THURSDAY, APRIL 23, 1914.

A TREATISE ON IGNEOUS ROCKS.

Igneous Rocks. Composition, Texture and Classification, Description and Occurrence. By Joseph P. Iddings. In Two Volumes. Vol. i. Pp. xi+464+3 plates. (1909.) Price 21*s.* net. Vol. ii. Pp. ix+685. (London: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1913.) Price 25*s.* 6*d.* net.

UNIFORM with the "Rock Minerals" of the same author, now in its second edition, the work which Prof. Iddings has now completed will take an assured place as the fullest and most comprehensive treatment of the subject in our language. Nor is it of the nature of a compilation, but presents numerous features of originality. There are novelties which will be cordially welcomed, and others which will probably meet a more doubtful reception. The author has not shrunk from introducing many debatable questions, and has pronounced on them in no uncertain tone. Although the spirit is that of the missionary rather than the controversialist, this somewhat impairs the utility of the work as a hand-book for students.

The first volume, which has been for some time in the hands of petrologists, deals with the composition, texture, and classification of igneous rocks. It includes a good account of the chemical composition of the rocks and of their component minerals, a discussion of the chemistry and physics of rock-magmas, an admirable and well-illustrated chapter on rock-textures, and a statement of the problem of magmatic differentiation. The last three chapters are concerned with the thorny subject of nomenclature and classification. Here we have first a historical sketch, then an arrangement of the principal igneous rocks in a "qualitative" mineralogical scheme, and finally an exposition of the "Quantitative Classification," of which our author is one of the creators.

The second volume, recently issued, deals with the description and occurrence of the rocks, and is divided into two equal parts. The final test of any classificatory scheme is its applicability in practice; and doubtless many petrologists have waited with curiosity to see how the author would develop a systematic treatment of igneous rocks on the lines of the Quantitative Classification. It seems that we may now congratulate him on recognising the impossibility of the task, for the system actually adopted does not differ in general plan from others in current use. The rocks are first divided into those characterised by (1) preponderance of quartz, (2) quartz and felspar, (3) felspar, (4) felspar and felspathoids, (5) felspathoids, and (6) ferro-magnesian minerals. Under each head "phanerites" and "aphanites" are separated, while the subdivisions are again based on mineralogical characters. To introduce the quantitative element, the author has often redefined terms already in use (a practice which he deprecates in others); but he has succeeded in producing a working scheme with less disturbance of accepted usage than we had expected. The principal relic of the specific "Quantitative Classification" is the use of an ideal mineral composition (the "norm") instead of the actual composition.

Nevertheless, there are many signs that the author is reluctant to abandon the conception of a classification laid down *a priori*. The precise boundaries which he demands are to be fixed by arithmetic, not by chemistry. He counts it a defect of the current systems that special importance is attached to the presence of even very small amounts of certain minerals, such as nepheline and leucite; but, as he has himself pointed out (prior to the birth of the Quantitative Classification), the mere appearance of one of these minerals shows that we have crossed a significant boundary-line in respect of chemical composition. Surely it is he, not his critic, who has lost appreciation of "the mathematical precision of stochiometric chemistry" (p. 7).

The second part of the volume we can praise without reserve. It is an account, such as has never been attempted before, of the geographical distribution of igneous rocks over the globe, with special reference to their chemical composition. This has not been merely compiled in the library, but represents the results of much travel and study in many lands. It is illustrated by maps of the several continents, and by more than 1200 analyses. We hope that in another edition some attempt will be made to distinguish on the maps igneous rocks of different geological ages.

A. H.

MATHEMATICS FOR FRENCH FRESHMEN.

Les Principes de l'Analyse Mathématique: Exposé Historique et Critique. By Prof. P. Boutroux. Tome Premier. Pp. xi+547. (Paris: A. Hermann et Fils, 1914.) Price 14 francs.

PROF. BOUTROUX appears to belong to the school of the laughing philosophers; for, like many of his distinguished compatriots, he has composed a work which is amusing as well

as learned. His six chapters range from elementary arithmetic to differential equations, and touch upon such things as friendly numbers, magic squares, the transcendency of π, Tartaglia's rhymed rule for solving a cubic, and so on. Altogether, the book is written in a light and elegant style, reminding us of Lucas; it is neither so technical, nor so critical, as its title might suggest.

