolutely non-Greek idiom even in classical times. In the Eteokretan country itself we find little proof of Minoan occupation except here and there on the coast, so it is probable that direct Knossian control in Minoan times ended with the Hierapytnian territory. The most easterly Minoan town in this district appears to be that discovered in 1901 by Miss Harriet Boyd at Gournia, on the Gulf of Mirabello, at the foot of the Aphendi, and nearly opposite the island of Psyra. In the same neighbourhood, at Kavousi, Miss Boyd had made fruitful excavations in the preceding year, but her discoveries at Gournia far

[1] See NATURE, vol. lxvi. p. 392. The identification of the Kahun ware with that of Kamárais is due to Mr. J. L. Myres.

[1] See "The Oldest Civilization of Greece," p. 296, where I have explained the form of the name.

exceed these in interest, and are of such great importance that the following short description of them, taken from the *American Journal of Archaeology* for January–March of this year, p. 71, is here quoted:—"A Mycenæan acropolis was found, approached by two long streets, about 5 feet wide, with terra-cotta gutters and good stone pavements. These lead to the palace of the Prince. Right and left are side streets and houses. The steeper parts of the roads are built in steps. The houses have rubble foundations, but the upper walls are of brick. In some parts of the palace the upper walls are of ashlar. Several houses have walls standing to the height of 6 or 8 feet. Plaster is used extensively for the facing of walls and door jambs. There are many proofs of the existence of a second story. Twelve houses have been excavated, most of which have eight rooms or more. Of the palace, fourteen rooms have been excavated, chiefly magazines, like those at Cnossus. A terrace court, a column base, and an aula, evidently belonging to a portal, have been uncovered. In the centre of the town is a shrine. It is a small, rectangular building, near the top of the hill. The most noteworthy of its contents are a low terra-cotta table, with three legs, which possibly served as an altar; cultus vases with symbols of Mycenæan worship; the disk, 'consecrated horns of the altar' [see NATURE, November 14, 1901, Suppl. p. vii.], and the double-headed Axe; and a terra-cotta idol of the 'Glaucopis Athene' type, with snakes as attributes . . ." The smaller objects found are of the usual Mycenæan type, including stone and bronze utensils. Very significant is the fact that the Double-Axe is found painted on vases, and carved also on one of the stone blocks of the palace, as at Knossos and at Phaistos. This marks the place as Minoan at once. Very possibly it was the frontier-town of the Knossian dominion on the Eteokretan border. It is "the most perfect example yet discovered of a small Mycenæan town." In fact, a Minoan Pompeii on a small scale!

Beyond the Aphendi Kavousi we are in the province of Sitia. On the site of the ancient Eteokretan capital, Praisos, excavations have been carried on by Prof. Halbherr and by Mr. R. C. Bosanquet, the present director of the British School at Athens. Here a few remains of Mycenæan culture were found by Mr. Bosanquet, including a large "beehive" tomb. Another inscription in the non-Hellenic tongue of the Eteokretans[1] was discovered, of course, of a date long posterior to the Mycenæan period!

Mr. Bosanquet has also excavated at Petras, a place on the harbour of Sitia, and, during the present year, at Palaiokastro, on the east coast, south of Cape Sidero, where he has found some very curious Mycenæan interments. Palaiokastro is, I am informed by Mr. Bosanquet, bigger and more important, as a site, than Gournia and Zakro, but more disturbed by cultivation. As a Mycenæan settlement, it is quite as noticeable as Zakro; a remarkable characteristic is the occurrence, dotted all over the plain, of the foundations of Mycenæan farmsteads, on which Mr. Bosanquet lays stress, as a fresh proof of the peaceful security enjoyed by the Mycenæan Cretans. Further south again, at Zakro (which Spratt considered to be the site of Itanos, but probably erroneously, since Erimopoli, north of Palaiokastro, has a better claim to this honour), Mr. Hogarth has discovered the remains of an important Mycenæan port-town, which, he thinks, was a Minoan outpost, a Knossian colony planted here to hold the most important haven on the east coast, which is still used by the sponge-fishers, who make it their rendezvous before starting for the African coast. Mr. Hogarth's discoveries here have been more fully referred to in the last volume of NATURE, p. 394, *q.v.*

We thus see that the main result of the excavations on Mycenæan sites in Crete which have been going on for the past two or three years has been the proof of the existence in the great Mediterranean island of a civilisation which was already ancient and highly developed at least as early as 1700 B.C., and was in connection with Egypt at that date and probably earlier. The origin of this culture is at present veiled from us; but various strange indications of a primeval connection with Egypt seem to point to *Africa* for its origin. More than this cannot be conjectured at present. Its centre seems to have been the central portion of Crete, the territory of Knossos and Phaistos, which is inextricably bound up with the famous legends of Minos and the Knossian thalassocracy. Mr. Evans's discoveries have breathed life into these legends, and though we may not believe in Minos as a historical personage, at any rate we see that he represents a dynasty and a power, and so we can speak of the Minoan dominion in Crete and of the Mycenæan civilisation of Crete, the chief monuments of which are at Knossos and Phaistos, as "Minoan."

The Knossian dominion extended in the east apparently as far as the borders of the independent Eteokretan country. One or two Knossian colonies seem to have been established on its further coast, such as Palaiokastro and Zakro. Similar Minoan colonies seem to have been also established in other islands of the Ægean, as in Melos, at Phylakopí. That we have here a confirmation of the legend of the Minoan thalassocracy there can be little doubt.

How far the Knossian dominion extended westward is as yet unknown. Axos, which lies at the upper end of the Mylopotamo valley at no great distance from the Knossian district, is now being excavated, but has as yet yielded nothing Mycenæan. There can, however, be little doubt that it was a Minoan city. I have elsewhere[1] suggested that the *Uashasha*, who invaded Egypt in concert with other Mediterranean tribes in the reign of Rameses III., probably some three hundred years after the most flourishing period of the Minoan age, were Cretans from Axos, and have given my reasons for the suggested identification. The objection that Axos is an inland town and so would not have taken part in an over-sea expedition is of no weight whatever; like Knossos, Lyttos, or Gortyna, each of which cities possessed a dependant port on the coast, Axos no doubt possessed its coast-haven, either in the neighbourhood of Bali Bay or nearer the mouth of the Mylopotamo. Further, Axos is actually connected in legend with Libya, and Herodotos (iv. 154) mentions traditions which connect it, as well as Itanos, with the Theræan colonisation of Gyrene. Other central and western sites, such as Eleutherna, Hyrtakina, Phalasarna, &c., will no doubt yield Mycenæan remains when excavated. In fact, the whole of Crete seems to be covered with traces of Mycenæan culture; I have not mentioned numbers of unexcavated sites from which inscribed seal-stones, &c., have been obtained.

The Minoan culture was probably older than the Mycenæan civilisation of continental Greece, and there seems little doubt that the original inspiration of the latter was derived from it.

Eventually the highly civilised and apparently peaceful Minoan dominion in Crete, weakened, perhaps, by luxury and unused to war, was overthrown by foreign attack. Who the conquerors were we do not know, but they probably came from the north. We may, perhaps, associate with their attack the convulsions among the

[1] "Oldest Civilization of Greece," p. 177.

[1] I must here state that in "The Oldest Civilization of Greece," p. 87, I had not the remotest intention of attributing to Mr. Arthur Evans the opinion that the well-known Inscription of Praisos was inscribed in a Semitic idiom. I was fully aware that he held no such view. I merely referred to his "Cretan Pictographs" as the latest authority on the subject generally. Unluckily, the small number pointing to the note below, containing this reference, was misplaced in the text. It was printed after the word "Eteokretans," but should have come after "Praisos," four lines above. I regret that this escaped my notice when reading the proofs of my book, and still more that the nature of the mistake was not understood.

Mediterranean tribes which caused the piratical onslaughts on Egypt in the thirteenth and twelfth centuries B.C., in which Cretan wanderers, expelled from their island by the northern newcomers, may well have taken part. It is certain that before this time the highly civilised Minoan Cretans or *Keftiu* had disappeared from the ken of the Egyptians, and are no more seen in Egyptian wall-paintings. One result of this convulsion seems to have been the settlement of a Cretan tribe, the Philistines, on the coast of Palestine.

When Crete emerges from the dark age which followed the break-up of the Minoan power, we find it a congeries of Greek city-states of the usual type, but of a more quarrelsome disposition than elsewhere; in the Minoan land itself, Gortyna conquers and destroys Knossos and Phaistos, in the east Hierapytna wages long wars with Praisos and Itanos, and so forth. Crete takes no part in the colonising activity of the new Greece, and is henceforth of no account in Hellas. Her day of glory had passed away with the Heroic age.

I am indebted to Mr. R. C. Bosanquet for information with regard to the work of the British School at Athens in eastern Crete. Subscriptions for this work will be gladly received by Mr. Walter Leaf, 6 Sussex Place, Regent's Park, N.W.

H. R. HALL.

P.S.—Photographs of the remains at Hyrtakina have been published by Messrs. Savignoni and De Sanctis in their publication "Esplorazione Archeologica delle Provincie Occidentali di Creta" (Rome, 1901). From their publication it would appear that Phalasarna, the most westerly site in the island, was certainly of Mycenæan origin. Near the remains of a city is a colossal stone throne, of the same type as those treated of by the late Dr. Reichel in his "Vorhellenische Götterkulte," on which is a relief of a symbolic pillar (see Evans, "Mycenæan Tree and Pillar-Cults," in the *Journal of Hellenic Studies*, vol. xxi. p. 99 *ff.*; reviewed in NATURE, November 14, 1901, Suppl.). The name Phalasarna is of the now easily recognisable "kleinasiatisch" præ-Hellenic type. Kretschmer has pointed out that the last two syllables may well be the same as the name of the Bœotian Arnê, which he has identified with the Lycian word *arñna*, "city" ("Einleitung in die Geschichte der griechischen Sprache," p. 406). There seem to be Mycenæan traces also at Vlithiàs and at Agia Irene (Kantanos?); see Savignoni and De Sanctis, *loc. cit.*, for photographs of polygonal masonry, &c.

Mr. Bosanquet informs me that he has found Mycenæan pottery-fragments on the small island of Mókhlos (wrongly called Hagios Nikólaos in Kiepert's map of 1897), off the north coast between Kavousi and Sitia.

THE SECOND INSTALMENT OF THE BEN NEVIS OBSERVATIONS.[1]

THE forty-second volume of the *Transactions* of the Royal Society of Edinburgh is devoted to the publication of five years' observations at the Ben Nevis Observatories, in continuation of those included in vol. xxxiv. of the same series of *Transactions* published in 1890, with appendices consisting of discussions of the results. It is edited by Dr. Buchan, the meteorological secretary to the directors of the observatories, and Mr. R. T. Omond, honorary superintendent of the observatories. The cost of printing is borne by the Royal Societies of London and Edinburgh. The observations include hourly readings and summaries of the meteorological elements, together with entries in the log-book at the summit station for the five years 1888-1892, and readings, five times daily, at the public school, Fort William, from January, 1888, to December, 1890; also the hourly readings with various summaries for the Fort William Observatory from the establishment of that institution in the autumn of 1900. There have also been added tables of mean hourly values of the barometer, temperature, &c., at Ben Nevis and Fort William Observatories, computed to the end of 1896, with mean monthly temperatures deduced from independent observations in the Stevenson screen at Fort William for the period August 1, 1890, to December 31, 1896, and differences between the observations in the Stevenson screen and the thermograph screen of the Observatory It is almost needless to say that the publication of these tables will be welcomed as representing the primary results of an enormous amount of patient and painstaking labour, controlled by a representative board of directors of conspicuous distinction and carried out by a body of enthusiastic observers in circumstances of no little difficulty.

This is not a suitable occasion for dealing independently with the observations, which are presented with the skill and care of which Dr. Buchan is an acknowledged master, and with all the assistance an accomplished printer can afford. We naturally turn to the appendices as representing the scientific results which have been obtained by those who have been associated with the working of the observatories and have devoted time and study to the many problems which the observations suggest.

The appendices consist of a series of papers, some of them *in extenso* and appearing now for the first time, others in abstract or reproduced from the publications of the Royal Society of Edinburgh or the Scottish Meteorological Society by Dr. Buchan, Mr. Aitken, Mr. Buchanan, Mr. Omond, Mr. Mossman and Mr. Rankin.

A brief survey of these discussions is sufficient to show that the problems suggested by the meteorology of Ben Nevis, taken separately or in comparison with that of Fort William, are many and difficult. Dr. Buchan returns to a voluminous but still unexhausted subject in a paper on the diurnal range of the barometer in fine and cloudy weather at stations in various latitudes, from San José, Costa Rica, to Jan Mayen in the North Atlantic. Mr. Aitken's report on atmospheric dust and Mr. Buchanan's discussion of the meteorology of a station in the clouds, as represented by the Ben Nevis records in foggy weather, are already well known contributions to science. The other papers are, as a rule, of less general scope.

Much attention is devoted to the relation of barometric readings at the summit to those at the base station, and here one of the difficulties of Ben Nevis observations becomes very conspicuous. When the velocity of wind reaches or exceeds twenty miles per hour, the barometer reading at the summit no longer represents the pressure of the air within 0·01 inch. All barometric readings with anything more than a moderate wind are subject to a correction of uncertain amount on account of dynamical disturbance. Moreover, the shape of the mountain, with its great cliff on one side of the summit, has a very marked effect upon the wind measures. This circumstance reminds me of a personal experience at Dover during a gale, when the only place in Dover screened from the wind was the top walk of the Admiralty pier, apparently as fully exposed to the gale as any position could be. Such dynamical effects upon barometer and wind make it very difficult to bring the summit observations of these primary meteorological factors into relation with corresponding observations elsewhere.

These are not the only difficulties associated with the reduction of the summit barometer readings to sea level, and the account of the attempts to carry out this reduction

[1] "The Meteorology of the Ben Nevis Observatories." Part ii., containing the Observations for the Years 1888, 1889, 1890, 1891 and 1892, with Appendices. Edited by Alexander Buchan, LL.D., F.R.S., and Robert Trail Omond.

suggests the possibility of regarding the barometric difference between Fort William and the summit as a primary element, without introducing a correction factor based upon a system really applicable only in the case of small heights. Differences from mean value instead of differences from a common hypothetical datum would probably give a more effective representation of the conditions.

The Ben Nevis work, as represented in this volume, is essentially self-contained. In the course of the discussion, observations at other stations are sometimes employed, but the work of other meteorologists concerned with similar problems is hardly referred to. Clayton and Fredlander are the only names I have noticed in the volume not immediately associated with Ben Nevis. This may possibly be accounted for by the majestic isolation of the Ben, but it is in some respects unfortunate. For example, a system is adopted for adjusting the twenty-four-hourly readings for non-periodic changes which is different from that adopted by the Meteorological Council in an annual publication dealing with their first-class observatories, including Fort William. If I judge rightly, one of the two systems must be wrong, and if the error is in Victoria Street it would have been wiser to point out the fact in adopting a different system. Again, a table of equivalents of the numbers of the Beaufort scale and wind velocities is given (pp. 5 and 492), in which numbers on the Beaufort scale are represented by velocities largely exceeding, indeed nearly double, those quoted by Hann ("Meteorologie," p. 377). The practice with regard to the use of velocity equivalents of the Beaufort scale is in a sufficiently chaotic condition already, and it is to be feared that the addition of another scale of equivalents without reference to the reasons for disregarding all other attempts to reduce chaos to order must tend to make confusion a little worse confounded.

The publication of the observations down to 1892, or in part to 1896, may seem to the reader a little belated. The editors are, however, to be warmly congratulated upon the substantial progress made with the work undertaken by the directors. The publication is opportune for two reasons. First, because the question of the future of the observatories is prominently before the public and the volume gives an adequate representation of their work. Secondly, because the International Meteorological Committee meets at Southport next September during the session of the British Association, and the occasion would be a suitable one for the discussion of the interesting questions arising out of observations at high levels. It is justly claimed for Ben Nevis as a high-level station that it is in an unique position. The first recorded entry in the log-book (January 1, 1888) is that the tracks of a hare were seen near the thermometer box. It is not the only hare to be raised on the Ben. If opportunity can be found for the discussion of some of the Ben Nevis hares at Southport, our visitors will relish their highland flavour.

W. N. SHAW.

NOTES.

THE following is a list of those to whom the Royal Society has this year awarded medals. The awards of the Royal medals have received His Majesty the King's approval:—The Copley medal to Lord Lister, in recognition of the value of his physiological and pathological researches in regard to their influence on the modern practice of surgery. The Rumford medal to the Hon. Charles Algernon Parsons, for his success in the application of the steam turbine to industrial purposes, and for its recent extension to navigation. A Royal medal to Prof. Horace Lamb, for his investigations in mathematical physics. A Royal medal to Prof. Edward Albert Schäfer, for his researches into the functions and minute structure of the central nervous system, especially with regard to the motor and sensory functions of the cortex of the brain. The Davy medal to Prof. Svante August Arrhenius, for the application of the theory of dissociation to the explanation of chemical change. The Darwin medal to Mr. Francis Galton, for his numerous contributions to the exact study of heredity and variation contained in "Hereditary Genius," "Natural Inheritance" and other writings. The Buchanan medal to Dr. Sydney A. Monckton Copeman, for his experimental investigations into the bacteriology and comparative pathology of vaccination. The Hughes medal to Prof. Joseph John Thomson, for his numerous contributions to electric science, especially in reference to the phenomena of electric discharge in gases.

MEN of science do not need to be reminded that their interests are cosmopolitan. Contributions to natural knowledge are not weighed in political balances, but by a scale of worth independent of nationality. Every effort should therefore be made to give clear evidence of this unity of spirit and bond of intention. An opportunity of doing this is afforded by the meeting of the American Association for the Advancement of Science, to be held in Washington, D.C., from December 29 of this year to January 3, 1903. At the recent Belfast meeting of the British Association, Prof. C. S. Minot, the president of the sister association across the Atlantic, gave a sincere and hearty invitation to the members of our Association to attend the forthcoming meeting at Washington. There are doubtless many men of science who would accept the invitation with the keenest pleasure if they could leave their work for the few weeks required for a visit to the United States; and if they are unable to do so the loss and regret will be theirs. To those who are able to make the journey, it ought to be regarded as almost a duty—though a pleasurable one—to attend the meeting. The mid-winter meeting is an experiment on the part of the American Association, but it has attracted a large number of affiliated societies, and there is every promise that the meeting will be an important one. Since Prof. Minot gave the cordial invitation at Belfast, a letter has been received from the permanent secretary of the American Association, Dr. L. O. Howard, expressing the hope that at least some of the officers and members of the British Association will be present at the Washington meeting. It will be to the advantage of both science and civilisation if this friendly invitation is accepted.

ANOTHER meeting which men of science who have a few months' holiday at the end of next year should attend is that of the Australasian Association, to be held in Dunedin, New Zealand, in January, 1904. Mr. G. M. Thomson, honorary secretary, has sent a letter to the general secretaries of our Association asking them to make known to members that special opportunities will be given to see the most interesting sights in New Zealand, so that the visit may be made a source of profit as well as of pleasure. Dunedin is the most southerly city of any importance in the British Empire, and it is scarcely necessary to remark that many lands and peoples of interest can be seen by men of science who are able to take a trip around the world to New Zealand. A formal invitation to attend the meeting will be brought before the members of the British Association next year at Southport.

DR. P. L. SCLATER, F.R.S., has resigned the secretaryship of the Zoological Society of London, and only holds office until his successor is appointed. The council has passed the following resolution on this subject and ordered it to be entered on their minutes:—"The president, vice-presidents and council of the Zoological Society of London desire to

record their sincere regret at the retirement of their secretary, Dr. Philip Lutley Sclater, after a service of nearly forty-three years. They wish to tender him their hearty thanks for his most valuable services to the Society during this long period, not only in the management of the Zoological Gardens, but also in the conduct of the publications of the Society and the general direction of its affairs. These affairs have prospered to a remarkable degree during his long term of office. The income of the Society has doubled, the Society's library has been entirely created, the membership has increased from 1500 to 3200. Dr. Sclater's own work as a zoologist is held in universal repute, and it is no exaggeration to say that the very high position occupied at the present day by the Zoological Society in the world of science is largely due to the exertions and the personal character of its retiring secretary."

IN the *St. James's Gazette* of November 17, "C. S." discusses the question as to the kind of winter we are to have, basing his arguments on a statement made by Bacon three centuries ago, that "a moist and cool summer portends a hard winter," and on the fact that severe winters have certainly occasionally followed wet or cool summers during the last century. The years particularly instanced are 1878, 1879 and 1880, which were followed by severe winters. The last severe winter was that of 1894–5, following a rather bad summer. The past summer bears considerable resemblance to that of 1879. We have occasionally referred to this subject, our remarks being chiefly based on Dr. v. Hellmann's discussion of the long series of Berlin observations. The results arrived at by Dr. Hellmann in a paper laid before the Berlin Academy in March, 1885, do not clearly support the views of "C. S.," so far as Berlin is concerned. Dr. Hellmann found that after a moderately warm summer a mild winter was probable, and, on the contrary, that a cold winter followed a warm summer.