Sometimes we are inclined to think that the author is poking fun; for instance (p. 50), he suggests that o (zero) is the initial letter of οὐδέν! It is scarcely necessary to say that the Greeks adopted the decimal notation, including zero and the nine other digits, after it had been invented by Eastern (probably Indian) mathematicians; and that our zero is almost certainly an enlargement of the dot which is still used by Oriental printers (unless the dot is a contraction for an older circle).

"Bernouilli," instead of Bernoulli, occurs so often that it can scarcely be condoned as a misprint; "Neper" we let pass, as a traditional misspelling; otherwise the names of authors seem to be correct. This is a small matter; a much more important fact is that the author, besides being interested in the discoveries of the ancients, is fully awake to the merits of the moderns. For instance, we have the modern definition of "function"; references to the modern theories of irrational numbers, of functional equations, and the like.

It is interesting to see from the preface that this book is intended to be a "repertorium" for "débutants en mathématiques." As a repertorium it is certainly not one of formulæ; so it must be judged as one of ideas, and since it begins with a quotation from Plato's "Republic," we may suppose that this is what the author means.

From this point of view, the author may be congratulated, because the ideas which he suggests are eternal, though the forms under which he presents them are merely those which seem for the present the most convenient and suitable. One great advantage of the historical treatment of the subject is that it shows how what we may call the machinery of the subject has been improved and simplified.

Prof. Boutroux promises us another volume dealing mainly with analytical geometry, mathematical logic, and infinitesimal calculus; it will also deal with complex quantities and series. Teachers will note that the range of the whole work approximately covers the course of general mathematics in the science faculties of the higher educational bodies in France.

G. B. M.

ANALYTICAL AND SYNTHETICAL CHEMISTRY.

(1) *Industrial Organic Analysis: for the Use of Technical and Analytical Chemists and Students.* By Paul S. Arup. With a foreword by Prof. J. C. Irvine. Pp. xii + 340. (London: J. and A. Churchill, 1913.) Price 7*s.* 6*d.* net.

(2) *A Text-book of Quantitative Chemical Analysis.* By Dr. A. C. Cumming and Dr. S. A. Kay. Pp. xi + 382. (London: Gurney and Jackson; Edinburgh: Oliver and Boyd, 1913.) Price 7*s.* 6*d.* net.

(3) *The Sugars and their Simple Derivatives.* By Dr. J. E. Mackenzie. Pp. xvi + 242. (London: Gurney and Jackson; Edinburgh: Oliver and Boyd, 1913.) Price 7*s.* 6*d.* net.

(4) *The Silicates in Chemistry and Commerce: including the Exposition of a Hexite and Pentite Theory and of a Stereo-chemical Theory of General Application.* By Dr. W. Asch and Dr. D. Asch. Translated, with critical notes and some additions, by Alfred B. Searle. Pp. xx + 456. (London: Constable and Co., Ltd., 1913.) Price 21*s.* net.

(5) *Die Elemente der siebenten Gruppe des periodischen Systems: aus Abegg's der anorganischen Chemie.* Vierter Band. Zweite Abteilung. Herausgegeben von Dr. Fr. Auerbach. Pp. x + 904. (Leipzig: S. Hirzel, 1913.) Price 26 marks.

(1) THIS volume is intended for the use of students who, having received a grounding in theoretical and practical chemistry, are desirous of gaining an insight into the methods of industrial organic analysis. Eight typical series of commercial organic products have been selected, and detailed instructions are given of the analytical processes employed in determining the industrial value of the materials under consideration. The subjects chosen include coal and coke, coal tar and its distillation products, the petroleums, the fatty oils and fats, soap, milk, butter, starch and its degradation products, flour, barley, malt, and the preservatives and colouring matters introduced into foods. One very valuable feature of the book is the references to the larger manuals and special monographs given at the end of each chapter.

In the foreword Prof. Irvine deals with the controversial topic of the college training of industrial chemists. The subject was not new thirty years ago, and although the discussion is unending there is really no general problem to be faced; still less is there any general solution to be provided. Experts differ, and the weighty opinions of Prof. Martin (*sic*) Bogert, President

of the Society of Chemical Industry, should be balanced against those of Dr. Messel, his predecessor in this office. The workings of the latter's mind in this connection are adumbrated in the recent creation of two additional Chairs of "pure" chemistry in the Imperial College of Science and Technology. However, if some degree of technical proficiency is insisted on, the student cannot do better than to work through a selection of Mr. Arup's thoroughly practical exercises in industrial analysis.

(2) The authors have arranged this manual so that some knowledge of the principles of quantitative analysis may be acquired by a practical study of the three introductory sections, which include general principles, volumetric analysis, and gravimetric analysis, including electrolytic methods. Owing to its educative value, a thorough training in volumetric analysis is recommended when time permits of little or no gravimetric work. The exercises included in the volumetric section form a very instructive and comprehensive series, involving the use of all the ordinary standard solutions. In view of the great importance attached by the authors to this side of analysis, it is perhaps allowable to suggest that a short description of the chemical nature of the organic indicators (methyl-orange, methyl-red, phenolphthalein) would have made the volumetric section more self-contained. The preliminary chapters are followed by sections devoted to colorimetric methods, systematic quantitative analysis, and the analysis of simple ores and alloys. Modern methods have been selected, among which may be indicated the estimation of potassium as perchlorate and the separation of iron from allied metals in acid solution by the use of "cupferron," the ammonium salt of nitrosophenylhydroxylamine. The appendix contains details of the preparation of this useful organic reagent. The section on gas analysis refers to the use of the simpler forms of apparatus, such as the Lunge nitrometer and the apparatus devised by Hempel and by Orsat. Water analysis is included as an introduction to the estimation of substances present only in traces. The short section on ultimate organic analysis would have been rendered more complete by a brief reference to the Carius method for the halogens and sulphur. The determination of molecular weights includes details of the vapour density, cryoscopic and ebullioscopic methods.

(3) This treatise is a very readable monograph on the sugars and their immediate derivatives, based on a course of lectures given at the Birkbeck College and in the University of Edinburgh. Rightly on account of their intrinsic importance three chapters each are devoted to cane sugar and glucose, these sections being a mine of information in regard to these well-studied sugars. Among the many researches summarised may be mentioned those on the methyl glucoses, the methyl glucosides, and their acetyl derivatives. One very interesting chapter is that relating to the configuration of the sugars, in which the stereochemical relationships of these compounds are fully discussed. Succeeding chapters deal with dioses, trioses, tetroses, pentoses, together with the naturally occurring mannose, *d*-fructose (lævulose), and raffinose. The less important synthetic sugars are also reviewed. A synopsis is furnished of the glucosides found in plants, and the concluding sections deal with fermentation and with the metabolic changes attending the use of sugars and allied carbohydrates as foodstuffs. References are given throughout to original sources of information, and the work is provided with complete author and subject indexes.

(4) It is impossible within the space available to discuss in detail the hexite–pentite theory devised by the authors, in the first instance, to explain the constitution of the naturally occurring aluminosilicates, and subsequently employed to elucidate the chemical structure of clays, ultramarines, glasses, glazes, porcelains, dental cements, hydraulic cements, and especially Portland cements. It is assumed that five or six molecules of hydrated silica, $Si(OH)_4$, unite with partial elimination of water to form cyclic systems containing five or six silica residues, these complexes being termed respectively silicon pentite and hexite. Aluminium pentite and hexite arise in a similar way by the condensation of five and six molecules of hydrated alumina, $Al(OH)_3$. The mineral aluminosilicates are regarded either as complex acids composed essentially of combinations of these silicon and aluminium pentite and hexite rings, or as salts of these acids when the hydroxylic hydrogens are more or less replaced by metallic elements. The felspars, micas, scapolites, etc., need no longer be regarded as molecular compounds belonging to different mineral groups; they can all be represented as unitary atomic compounds of the same class with definite structural formulæ. A similar hexite–pentite hypothesis is employed to explain the constitution of vanadic, molybdic, and tungstic complexes.