OWING to illness, Mr. James Swinburne, president of the Institution of Electrical Engineers, was unable to be present at the opening meeting of the new session of the Institution, held on Thursday last. His inaugural address was therefore postponed. It was announced that Prof. Ayrton had, from ill-health and pressure of other business, resigned the honorary treasurership of the Institution, and that Mr. Robert Hammond had consented to fill his place. The council has had under consideration the continuance of the useful and pleasant visits of the members of the Institution to foreign countries, and has arranged the preliminaries for a visit to Italy in the spring of next year. The Institution has received a cordial invitation from the American Institute of Electrical Engineers to visit the United States and hold a joint meeting there or in Canada. The communication suggested that such a meeting might be arranged for Montreal next year, or at some spot in the eastern part of the United States in 1904, to include a subsequent visit to the St. Louis Exhibition, where an electrical congress will be held. The council has decided that as a meeting for next year could not be arranged, owing to the projected visit to Italy, the invitation for 1904 should be accepted. It was suggested at the same time that the joint meeting might be held in Canada, where the Institution might hope to receive the cooperation of the McGill University.

A REUTER message states that the *Morning*, which has been sent out as a relief ship to the *Discovery*, has arrived a Lyttelton, New Zealand.

PROF. J. WILLARD GIBBS, professor of mathematical physicst at Yale University, New Haven, has been elected a corresponding member of the Academy of Sciences at Munich.

A MEMORIAL tablet in memory of Richard Jefferies was unveiled at Swindon on Saturday by Lord Avebury. The tablet has been erected at the house where Jefferies lived for two years before his death.

PROF. J. MILLAR THOMSON, president of the Institute of Chemistry, and Miss Thomson, have issued invitations to a private soirée to be held at the Galleries of the Royal Society of British Artists on Wednesday, December 10.

THE Paris correspondent of the *Chemist and Druggist* states that the Paris Academy of Sciences has awarded the Lavoisier medal this year to Prof. Cannizzaro, of Rome, in recognition of his contributions to the advancement of chemistry.

THE new building of the Museum of Egyptian Antiquities at Cairo was opened by the Khedive on November 15 in the presence of Lord Cromer and Lord Kitchener, the Ministers, the Sirdar, and many European and native officials. The whole collection has been arranged in the new building under the supervision of the director, M. Maspero, and the curator, Emil Brugsch Bey.

A FEW particulars of the eruption of the Soufrière of St. Vincent which occurred on October 15 and 16 are given in extracts from despatches received by the Colonial Office. Sir R. B. Llewelyn, the Governor of the Windward Islands, remarks that there has been a largely increased area of land damaged by this last outburst, and the prospects are now much blacker than they were. It is suggested as a matter for serious consideration whether Georgetown, at present deserted, may not have to be abandoned; indeed, it is considered doubtful whether any part of the island can confidently be said to be without the range of danger from the volcano, and the possibility of abandoning the whole island has therefore to be faced.

REPORTS from Samoa published in the *Times* state that the volcano on the Island of Savaii is in active eruption. Several craters are emitting dust and vapour, and one village is two inches deep in ashes. Reports from Honolulu, dated November 11, state that, according to a wireless message from Hawaii, the volcano of Kilauea in that island has been in a state of the most violent eruption known for the last twenty years. A Reuter message from Catania states that a fresh eruption of Stromboli took place on November 16, and that incandescent stones, smoke and dust were thrown out. There was an explosion, followed by other silent eruptions, and a flow of lava. A shock of earthquake, accompanied by a loud rumbling noise and lasting five or six seconds, occurred at Oran, Algeria, on November 17, about 9.30 p.m.

AT Seville Cathedral on November 17, the ceremony of depositing the ashes of Christopher Columbus in a special mausoleum was carried out with impressive solemnity. The remains of Columbus rested for two centuries at Santo Domingo, and in 1796 were transferred to the Cathedral at Havana. After the Spanish-American war, they were taken to Spain, where, by desire of a descendant of Columbus, the Duke of Veragua, they have been interred in Seville Cathedral.

A REUTER message from Mantes, France, states that the navigable balloon constructed by the brothers Lebaudy made its first free ascent on November 3. Several ascents were made, the balloon returning to a given spot each time. It moved in all directions above the fields and woods which border the Seine. The report states that in every instance the airship was brought back to its starting-point at a speed of 25 miles an hour, the turn being made against the wind.

LARGELY with the idea of broadening the demand for German wares, Germany will take part in the Universal Exposition to be held in St. Louis in 1904. This decision has now

been officially announced. It is as yet unknown what sum of money is likely to be set aside for the purpose of the St. Louis exhibit, but from assurances given by the Emperor that every branch of German artistic, manufacturing, agricultural and industrial developments will be represented, it is supposed that 200,000*l.* will be devoted to the objects of the exhibit.

A MEETING of the executive committee of the Cancer Research Fund, under the direction of the Royal Colleges of Physicians and Surgeons, was held last week. Dr. Bashford, who has been appointed to the post of superintendent of cancer research, has decided to proceed at once to Germany to inquire into the present lines of investigation in that country, and to cooperate, as far as possible, with the German committee, especially in the direction of statistical investigation. The statistical committee which has been appointed will at once enter into correspondence with scientific workers in the United States, and Prof. Gilman, principal of the Carnegie Fund in Washington, has already expressed his willingness, through the chairman of the executive committee, to take joint action with the British committee, both in regard to statistical and laboratory investigation.

THE death of Mr. William H. Barlow, F.R.S., at the age of ninety, is announced in the *Times*. He was a distinguished civil engineer, well known as the designer of the St. Pancras Station and other large works upon the Midland Railway, to which he was consulting engineer. He was the son of Peter Barlow, F.R.S., who was professor of mathematics at the Royal Military Academy, Woolwich. Mr. Barlow inherited much of his father's mathematical ability, and his chief claim to recognition is that in the early days of railway engineering he endeavoured to introduce more scientific precision into the design of engineering structures. He was the inventor of a form of rail intended to dispense with the use of cross-sleepers. Jointly with Sir John Hawkshaw, he was engineer for the Clifton Suspension Bridge over the Avon. Mr. Barlow was the engineer of the new bridge over the Tay, built to replace the structure blown down in December, 1879, and was one of the committee of selection appointed to consider the designs for the new Forth Bridge.

THE Society of Arts commenced its 149th session on November 19 with a meeting at which an address was delivered by Sir William H. Preece, the chairman of the council, and the medals awarded by the Society during the past session were presented. At the next meeting, on November 26, Dr. Goegg will read a paper in French on the Simplon Tunnel and its effects on railway traffic to the East. At the other meetings before Christmas, there are to be papers on "Photographic Development," by Mr. Watkins; on "French Education," by Mr. C. Brereton; and on the "Russian Iron Industry," by Mr. Head. There will also be a meeting of the Indian Section, at which a paper on "Domestic Life in Persia" will be read by Miss Ella Sykes, who, with her brother, Major Molesworth Sykes, has had much experience of Persian travel. The Monday evenings up to Christmas will be devoted to a course of Cantor lectures on "Gas and Allied Illuminants," by Prof. Vivian Lewes.

WE learn from the *Times* that a meeting of the Stonehenge Committee, consisting of Lord Dillon, the Bishop of Bristol, Mr. Thackeray Turner, Mr. John Carruthers, the Rev. E. H. Goddard, Mr. N. Story Maskelyne, Mr. W. Gowland and Mr. C. H. Read, representing the Society of Antiquaries of London, the Wilts Archæological Society and the Society for the Protection of Ancient Buildings, was held at Burlington House this week. The committee received a report of the operations that had taken place under its advice, with the sanction and at the cost of Sir Edmund Antrobus, expressed approval of the steps already taken towards ensuring the safety of Stonehenge, and repeated its resolve that further steps must be guided by the determination to do as little as possible in order to save the monument for posterity. The committee is anxiously conscious of the fact that in the present state of Stonehenge there is grave danger of further accident. To meet the dangers of the present winter, it has now recommended the immediate application of wooden props to the stones about which the chief anxiety is felt.

UNDER the title *The Foreigner in Italy*, a new weekly paper has been started under the auspices of a new organisation founded last spring and styled the "National Association favouring the Foreign Element in Italy," 11 Piazza Barberini, Rome. The first number, bearing the date November 1, contains a notice of the ships which have been submerged in the lake of Nemi since the time of the Romans, and which it is proposed to raise by artificially draining the lake for the purpose. These ships, which were of the nature of floating palaces, have been examined on one or two occasions (1535, 1827, 1895), and explored by means of diving bells. One is 64 metres long and 20m. broad, and slopes down from 5m. to 12m. in depth at a distance of 20m. from the shore; the second is 71m. long, 21·4m. broad, and its depth is from 16m. to 22m., its distance from the shore being 50m. and from the first 200m. Further particulars have been given in numbers which have since appeared. The second number contains a short note upon the legendary origin of the name Pelée. The original Pelée is said by tradition to have been a maiden who was pursued by a giant and fled to the crater of the volcano for refuge. The gods of the volcano came to her assistance and overwhelmed the giant with lava, burying him beneath the rocks.

AN account of the mathematical work of Ernest de Jonquières is given in the *Bibliotheca mathematica*, iii. 3, by Prof. Gino Loria, of Genoa, who has also contributed a list of his papers and notes to the mathematical *Bolletino di bibliografia*, published by Clausen, of Turin. Jean Philippe Ernest Fauque de Jonquières was born at Carpentras on July 3, 1820, and died on August 12, 1901. His earliest recorded notes bear the date 1855, but from 1860 onwards he devoted himself for some time to the line of study opened up by Poncelet and Chasles, and in 1862 he was awarded two-thirds of the prize offered in connection with the study of curves of the fourth order. His mathematical writings, of which, including solutions to questions, 155 are enumerated, deal mainly with the following points: the higher geometry of Chasles, the theory of algebraic plane curves and systems, properties of algebraic gauche curves and surfaces, geometrical transformations and Eulerian polyhedra, theory of equations and theory of numbers.

IN the *Bulletin* of the Tokio Mathematico-Physical Society, Mr. T. Hayashi discusses the so-called "isosceles trapezium problem," according to which, if an ellipse be inscribed in an isosceles trapezium and circles are inscribed in the four corners, each circle touching the ellipse and two sides of the trapezium, then the radii of the four circles form a proportion. This problem has previously received attention from Japanese mathematicians. It looks as if a proof ought to be possible based on the property that tangents to an ellipse are proportional to the parallel diameters. Incidentally, it is proved that the points of contact of the inscribed ellipse divide the parallel sides proportionally; this is a simple corollary of the anharmonic property of four tangents.

REFERRING to a recent fatal accident caused by the unfortunate opening of one of the carriage doors of a train in motion, Sir Oliver Lodge, F.R.S., gives some sensible advice to passengers

in a recent letter to the *Times*. He points out that the door on the left of the traveller with his face towards the engine, with its hinge forward, is safe; but the door on the right, with latch forward, is very unsafe to open even slightly. The wind rushing by at hurricane speed gets into the opening, snatches the door wide open, thereby pulling the unwary passenger with his hand on the latch out on the line. If the door is six feet by three and the wind is exerting an average pressure of twenty pounds to the square foot, the force on the open door is as much as three cwts.

A RECENT issue of the *Scientific American* contains a description of the multiplex system of page-printing telegraphy described by the late Prof. H. A. Rowland. In this system, alternating currents are used for transmitting the signals, which are made up by suppressing different combinations of two half-waves in a series of eleven half-waves. The transmitting instrument has a typewriter keyboard, and four operators work over the same line; the messages sent by the different operators are separated by a commutator, which rotates in a quarter of a second and allows each operator to use the line for one-quarter of this period. In this way, with duplexing, 1920 signals or 320 words can be sent over one line in a minute. The receiving instrument prints the message on a sheet of paper, spacing it out into words and lines so that it appears like an ordinary typewritten sheet. It is said that the system has been successfully operated under the Government in America over a distance of 550 miles.

THE paper on "Electric Tramways" read by Messrs. C. and B. Hopkinson and E. Talbot before the Institution of Civil Engineers last week derives especial interest from the fact that it is based on the experience gained by the authors in the construction of the tramways at Leeds and Newcastle-on-Tyne. The chief points considered were the generation and transmission of power, the construction of rolling stock, and the vexed question of earth returns and electrolysis. It is interesting to note that the authors find that with seventy or more cars the load is so nearly constant that the steam consumption per unit is practically the same as for a constant load. In such a case, therefore, batteries are only needed as a stand-by or for night work. As regards electrolysis, it is stated that experiments showed that, except in special circumstances, the 7-volt Board of Trade limit might be exceeded many times without risk of damage to gas and water pipes, but if high conductivity strata existed at certain parts, there might be considerable damage caused by the leakage currents even below the 7-volt limit.

THE Report for the year ended December 31, 1900, of the Meteorological Service of Canada, compiled by the director, Mr. R. F. Stupart, has now reached us. The report consists of an introduction in which the Canadian observing stations are classified and the weather conditions summarised for each month of 1900. This is followed by separate parts, containing monthly and annual summaries for the chief stations; meteorological summaries for telegraph reporting stations; bi-hourly and hourly temperatures and barometric pressure during 1900; mean, maximum and minimum temperatures; rainfall and snowfall in 1900; and amount of bright sunshine registered in each month.

A STRIKING instance of the value of the work performed by meteorological observatories to those engaged in agriculture is contained in the last report of the chief of the U.S. Weather Bureau. On the morning of February 23, 1901, the following special warning was telegraphed from Washington to Jacksonville, Florida, with instructions to give it the widest possible distribution throughout the State. "Temperature will fall to-night to a minimum of between 20° and 25° at Jacksonville, and to freezing as far south as Tampa, with frost extending somewhat south of the latitude of Jupiter." Frost occurred as predicted, and the minimum temperature at Tampa was 32°. More than 500 telegrams were sent from the Weather Bureau office at Jacksonville, and the railroads of the State energetically cooperated in disseminating the warnings. Fruit and vegetable growers estimated the value of orange bloom, vegetables and strawberries known to have been saved, as a result of the warnings, at more than a hundred thousand dollars.

IN part iv. of vol. lxxii. of the *Zeitschrift für wissenschaftliche Zoologie*, Herr K. Hesse brings to a conclusion his valuable account of recent researches on the visual organs of invertebrates.

THE latest issue of Gegenbaur's *Morphologisches Jahrbuch* (vol. xxx. part iv.) contains a "symposium" on the morphology of the cloaca and certain of the reproductive organs of the amniote vertebrates.

IN the *Emu* for October, Mr. A. W. Milligan gives an illustration and description of the nesting-mound of one of the megapodes, the mallee (*Lipoa ocellata*). It appears that in hot weather the birds remove the top of the heap so as to form a saucer-like depression, which is again filled up when the weather becomes rainy. The author was fortunate enough to see the cock-bird performing the latter operation. A feature of this number of the *Emu* is the beautiful plate of the eggs and nest of the chestnut-backed quail.

THE evidence as to the origin of the paired limbs of vertebrates forms the subject of an article by Prof. B. Dean in the October number of the *American Naturalist*. This evidence, it is urged, is strongly in favour of the view that paired limbs have been developed from skin-folds running along the sides of the body, as exemplified in the earliest and most primitive sharks. In the same issue, Prof. D. S. Jordan discusses the coloration of fishes, and concludes that, as in other vertebrates, some colour-types in this group serve for protection, others act as recognition-marks, while others, again, have been developed for sexual attraction.

WE have received the prospectus, together with an advance copy of the preface, of the long-expected work on the mammals of Egypt commenced by the late Dr. John Anderson and completed by Mr. W. E. de Winton, which promises to be of the highest value to naturalists. For many years before his death, Dr. Anderson had been assiduously collecting Egyptian mammals; but, even with the assistance of others, the series of specimens available to the authors, although very large, was not in all respects complete. Mrs. Anderson, who made all arrangements for the publication of the work and has supervised its contents, has herself contributed the preface. The price of the work, which is uniform with Dr. Anderson's "Reptiles of Egypt," has been fixed at seven guineas net.

THE *Illustrirte Zeitung* of September 18 contains a good figure of the aye-aye of Madagascar, taken from a specimen living in the Zoological Garden of Berlin. It is, however, quite incorrect when Dr. Heck, who writes the accompanying letterpress, claims that this is the only figure of this animal ever drawn from life. Prof. Owen's celebrated memoir on *Chiromys madagascariensis*, published in the fifth volume of our Zoological Society's *Transactions* in 1862, contains an excellent figure of this animal, taken from the specimen living in the Regent's Park Gardens in October, 1862, and drawn by the celebrated artist Joseph Wolf. There have been at various times *four* examples of the aye-aye living in the Zoological Society's Gardens, and its anatomy and osteology were elaborately described from them

by Owen forty years ago. Now our friends at Berlin are congratulating themselves because they have obtained a single individual, and are trying to make out that the animal has never been properly figured!

AMONGST the recent additions to the Zoological Society's reptile house are several specimens (deposited by the Hon. Walter Rothschild, M.P.) of the very curious large iguanoid lizard (*Conolophus subcristatus*) which inhabits the central islands of the Galapagos group, and the habits of which were described by Darwin in his "Naturalist's Voyage" (vol. iii. p. 469). It is a terrestrial species, and is stated by Darwin to be so numerous in certain districts that he and his companions could scarcely find a spot free from their burrows on which to pitch their tent. Closely allied to it is a large marine species of lizard (*Amblyrhynchus cristatus*), also confined to the Galapagos group, which lives exclusively on the rocky sea-beaches and is said "to go out to sea in shoals to fish." Living examples of the latter species were also brought away by Mr. Beck, Mr. Rothschild's collector, from the Galapagos, but, unfortunately, they did not reach England alive.

WE have received parts xii. and xiii. of the *Bulletin* of the Geological Commission of Finland, containing papers on the crystalline rocks of the country by B. Frosterus, and on a meteorite by W. Ramsay and L. H. Borgström.

THE *Transactions* of the Leicester Literary and Philosophical Society (vol. vii. part i., July, 1902) contain useful geological maps by Mr. Fox Strangways, on the scale of two inches to a mile, illustrating excursions made to parts of the Soar and Wreak valleys; and there is an instructive infra-Triassic map of Charnwood Forest by Prof. W. W. Watts. There is also a detailed report, with map, on the geology of the Beaumont Leys Estate, near Leicester, by Mr. Montagu Browne. Geology evidently flourishes in this Society under the enthusiastic leadership of Mr. H. A. Roechling.

FROM the New Mexico College of Agriculture and Mechanic Arts we have received *Bulletins* Nos. 42 and 43, in which Mr. J. D. Tinsley deals with the problem of alkali in the soil, and with drainage and flooding for its removal. Sodium carbonate is the essential constituent of "black alkali," as it appears to blacken the vegetable matter in the soil; while other salts of soda, as well as salts of magnesia and lime, help to form what is termed "white alkali" soil. It is pointed out by the author that the alkali is left in the soil by the evaporation of water that has gradually risen to the surface. When this excess of water is removed, the alkali will cease to accumulate and soon be washed out of the soil.

THE latest issue (1900–1901) of the *Proceedings* of the Royal Physical Society of Edinburgh contains a full report of the presidential address delivered by Mr. B. N. Peach in November, 1900, the subject of which is Scottish palæontology during the last twenty years. Full justice is done to workers in all branches of this science, while special attention is directed to the important service rendered by palæontological investigations to the task of unravelling the geological sequence in the Highlands. "The work done in Scotland during the period under consideration has thoroughly established the paramount value of palæontology in the interpretation of the geological structure of the country."

DR. G. T. MOODY describes a new "laboratory shaking machine" in the *Chemical News* of November 7. As a shaking machine capable of giving satisfactory results in the laboratory has long been sought by chemists, it is worth while to direct attention to that devised by Dr. Moody.

A SECOND enlarged and revised edition of "Das Wachstum des Menschen," by Dr. Franz Daffner, has been published by Mr. W. Engelmann, Leipzig (London: Williams and Norgate). The volume contains many interesting papers on the rate and character of the development of the different parts of the human body from embryonic stages to maturity.

IN the numbers of the *Journal* of the Society of Arts for October 17, 24, 31 and November 7 are reprinted the four Cantor lectures recently delivered by Dr. R. T. Glazebrook, F.R.S., on "Glass for Optical Purposes." The first lecture deals with the optical purposes for which glass is used and what it is that the glass used has to do. The defects of microscopes and the way in which they are cured or improved, chiefly by means of the use of glass of varying refrangibility and lenses of different curvature, are included in the second lecture; photographic lenses are considered in the third, and lenses for telescopes in the fourth lecture. Students of optics will find in the lectures a wealth of accurate and instructive information upon many points of interest.

SOME very interesting observations relative to the cause and nature of radio-activity have been recently made by Messrs. Rutherford and Soddy, an account of which is given in the September number of the *Philosophical Magazine*. The experiments were carried out with thorium compounds, all of which are radio-active. The authors arrive at the conclusion that the greater part of the radio-activity of thorium is due to a non-thorium type of matter, represented symbolically by ThX, possessing distinct chemical properties. The activity of this new type is not permanent, but undergoes a gradual process of decay, the value falling to one-half in about four days. The constant radio-activity of thorium is supposed to be maintained by the continuous production of this new type of matter from the thorium compounds. Its rate of production and the rate of decay of its activity appear to be independent of the physical and chemical conditions of the system. The ThX is capable of exciting radio-activity on surrounding inactive bodies, and about 20 per cent. of the total activity of thorium is due to this action of the ThX. By suitable means, thorium can be freed from both ThX and the excited radio-activity produced by the latter, and then possesses an activity about 25 per cent. of its original value. This latter, the authors believe, is due to a second non-thorium type of matter.