The translator, who has added several instructive and critical notes, doubts whether the authors are justified in extending their views to explain the plasticity of clays. The authors' theory has already been criticised by several writers, and

the present volume contains many polemical replies, notably in connection with the constitution and hardening of Portland cements. These hydraulic cements are considered to be basic lime salts of complex aluminosilicic acids containing coalesced hexite and pentite rings with calcium oxide side-chains replacing the hydroxyls of the hydrated silicon complexes, and occasionally containing alkali metals similarly attached to the aluminium hexite rings.

It is highly probable that the refractory oxides, silica, alumina, and their allies exist in highly complex molecules, and since among both inorganic and organic compounds there exists a certain tendency for the formation of five- and six-membered rings, it would probably be accepted by most chemists as a working hypothesis that such cyclic systems occur in the natural and artificial aluminosilicates and their derivatives, but it is open to doubt whether the authors do not greatly prejudice their case by attempting to extend this hypothesis to the explanation of the facts of coordination, radioactivity, and the constitution of organic substances, such as benzene, the artificial colouring matters, and the proteins.

(5) The appearance of this volume is a welcome indication that this monumental treatise on inorganic chemistry will be brought to completion in spite of the untimely death of its originator, the late Prof. Richard Abegg. There still remain for consideration, however, several important groups of elements, and the remaining volumes of the work are eagerly awaited by all interested in the systematic study of the chemical elements. A praiseworthy feature of the treatise so far as it has yet appeared is the thoroughness with which the compilers have accepted the periodic classification of the elements; this insures uniformity of arrangement, and renders the task of reference a very easy one. It is rarely necessary to turn to the indexes. The present volume is devoted to the halogens and manganese, the elements of the seventh periodic group. In the case of each element the opening section deals with the determination of its atomic weight. The descriptions of the physical and chemical properties of the elements and their compounds are very complete, and include, in addition, the mathematical treatment of many important examples of chemical equilibria, such as the Deacon's chlorine process, the variations in the vapour density of the halogens and their partition coefficients in various solvents. Special sections deal with the colloidal chemistry of the halogens and manganese.

The bibliography is remarkably full, there being more than fifteen hundred references for iodine and its derivatives alone. Manganese varies considerably in its habit of combination, and its compounds are arranged whenever possible under the headings of the various valencies of the metal, but reference is also made to its alloys, and to compounds in which the valency of the metal is undetermined. G. T. M.

TEXTILES.

Textiles: a Handbook for the Student and the Consumer. By Mary S. Woolman and Ellen B. McGowan. Pp. xi+428. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1913.) Price 8*s.* 6*d.* net.

THIS book strikes a new note from an educational point of view, and represents a serious attempt to present a course of instruction to students who intend to make some branch of textile work their future business, or who are, or will be, the buyers of textiles for personal or household purposes. Whilst its strongest appeal is to students of the type mentioned, the matter is so arranged that it offers a mass of information to a wide range of readers who are out of touch with technical methods, and yet are seriously concerned and interested about the character of the textile materials they sell, purchase, or use. It fills the wide gap at present existing in the domestic economy course of instruction in our colleges and schools, and as it deals with practically all kinds of fibres and the textiles into which they are made, it presents in a most interesting manner a remarkably concise and exact description of the methods and machinery used for producing the various materials.

Unusually full details are given for distinguishing the constituents of any textile material, to detect frauds and to estimate value. The character of the various types of dyes and their use, together with notes on finishing and laundry work, add materially to the value of the book. The last three chapters deal with the hygiene of clothing, economic and social aspects, and a series of clothing budgets, these latter being unusually complete and valuable as guides in the laying out of money the clothing of families and individuals of various degrees of economic status.

The book represents a well-defined arrangement of accurate information gathered from a multitude of sources, chiefly of a highly technical nature, and rewritten in a simple and interesting manner with a very clear view to their utilisation by those who are, after all, the consumers of all that is produced by the vast number of our textile factories and workshops, and on whom these in-

numerable industries depend for their existence. In addition to its value as a text-book on domestic economy, it is well worthy of a place in every textile-worker's library, and can be recommended as a reference book in the household.

WM. SCOTT TAGGART.

OUR BOOKSHELF.

The Reform of the Calendar. By Alexander Philip, Pp. xiii + 127. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1914.) Price 4*s.* 6*d.* net.