THE additions to the Zoological Society's Gardens during the past week include two Chacma Baboons (*Cynocephalus porcarius*) from South Africa, presented respectively by Mr. C. S. Blundell and Captain P. J. Probyn, D.S.O.; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. J. H. Kirby; two Prairie Marmots (*Cynomys ludovicianus*) from North America, presented by the Countess de Grey; a White-collared Mangabey (*Cercocebus collaris*), a Rose-ringed Parrakeet (*Palaeornis docilis*) from West Africa, deposited; two Brown Pelicans (*Pelecanus fuscus*) from the West Indies, received in exchange.

OUR ASTRONOMICAL COLUMN.

CHANGE OF FOCUS IN THE LIGHT FROM NOVA PERSEI.—As previously recorded in these columns (July 3), Prof. E. E. Barnard made several determinations, during 1901, of the visual focus of the light from Nova Persei, in order to determine if the presence of the nebula lines in its spectrum produced the difference from stellar focus observed in the case of planetary nebulæ; his observations showed no decided difference of focus.

Observations made on July 14, August 29, September 1 and September 16 of this year produced a like negative result, and

the colour of the Nova was recorded as "a pale bluish white" on each occasion.

However, further observations, made on October 6, 7 and 14, indicate that the Nova has now assumed a bluer colour than hitherto observed, and that the visual focus is now about 0·2 inch greater than that of a star, that is to say, it now corresponds with the visual focus for planetary nebulæ. Prof. Barnard is certain that this change has taken place since August 29 of this year (*Astrophysical Journal*, vol. xvi. No. 3).

NEW MINOR PLANETS.—In No. 3826 of the *Astronomische Nachrichten*, Prof. Max Wolf records yet another batch of seven new minor planets, all of which were discovered, photographically, on October 25.

The planet 1902 K.E., discovered on October 25, has since proved to be identical with (19) Fortuna, the previously published ephemeris of which was incorrect. A new ephemeris is now given.

The minor planets (477) [1901 G.R.] and (478) [1901 G.U.], discovered by Dr. Carnera, have been named Italia and Tergeste respectively.

OBSERVATIONS OF THE AURORA.—A very interesting and valuable series of observations of the Aurora, which have been made at the Yerkes Observatory during the period 1897–1902, are recorded and commented upon by Prof. Barnard in the current number of the *Astrophysical Journal*.

The observations are recorded *in extenso*, and contain full details of the various phenomena attending the displays. Special notice is made of several interesting features, amongst them being the bank of apparent cloud which has a dark, smoky appearance and generally fills the space on the under side of the auroral arch. This cloud generally gives the appearance of being densely opaque, but that this is not the case is shown by the fact that the observations record the bright appearance of Vega as seen through the apparent cloud. The "pulsating clouds," which are generally 5° to 10° in diameter, are recorded as "fading out and quickly brightening again, as if someone were capriciously turning on and off their light." Another striking feature of the subject, which Prof. Barnard believes to be of importance, is the greatly varying altitudes of the summits of different auroræ, and these are carefully noted in the observations. The positions of the summits of various auroræ are generally recorded as being 20° to 25° east of north. A singular appearance—unique in Prof. Barnard's observations of these phenomena—was that of a quarter of an auroral arch on February 15, 1899, no other signs of auroral display being visible at the time.

The Yerkes observations of the grand aurora of September 10, 1898, which was accompanied by decided magnetic effects, describe it as the grandest display observed throughout the whole period, and state that the light in the north was so intense, at times, as to cast a distinct shadow.

As Prof. Barnard remarks, these observations, which cover a period of sun-spot minimum, will doubtless be important in their bearing on the connection between sun-spots and auroræ.

COOPERATION IN OBSERVING STELLAR RADIAL VELOCITIES.—Prof. E. B. Frost, having been struck by the fact that it is not possible to find, amongst published observations, a dozen stars the radial velocities of which have been determined at more than three different observatories, has sent a circular letter to the recognised workers in this field of astronomical physics asking them to join in a cooperative scheme for observing the radial velocities of the stars given in a mutually selected list.

All of the observers to whom the letter was addressed, seven in number, have agreed to the general scheme, and a primary list of about ten stars has been decided upon. Their programme, for the present, includes the making of three determinations of the radial velocity of each star in the list, per annum, by each observer (*Astrophysical Journal*, October.)

THE MARKINGS ON VENUS.—Prof. Percival Lowell, of Boston, has written to the *Astronomische Nachrichten*, No. 3823, suggesting that the spoke-like markings of the planet Venus are not really present on the surface of the planet, but that their appearance is due to an optical effect produced by the eye wandering from the dark indentations which are seen along the terminator, and the smaller spots and streaks, to the centre of the disc. To test this theory, Prof. Lowell has observed a large number of artificial discs, marked without his knowledge, and set up at a distance so as to be, as nearly as possible, under the same observing conditions as the planet.

These experiments tend to prove his theory, but are not sufficiently decisive to place the non-objective existence of these peculiar markings beyond doubt; therefore Prof. Lowell, for the present, only enters a caveat against the acceptation, as a fact, of their real existence.

THE NERNST LAMP.

THE Nernst lamp can now be said to be well upon its way from the experimental to the commercial stage. It has appeared strange to many people that it has taken such a long time before lamps could actually be bought for use, but a critical examination of the lamps now to be had causes one to wonder, not that its development has taken a long time, but that it has been possible to practically develop it at all. Of all artificial methods of illumination it is the most complicated, and its various auxiliary parts are in themselves inventions requiring for their inception no ordinary genius and perseverance. The Nernst lamps now to be had in England are made by the Allgemeine Elektricitäts Gesellschaft of Berlin. The only other manufacturer of Nernst lamps is the Nernst Lamp Company of the United States, which has acquired the rights for that country. The demands of the rest of the world are being supplied by the A.E.G., the agent of whom for the British Colonies, Asia, Africa and South America is the Nernst Electric Light, Limited, of London, which, in the form of an attractive

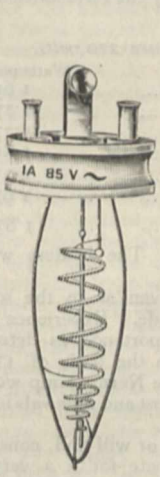


FIG. 1.

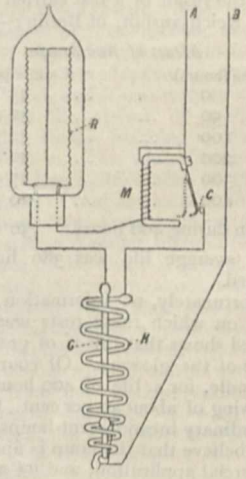


FIG. 2.

pamphlet, has just issued a description of the various lamps it is prepared to sell.

The lamps are of two types and are rated by current, not, as is usual with incandescent lamps, by candle-power, viz. 0·25, 0·5 and 1·0 ampere lamps. The watts consumed per candle-power are about 1·8.

The larger lamp used for all high candle-powers, *i.e.* 50 candle-power and upwards, consists of three parts, the carrier, the lamp body and the globe. The current is led into the lamp body by insulated plug contacts, on the withdrawal of which the lamp is rendered entirely dead and can be handled with safety. The lamp body contains the magnetic cutout for interrupting the current through the heater, after the glower has lighted up, also the series resistance. The contacts for the replacement piece are also carried by the lamp body. This is shown in Fig. 1, and consists of a round piece of porcelain on which are fixed the heater and glower. The general connections of the lamp, as also the functions of its several essential parts, can be seen by reference to Fig. 2. On first switching on current to the lamp, the circuit is closed through the armature and contact C of the cutout M, and through the heater H. The heater is a marvel of ingenuity. It consists of an exceedingly fine platinum wire wound on a rod of porcelain, the rod being in the form of a spiral in the axis of which the glower G is placed. The method of manufacture adopted is to wind the straight rod with the wire, then to cover

this with a protecting layer of porcelain paste and after drying to bend the whole into spiral form by means of a blowpipe. The glower, which is composed of a mixture of zirconium oxide with the yttria-erbia oxides, is, of course, while cold a non-conductor of electricity. Heated, however, by the heater it begins to conduct, rendering itself hotter by its own current energy, getting hotter and hotter until it reaches its normal brilliant state of incandescence. The glower current flowing through the coils of the cutout magnetises the same, causing it to pull in its armature and break the heater current at C.

An unfortunate feature of the Nernst glower is that at the necessary state of incandescence the voltage across it decreases with increase of current. If one wished to express this mathematically, one would say its $\delta v/\delta a$ (v = volts, a = amperes) is negative. A conductor possessing this property placed across supply mains of constant voltage is, however, in an unstable state of equilibrium and will not burn properly. The function of the series resistance R is to correct this. This consists of a very fine iron wire placed inside a glass bulb containing hydrogen gas at low pressure. The thickness of the iron wire is so chosen that at the normal current it is just at its critical stage, *i.e.* at that point, just under the red heat, where its $\delta v/\delta a$ is highly positive; the instability of the glower by itself is thus compensated and the whole glower circuit across the mains is rendered stable.

The smaller lamp, used for all candle-powers below fifty, consists of essentially similar parts to the larger model already described.

As to the economy of the Nernst lamp, the following table shows the result of a test carried out by the Physikalische Technische Reichsanstalt, of Berlin:—

Mean of five lamps. Pressure 220 *volts.*

Time (hours).	Candle-power.	Watts per candle.
0	35·1	1·65
50	32·4	1·77
100	32·3	1·77
200	30·1	1·85
300	27·5	1·93
400	26·5	1·97
Mean during 400 hours	30·1	1·83

The average life was 380 hours. The heaters were not damaged.

Unfortunately, no information is given as to the source of supply on which these tests were made. Experience already acquired shows that this is of great importance as determining the life of the glowers. Of course, on the basis of 1·8 watts per candle, for a life of 400 hours, the Nernst lamp works out at a saving of about 40 per cent., first cost and renewals included, over ordinary incandescent lamps.

We believe that the lamp is finding, or will find, considerable commercial application, and we anticipate for it a very useful and prosperous future. C. C. GARRARD.

NATURAL PROPORTIONS IN ARCHITECTURE.[1]

IT is well known that formal decoration must be based upon exact geometrical construction. The history of art and architecture shows that the most beautiful buildings and formal ornamental *motifs* are those depending upon definite and regular principles. The symmetry of architecture consists of the rhythmical repetition of certain parts of a design in relation to a plan or scheme as a whole, or uniformity as regards the answering of one part to another. The symmetrical forms of Nature have the same interdependence of detail. If a flower is examined which possesses a definite and unmistakable symmetrical adjustment of part to whole, it will furnish a case in point. If even a glimpse could be obtained of the manner in which Nature made the adjustment of her detail, it seemed not unreasonable to expect that the principles involved would be of assistance to design. Even a casual examination showed that much of the harmony of relationship of parts in regular objects could be expressed graphically by geometrical lines. It was found by experiment that this expression was very simple. In most cases, a few circles described concentrically would entirely satisfy

[1] Abstract of a paper read before the Hellenic Society on November 4 by Mr. Jay Hambidge.

zones of symmetry involved in some forms. In addition to the formal plans disclosed in plants, with their leaves, flowers and fruit, the author investigated the beautiful curves of the wings and bodies of butterflies, beetles, moths and bees. He found that in all such examples, these curves were best satisfied by the tangent arcs of circles which had their radii determined by a simple ratio. This ratio almost invariably was a double or binary one, the unit being obtained from the length of the subject's body. With such a unit as a radius, a circle would be described; the diameter of it would be taken as a radius for another, the radius of this for still another, and so on. This progression would be continued until enough arcs had been secured to satisfy all the curves involved. The tangent arcs of circles so related would satisfy these curves, so that it would be impossible for the eye to detect any difference between the approximated and the actual form.

The circles used to satisfy curves of natural objects in this manner may be termed binary circles. They are really circles having radii which form a geometrical progression with a ratio of two. By describing these binary circles concentrically, many proportions involved in the plans of certain forms were accounted for. There were other proportions, however, which these circles did not explain, but the three simple figures which compose the regular polyhedra are involved in the construction

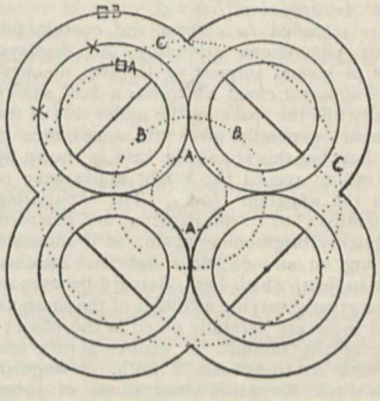
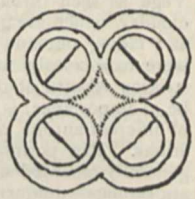


FIG. 1.

A A Primary Circle 1.
B B ,, ,, 2.
C C ,, ,, 3.
□ A Circle 1 derived from □ in A.
□ B Circle 2 ,, ,, □ in A.
× = □ ○ in Circle A.
The symmetry expressed formally.



Cross section of young fruit and contained seeds of the verbena.

to satisfy them. There are but five possible regular polyhedra, and the three simple figures which compose their faces are the equilateral triangle, the square and the regular pentagon. Once having obtained the primary circles, these simple regular figures may be inscribed in any one of a binary series and a side of each used as a radius to describe others concentrically.

With this simple geometrical formula, it is possible to account for every possible combination of symmetry and proportion. Snow crystals and mineral crystals furnished, so to speak, the converse aspect of the curved forms of organic nature. The straight lines used in the graphic expression of the form of a crystal of any system may be shown to be connected with circles such as have been described. The precision with which this formula analyses the symmetrical shapes of Nature is very remarkable.

If the master architects and decorative artists of the past were guided by Nature, we ought to find an agreement between the proportions of curve and straight line which they employed in their plans and the plans of regular natural objects. This is exactly what a general analysis of architecture and formal art has disclosed. As the designer has used good or bad proportions in his architectural and decorative compositions, there may be found, by this method of analysis and comparison, harmony with the proportions which Nature employs.

The fact that the simple figures of the polyhedra are involved in all symmetrical forms of Nature has naturally suggested that their proportional properties be investigated. If these figures are considered as representing elements of symmetry and the

peculiar manner in which they lend themselves to subdivision or multiple expansion is examined, it will be seen that they are inseparably connected with circles which have their radii related in the manner described. Study of these figures will enable one to tell, by merely looking at a proportioned object, the order of its symmetry or character of its plan. For instance, in a cross-section of the young fruit and contained seeds of the verbena, certain circles are involved in relationship to a square. Without making any measurements from the fruit, the plan can be accurately formulated (Fig. 1).

This construction is simple, but it involves principles which are far-reaching. The ground plan of the Parthenon is an instance of architectural construction where the detail is co-ordinated in much the same manner.

The basal projection of the crystal of topaz (Fig. 2) involves all the proportions which occur in regular forms. There are the primary circles the radii of which form the geometrical progression with the binary ratio, and the secondary circles as derived from the sides of the equilateral triangle, the square and the regular pentagon. This example also includes the odd proportion derived from the perpendicular of an equilateral triangle. This

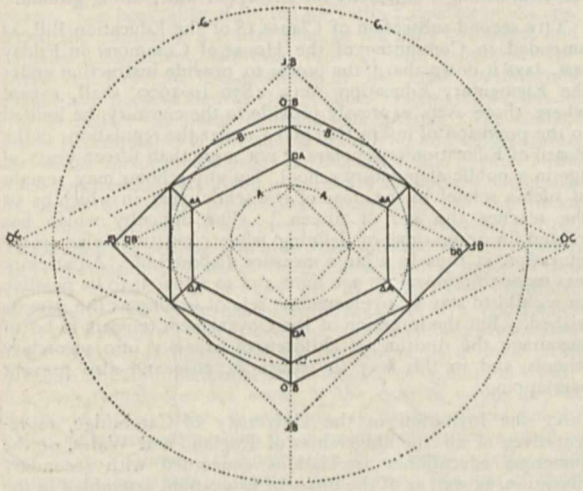


FIG. 2.—Crystal of topaz—basal projection.

A A Primary circle 1.
B B ,, ,, 2.
C C ,, ,, 3.
Distance of point □ A from centre determined by □ in A.
,, ,, △ A ,, ,, ,, △ in A.
,, ,, ○ B ,, ,, ,, ○ in B.
,, ,, □ B ,, ,, ,, □ in B.
,, ,, ⌋ B ,, ,, ,, ⌋ in B.
,, ,, ⬡ C ,, ,, ,, ⬡ in C.

This crystal base contains the entire scheme of proportion and symmetry as found in the Parthenon.

is the only proportion found in symmetrical natural form which seems to be connected with an arithmetical progression.

The Greek and Gothic styles of architecture furnish the most satisfactory results in a comparison of their curves and proportions with the curves and proportions of natural symmetrical forms. In the finest example of the former, the Parthenon, the agreement is so extraordinary that all its proportions and curves may be obtained with no other instrument than a string and a couple of sticks. A surface of levelled earth would furnish a place to make the simple constructions. The beautiful curves found in this building, which so simulate those of conic sections as to deceive the expert mathematician, can be accounted for by this method. In fact, there is no curve in Greek formal art which may not be simply, rapidly and accurately drawn with a compass, and when so drawn, the circles used will be found to possess a definite relationship one to the other. This method would seem to furnish a simple explanation as to how the Greek architects used these curves so long before their supposed discovery. The agreement between the plans of the regular forms of Nature and the plans of the best buildings would seem to suggest that the great architects possessed a formulated or intuitive knowledge of simple principles of proportion which are unknown to us.

[1] ⌋ is the symbol for the perpendicular of the equilateral triangle.

EARTHQUAKES AND EARTH PHYSICS.

PROF. J. MILNE, F.R.S., read a paper on "World-shaking Earthquakes" before the Royal Geographical Society on November 11. In the course of his paper, he remarked that earthquakes may be divided into two groups—first, those which disturbed continental areas, or even the world as a whole, which he called macroseismic, and, secondly, local earthquakes disturbing a few miles' radius, or not more than 100 or 200 miles, which he called microseismic. Evidence of the existence of large earthquakes was sometimes afforded, even though they could not be felt; for example, in 1755, the motion of the water in lakes and ponds observed in England, Scandinavia and North America was attributed to the earthquake at Lisbon. Another form of evidence was sometimes discovered by astronomers, as in May, 1877, M. Nyrén observed disturbances in the level of the axis of the transit at Pulkova, which were held to be due to an earthquake about an hour and a quarter earlier at Iquique. The first instrumental record obtained by the writer of an earthquake which could not be felt was in March, 1884. This and others were referred to as "slow earthquakes." A long series of observations justified him in saying, in 1883, that every large earthquake might be recorded at any point on the land surface of the globe. Thus a new field was open to seismologists, and recording stations were now to be found in many countries, the most complete organisation working in connection with a committee of the British Association. A large earthquake seemed to propagate a series of waves in all directions through and in all directions over the world's surface. Describing in detail the character of this motion, he said that the large waves of earthquakes seemed to pass beneath a country like ours with the character of an ocean swell. The character of these waves was still in process of investigation, and there were reasons for and against any conclusions which might be reached. It would appear that the effective rigidity of the world was about twice that of steel, and it was easy to measure the difference in time between the arrival of preliminary tremors and of large waves—the former reaching a place 80° from their origin in about fifteen minutes, whilst large waves took about fifty minutes. From these differences in times of arrival of different waves, distances of origins could be obtained, and from the distance ascertained from several distant stations the origin might be easily located. Another method of ascertaining origin was the difference of the times of arrival at different stations of large waves, and by these methods the origin of the world-shaking earthquakes for 1899, 1900 and 1901 had been determined. Prof. Milne established a relationship between the distribution of the origins of large earthquakes and the pronounced irregularities of the surface of the earth by a number of illustrations taken from the Alaskan region, which had yielded large seismograms to the Cape of Good Hope, which was antipodean to Alaska, the Cordillerean region, the Antilles, the Andes, Japan, and other parts of the world. He also gave an historic account, dating from 1692, of the mass displacements which had been caused by great earthquakes. As examples, in 1855, in New Zealand, 4600 square miles were raised 1 foot to 9 feet; and in 1897, in Assam, according to Mr. R. D. Oldham, 10,000 square miles of country were displaced possibly 16 feet along a thrust plane.

The connection between large earthquakes and volcanic activity was considered; and instances were given of the seismic convulsions which apparently resulted in reliefs of volcanic strain. So recently as the early part of last summer, the symptoms of volcanic and seismic activities in the Western Hemisphere culminated in the terrible explosions in Martinique and St. Vincent. Prof. Milne also gave the result of inquiries into the relationship between world-shaking earthquakes and unusual movements of magnetic needles. At certain stations, the unfelt waves of large earthquakes disturb magnetic needles, but this is not the case at all stations. This difference in behaviour is not explicable on the assumption that the movements are due to tilting of the instruments, but it is possible that they may be due to magnetic influences. The stations at which movements are observed, Prof. Milne suggests, may be nearer to the magma in which the large waves are propagated than the other stations where movements are not observed. Inasmuch as this magma is not only magnetic, but is also dense at the former stations, the observed value for g would exceed that at the remaining stations, *caeteris paribus*. In support of this view, figures were adduced. References were made to small changes in latitude. When

these were pronounced, world-shaking earthquakes had been frequent. A comparison of the varying number at different periods of small earthquakes showed that the number recorded increased; but this was evidence, not of the growth of seismic activity, but of more general observation. Nearly all large earthquakes were followed by a long series of after-shocks. For example, after the disturbance of October 28, 1901, which had its origin in Central Japan and which might be regarded as a typical world-shaking earthquake, during the first twelve months, 2956 shocks were noted. Next year the number fell to 391. The conclusion seemed to be that in any given year there were 27,500 shocks which could be recorded in epifocal districts, and that, on the average, there annually were 30,000 small earthquakes. From seismograms obtained in epifocal areas, measures of earthquake energy had been obtained. The result was that engineers and builders were now able to build to withstand known forces, and in Japan, in particular, effectual methods had been adopted to resist the severe shakings to which that country was subject. The Japanese Government had so far recognised the importance of seismology as to establish professorships to encourage its study.

THE ROYAL PHILOSOPHICAL SOCIETY OF GLASGOW.

NOT many scientific societies of the kingdom can boast of having existed for a hundred years, but the Royal Society of Edinburgh a few years ago celebrated its centenary, and last week what is now known as the Royal Philosophical Society of Glasgow was engaged in celebrating the attainment of its hundredth year, for it came into being on November 9, 1802, with sixty-two of the most prominent men in the city as members, many of whom have since acquired prosperity and reputation. There was Dr. William Meikleham, the professor of astronomy and natural philosophy in the University, and who was Lord Kelvin's predecessor in the natural philosophy chair, so that those two men practically covered the century between them. There was also Dr. George Birkbeck, subsequently a professor in the "Andersonian," and the founder (in London) of mechanics' institutions. Patrick Cumin, another foundation member, was the professor of Oriental languages. A particularly notable man in the membership was David Mushet, the discoverer of the famous blackband ironstone which did so much to make Scotland the leading element in the creation of the iron industry. Among other original members were Charles Macintosh, who originated the "macintosh" as an article of clothing for wet weather; Mr. John Roberton, a famous iron-founder, who read many papers in subsequent years; and Mr. William Dunn, of Duntocher, a well-known machine-maker. Mr. James Boaz was an accountant; he took a warm interest in the Society, and became secretary in the year 1804, remaining in that office to the great credit of the Society for twenty-six years. Sundry other original members might be named and descanted upon, men from the very highest ranks, and who collectively made Glasgow or contributed very materially towards it, but we must refrain from doing so. Worthy John Geddes, of Verreville, glass manufacturer and potter, was an early member, and he was the second president. The Society did not publish any *Proceedings* or *Transactions* until the year 1844, after Dr. Thomas Thomson, F.R.S., had become president. That gentleman was the famous professor of chemistry in the University, and his knowledge was frequently called forth during the eighteen years that he held the office of president. Mr. Walter Crum, F.R.S., famous as a scientific calico printer, succeeded Dr. Thomson in the chair, and then there was a somewhat continuous run of University presidents, such as Dr. Allen Thomson, F.R.S., Prof. Wm. Thomson, F.R.S. (now Lord Kelvin), Prof. Thomas Anderson (distinguished as a chemist), Prof. W. J. Macquorn Rankine, C.E., F.R.S., and Prof. Henry D. Rogers (American geologist). After he had been knighted, the professor of natural philosophy was again made president for the years 1874-75-76-77. The Society was always in a position to command the services of able and learned men to take the presidential chair, and business men have always been in abundance to fill the executive offices and to discharge the duties pertaining to them for periods extending from six years (in the case of Prof. McKendrick as secretary) to upwards of thirty years, as in the case of Mr. John Mann, the present treasurer.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—An Isaac Newton studentship in physical astronomy and optics, of the value of 200*l.* a year for three years, will be awarded in the Lent term, 1903. Candidates must be Bachelors of Arts who are under twenty-five years of age on January 1, 1903.

IT is announced that a chair of tropical medicine has been founded in University College, Liverpool, with an endowment of 10,000*l.* Major Ronald Ross, C.B., F.R.S., has been elected to the chair.

SIR OLIVER LODGE, F.R.S., was on November 14 entertained at the annual dinner of the Liverpool Philomathic Society, when he delivered an address. He said his removal to Birmingham was solely because of the greater opportunity for his own work which his position in that city afforded him. Speaking of universities, he remarked that the competition among cities to make themselves worthy to become the seat of a university was healthy and holy, and he trusted the movement for establishing a university for Liverpool was gaining ground.

THE second subsection of Clause 18 of the Education Bill, as amended in Committee of the House of Commons on Friday last, lays it down that "the power to provide instruction under the Elementary Education Acts, 1870 to 1900, shall, except where those Acts expressly provide to the contrary, be limited to the provision of instruction given under the regulations of the Board of Education to scholars of not more than fifteen years of age in a public elementary school, but any scholar may remain in such a school to the close of the school year in which he or she reaches the age of fifteen." The difficulty which has existed for some time of defining what constitutes elementary education is thus in a large measure disposed of. An attempt was made to remove the age limit and so allow it to be possible for a child to stay at an elementary school so long as the parents wished. But the intention of the Government appears to be to encourage the drafting of children of capacity into secondary schools, and in this way to reduce expense and also prevent overlapping.

AT the invitation of the University of Cambridge, representatives of all the universities of England and Wales, of the numerous educational associations concerned with secondary education, as well as of the Board of Education, assembled in the Senate House at Cambridge on November 14 and 15 to confer as to the training of teachers in secondary schools for boys. Among men of science who took part in the interesting debates, following the papers on different subjects requiring consideration, were Prof. H. E. Armstrong, F.R.S., Sir Oliver Lodge, F.R.S., Prof. John Perry, F.R.S., and Sir Arthur Rücker, F.R.S. The Vice-Chancellor of the University presided at both meetings, and among the papers, those of Sir Richard Jebb, Mr. Sidgwick and the Master of Marlborough were of particular importance. As Sir John Gorst, whose speech concluded the proceedings, pointed out, if the universities intend to remain at the head of this movement for obtaining suitable training for the masters in secondary schools, they must be progressive and make use of the best of the methods which experience has shown to be suitable to the new demands. One such method, he pointed out, is that by which science is studied by research carried on by the pupils.

SOCIETIES AND ACADEMIES.

LONDON.

Mathematical Society, November 13.—Dr. E. W. Hobson, president, in the chair.—The De Morgan medal for 1902 was presented to Prof. A. G. Greenhill.—Mr. Tucker having retired from the office of secretary, the following resolution was proposed by Dr. Hobson, seconded by Dr. Glaisher, and carried unanimously:—"That the thanks of the London Mathematical Society be offered to Mr. Robert Tucker for the eminent services which he has rendered to the Society during the thirty-five years in which he has held the office of honorary secretary."—The council and officers for the ensuing session were elected. They are as follows:—President, Prof. Lamb; vice-presidents, Mr. Tucker, Dr. Hobson, Dr. Baker; treasurer, Dr. Larmor; secretaries, Prof. Love and Prof. Burnside; other members of

the council, Mr. Campbell, Lieut.-Colonel Cunningham, Dr. Glaisher, Prof. Greenhill, Mr. Macdonald, Major MacMahon, Mr. Western, Mr. Whittaker, Mr. A. Young.—Prof. Lamb having taken the chair, Dr. Hobson delivered an Address on the infinite and the infinitesimal in mathematical analysis. He sketched briefly the history of the attempts that had been made at various times to deal with questions of the infinite, and dwelt especially upon the critical work of the latter half of the nineteenth century, pointing out that pertinent criticism of fundamentals almost invariably gives rise to new construction. He explained how the system of analysis, connected with the title "arithmetisation," had turned a difficulty, to which all previous systems were liable, in that they were unable to give a proof of the existence of the limit. He described the character of the numerical continuum, and contrasted its properties with those of other aggregates, which possess unlimited divisibility. He proceeded to recount the objections that had been raised to the introduction of infinite numbers, as opposed to variables which become indefinitely great; and he concluded with an outline of the theory of transfinite numbers.—The following papers were communicated:—Prof. D. Hilbert, Ueber den Satz von der Gleichheit der Basiswinkel im gleichschenkligen Dreieck. The paper forms part of a critical discussion of geometrical axioms. The possibility of setting up various systems of axioms, so that the axioms of a system shall be mutually consistent and mutually independent, has been proved; and it becomes important to ascertain the relations of the more fundamental geometrical propositions to the possible systems of axioms.—Prof. Burnside, On linear homogeneous groups. The characteristic determinants of any simply transitive, and of any transitive, linear homogeneous group are discussed, and general forms of the determinants are given; the results are applied to simplify the proofs of known propositions concerning the continuous group that is defined by any given group of finite order.—Prof. Lamb, On wave-propagation in two dimensions. The divergence, in two dimensions, of waves from a source, of a more or less transient character, is worked out in detail and illustrated graphically. The disturbance begins suddenly at a place when the wave reaches it; but it does not cease suddenly after a time equal to that during which the source is in action. The existence in two-dimensional wave motion of a sort of "tail" to a wave, which does not occur in the case of waves in one dimension or in three dimensions, is further elucidated by various comparisons between the characters of the three cases.—Prof. A. C. Dixon, (1) Summation of a certain series; (2) Expansions by means of Lamé's functions. The first of these papers is a development of previous work by Morley on the hypergeometric functions that arise from the consideration of the sum of the cubes of binomial coefficients. The second paper contains a discussion of the use of Lamé's functions to determine a potential from its singularities and boundary values for the following regions:—(*a*) the interior of an ellipsoid, (*b*) the exterior of an ellipsoid, (*c*) the space between two confocal ellipsoids, (*d*) two distinct regions, bounded by confocal ellipsoids, wholly or partly coextensive and connected together through the area of the focal ellipse.—Mr. W. H. Young, (1) On sets of intervals, (2) Note on unclosed sets of points defined as the limit of a sequence of closed sets of points. The first of these papers aims at developing the theory of sets of intervals on the straight line in a systematic manner; it is pointed out that, although the discussion of such sets forms a natural introduction to some parts of the theory of aggregates, only a few isolated theorems about such sets have been formulated hitherto. The object of the second paper is to obtain the necessary and sufficient condition that the content of the set obtained by closing an unclosed set, which is the limit of a sequence of closed sets, may be the limit of the contents of the closed sets of the sequence.—Prof. Hill, The continuation of certain fundamental power series. The object of the paper is to illustrate the theory of continuation in simple cases in which the work need not be artificial. The continuations, along arbitrary circuits, of the binomial series, the logarithmic series, the series for arc tan x, are developed in detail. The methods of the paper depend upon theorems proved by Abel in his classical memoir on the binomial series.—Prof. L. Crawford, A geodesic on a spheroid and an associated ellipse. The length of the arc of a geodesic drawn from a given point on a spheroid in a given direction is found as the length of an arc of an ellipse, and the difference of longitude of any point on the geodesic and the given point is expressed as an elliptic function of an angle connected with the corresponding points on the same ellipse; an expression is found for the change in longitude on return along the geodesic to the same latitude.—Prof. A. W. Conway, The propagation of light in a uniaxal crystal. New forms of integrals of the equations of propagation are obtained. The results are applied to the discussion of the direction of vibration and the flow of energy; it appears that the ray direction is not the direction of the energy flux in waves diverging from a source within the crystal. Applications of the integrals are also made to discuss the passage of parallel and of divergent beams of light through a thin crystalline plate.—Mr. E. T. Whittaker, On a new connection of Bessel functions with Legendre functions. A symbolic relation, which connects the functions in the case where the order of the Bessel functions is half an uneven integer, is transformed into an expression for the Bessel functions of unrestricted order as definite integrals involving Legendre functions of unrestricted order.

Chemical Society, November 6.—Prof. McLeod, F.R.S., in the chair.—The following papers were read:—The specific heats of gases, by Mr. H. Crompton. An extension of the application of Le Chatelier's formula for the specific heats of elementary gases to the vapours of complex substances.—The action of nitric acid on bromophenolic compounds, by Mr. W. Robertson. An investigation of the effect produced by displacement of the hydroxyl group by methoxy- or acetoxy-groups in inhibiting the replacement of bromine by nitroxyl.—3:5-dichloro-*o*-xylene and 3:5-dichloro-*o*-phthalic acid, by Drs. Crossley and Le Sueur.—The combination of carbon monoxide with chlorine under the influence of light, by Drs. Dyson and Harden. These gases when dried, mixed in equal quantities and exposed to light, undergo first a period of photochemical induction and finally reach a stage of equilibrium with the carbonyl chloride formed.—The constituents of commercial chrysarobin, by Dr. Jowett and Mr. Potter.—The constituents of oil of rue, by Dr. Power and Mr. Lees. The following new constituents have been obtained:—methyl *n*-heptylcarbinol, methyl *n*-nonylcarbinol, methyl salicylate, cineol, limonene and pinene.—Methyl β-methylhexyl ketone, by Mr. H. Lees.—Di-indigotin, by Dr. Moir. This substance was obtained by the application of Baeyer's process for the synthesis of indigotin from *o*-amidocinnamic acid to the diphenyl analogue, benzidine dicarboxylic acid.—The localisation of phosphates in the sugar-cane, by Mr. Sprankling.—On the non-existence of the gaseous sulphide of carbon described by Deninger, by Messrs. Russell and Smith.—Isometric anhydrous sulphates of the form $M''SO_4,R'SO_4$, by Mr. F. R. Mallet.—The catalytic racemisation of amygdalin, by Dr. J. W. Walker. The optically active glucoside is converted by the hydroxyl ions of aqueous alkaline solvents into racemic amygdalinic acid.—On asymmetric optically active selenium compounds, and on the hexavalency of selenium and sulphur, by Prof. Pope and Mr. Neville. Methylphenylselenetine has been obtained in dextro- and lævo-modifications by fractional crystallisation of the *d*-bromcamphorsulphonate.—The transformation of acetylchloroaminobenzenes into the isomeric chloroacetanilides, by Drs. Chattaway and Orton.

PARIS.

Academy of Sciences, November 10.—M. Albert Gaudry in the chair.—On uniform transcendentals defined by the equation $y'' = 6y^2 + x$, by M. Paul Painlevé.—On quasi-waves, by M. P. Duhem. From the theoretical examination of the velocity of propagation of sound waves in air, it is shown that if the coefficient of conductivity has a finite value, however small, the waves will be propagated in accordance with the formula of Newton, and it is only in the case where the conductivity coefficient is rigorously zero that the waves will travel in accordance with the formula of Laplace. But although the conductivity of air is small, it is not zero, and this leads to a serious discrepancy between theory and experiment. The author shows that the existence of viscosity in air, although small, renders impossible the propagation of waves properly so called, and examines the conditions of transmission of the quasi-waves which are possible, and succeeds in showing that an explanation of the discrepancy becomes possible.—Further observations and experiments relating to the determination of the velocity of the X-rays, by M. R. Blondlot. According to the theory put forward by Wiechert and Sir G. G. Stokes, the X-rays consist, not of continuous ether vibrations, but of extremely short, isolated pulsations, and this hypothesis has been shown to give a complete explanation of the absence of refraction and reflection and of the diffraction phenomena shown by the rays. All the experimental results obtained by the author are also in accord

with this hypothesis, which appears to render a complete account of all the facts at present known.—Study of the climate of Toulouse from 1863 to 1900, by M. B. Baillaud.—Remarks by M. Haton de la Goupillière on a recent paper by M. Gréhant on the analysis of air from mines.—On the present condition of the volcano at Mont Pelée, by M. A. Lacroix.—Gravity along the mean parallel, by M. J. Collet.—On Cremonian substitutions in space, by M. Léon Autonne.—On the breaking and displacement of equilibrium, by M. Jouguet.—On the equivalence of differential systems, by M. E. Cartan.—On certain remarkable equalities, by M. W. Stekloff.—On Hall's phenomenon and thermo-electric power, by M. Edmond van Aubel. According to the views of Nernst and von Ettingshausen, there should be a relation between the thermoelectric power and Hall's phenomenon in metals. It was found by Becquerel that certain alloys of bismuth and antimony and a mixture of bismuth with bismuth sulphide possess very high thermoelectric power, and these have now been examined by the author with respect to the magnitude of the Hall effect. The results confirmed the theory of Nernst and von Ettingshausen.—On the conductivity of solutions at low temperatures, by M. J. Kunz. The electric conductivities of solutions of sulphuric acid have been determined at temperatures between 0° C. and −70° C. The conductivity does not vanish at −39°C., as had been suggested by Kohlrausch, but diminishes continuously with the temperature.—Some new experiments on the electrical resistance of selenium and its application to the transmission of luminous images and impressions, by M. Dussaud.—The artificial production of rubies by fusion, by M. A. Verneuil. The exact conditions necessary for the production of artificial rubies have now been worked out, and specimens have been obtained possessing a fine red fluorescence, and which have been found by the lapidaries employed to cut them to possess the same hardness as natural rubies, and to take the same fine polish. Occasionally, rubies have been made which it is impossible to distinguish from natural ones, but as a rule there are slight faults which can be made out on careful examination.—On the alloys of copper and magnesium, by M. O. Boudouard. The fusing points of a series of alloys of copper and magnesium, when arranged on a curve, give three maxima and four minima. The former correspond to the existence of three definite alloys, $CuMg_2$, CuMg and Cu_2Mg. The mechanical properties show a general parallelism with those of the aluminium-copper alloys, studied by Debray.—On the presence of volemite in some Primulaceæ, by MM. J. Bougault and G. Allard. The polyatomic alcohol, extracted from the roots and rhizomes of *Primula grandiflora*, and previously described as primulite, has now been recognised as identical with the volemite of Bourquelot and E. Fischer.—Study of the chemical composition of copal, by M. Marcel Guédras.—On the grouping of crystals of different species, by M. F. Wallerant.—On the development of the ovule in the Asclepiadeæ, by M. Paul Dop.—On the Nubian Sandstone, by M. R. Fourtau.—On the nature of the electric currents of the nerve, by M. B. E. Wedensky.—The *rôle* of the adipogenic function of the liver in the invertebrates, by Mlle. C. Deflandre.—On the existence of arsenic in the animal kingdom, by M. Gabriel Bertrand. The animals examined ranged from the higher vertebrates to the sponges, and in all cases small amounts of arsenic were found. The author concludes that this element forms a fundamental constituent of protoplasm, and points out the bearing of this fact in medico-legal cases.—Remarks on the preceding paper, by M. Armand Gautier. Arsenic is found to be specially localised in the ectodermic organs. It is not peculiar to the animal kingdom, as it has been found in certain Algæ and is probably present in sea water.—On the preparation of a pulverulent sulphur directly miscible with copper solutions, and on the simultaneous treatment of vineyards against oidium and mildew, by MM. A. and M. Campagne.—On the working and feeding of the fountain of Vaucluse, by M. E. A. Martel.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 20.

ROYAL SOCIETY, at 4.30.—Report on the Recent Eruption of the Soufrière in St. Vincent and of a Visit to Mont Pelée. Part I.: Dr. Tempest Anderson and Dr. J. S. Flett.—On the Correlation of the Mental and Physical Characters in Man. Part II.: Miss A. Lee, Miss M. A. Lewenz and Prof. K. Pearson, F.R.S.—Contributions to a Theory of the Capillary Electrometer. II. On an Improved Form of Instrument: G. J. Burch, F.R.S.—An Experimental Determination of the Variation of the Critical Velocity of Water with Temperature: Dr. E. G. Coker and S. B. Clement.

LINNEAN SOCIETY, at 8.—Digestion in Plants: Prof. Sydney H. Vines, F.R.S.—Relation of Histogenesis to Tissue-Morphology: A. G. Tansley.—Stelar Structure of Schizæa and other Ferns: L. A. Boodle.

FRIDAY, NOVEMBER 21.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Adjourned Discussion upon Captain C. C. Longridge's Paper on Oil Motor Cars of 1902.—And, *time permitting*, Recent Practice in the Design, Construction and Operation of Raw Cane Sugar Factories in the Hawaiian Islands: J. N. S. Williams.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—What is Climatic Disease: Lieut.-Col. A. M. Davies.

MONDAY, NOVEMBER 24.

INSTITUTE OF ACTUARIES, at 5.—Inaugural Address by the President, Mr. W. Hughes.

SOCIETY OF ARTS, at 8.—The Future of Coal Gas and Allied Illuminants: Prof. Vivian B. Lewes.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Explorations in Western China: Capt. C. H. D. Ryder, R.E.

TUESDAY, NOVEMBER 25.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: Electric Tramways: C. Hopkinson, B. Hopkinson and E. Talbot.

ANTHROPOLOGICAL INSTITUTE, at 8.15.—Anthropometric Investigations among the Native Troops of the Egyptian Army: Dr. C. S. Myers.—The Oldest Bronze Age Ceramic Type in Britain: Hon. J. Abercromby

WEDNESDAY, NOVEMBER 26.

SOCIETY OF ARTS, at 8.—Le Tunnel du Simplon, et la nouvelle Ligne de Chemin de Fer Directe Anglo-Italienne pour l'Orient: Prof. Gustave Goegg.

THURSDAY, NOVEMBER 27.

ROYAL SOCIETY, at 4.30.—*Probable papers*:—Experiments on the Effect of Mineral Starvation on the Parasitism of the Uredine Fungus *Puccinia dispersa* on Species of Bromus: Prof. H. M. Ward, F.R.S.—Note upon Descending Intrinsic Spinal Tracts in the Mammalian Cord: Prof. C. S. Sherrington, F.R.S., and Dr. E. E. Laslett.—The Inter-relationship of Variola and Vaccinia; with Special Reference to the Possible Derivation of Cow-pox from the Inoculated Form of Small-pox in Man: Dr. S. Monckton Copeman.—The Colour-Physiology of Higher Crustacea: F. Keeble and Dr. F. W. Gamble.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—On Electrons: Sir Oliver Lodge, F.R.S.

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