MR. PHILIP reminds us that, apart from minor notes, we have discussed different aspects of calendar reform already in these columns (April 27 and October 26, 1911). The reader who looks for enthusiastic advocacy of some change and an account of the various proposals which have been put forward in recent years may be referred to this little book on the subject.

We wish to speak of Mr. Philip with some respect. Not that we regard calendar-making as a high order of achievement, although Mr. Philip's original scheme was probably as good as any other of its class, and certainly a great deal better than some. But he has also the broad mind which appreciates objections and prejudices, and he has been led to reduce his first proposal to a minimum adjustment of the days of the months. The week is left undisturbed, and his present scheme may be represented thus:—

Jan. 31	Feb. 30	Mar. 30	April 31	May 30	June 30 (31)
July 31	Aug. 30	Sept. 30	Oct. 31	Nov. 30	Dec. 31

Perhaps something might be said in favour of interchanging the second and fourth quarters so as to bring leap day (when it occurs) to the end of the year. But little can be seriously urged against a change which makes the months and quarters more equal and introduces an approximately rhythmic (? dactylic) arrangement. What is to be feared rather is that so slight an adjustment offers so small an advantage, in spite of Mr. Philip's glowing optimism, as to lack the necessary driving force for its adoption. Does there indeed exist a practical middle course between the Scylla of traditional prejudice and the Charybdis of triviality?

H. C. P.

Les Zoocécidies des Plantes d'Europe et du Bassin de la Méditeranée. By C. Houard. Tome Troisième. Supplément: 1909–1912. Pp. 1249–1560. (Paris: A. Hermann et Fils, 1913.) Price 10 francs.

THE rapid progress of cecidology has led Prof. C. Houard to publish a supplement to his two indispensable volumes on the Animal Galls of Europe. This third volume deals with what has been done between 1909 and 1912, and it is astonishing to find a registration of 1,300 new galls, bringing up the total to 7,556! The author has exercised discretion in what he has included, and he makes an appeal to those interested in galls—and what naturalist is not?—to refrain from rushing into print with new discoveries until they have studied them for, say, two successive years! Everything has been done in the way of double entry and bibliography to make the catalogue serviceable, and both pagination and enumeration are in continuity with the previous volumes. There are 201 illustrations, and there is an appropriate frontispiece with photographs of Rübsaamen, Kieffer, Massalongo, and the late Prof. Giard.

The Principle of Relativity in the Light of the Philosophy of Science. By Paul Carus. Pp. 105. (London and Chicago: The Open Court Publishing Co., 1913.) Price 4*s.* net.

THE author of this work has made up his mind in advance that the question of relativity is a philosophical problem. It is therefore necessary for him to dismiss contemptuously all the history of the purely physical principle technically known as "the principle of relativity." To say as he does that the Michelson-Morley experiment "assuredly has nothing to do with the principle of relativity" is simply to say that the principle is not what it is. The author refuses to call the principle a hypothesis, and asserts "that it is an *a priori* proposition, a postulate of pure thought which either holds good universally or has no validity whatever."

Whatever opinion may be held on this point, it is impossible to say that to the student of dynamics there is no difference in status between rotation and translation. If relativity is a requirement of pure thought, why cannot Newton's laws of motion be used equally well for two frames of reference, of which one is in rotational motion relative to the other? Are those laws wrong, or is pure thought irrelevant to dynamics? One aspect of the principle of relativity is that we do know whether it is convenient to think of a system as having no rotation. This is a matter of common experience. If pure thought denies it, it is clear that it is thinking about something other than the facts with which experiment deals.

Nature and the Idealist. Essays and Poems. By H. D. Shawcross. Pp. xii + 186. (London: Sampson Low, Marston and Co., Ltd. n.d.) Price 5*s.* net.

THE late Mr. Shawcross died last year at the early age of twenty-nine. He was a newspaper journalist whose work had to be done in a busy Lancashire town, though all his instincts and his love for nature would have taken him into the country. His essays and poems reveal much of the struggle he continually had and their merit suggests that had he lived longer he would have become known as a poet and essayist to a wide circle of lovers of nature.

LETTERS TO THE EDITOR.

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

The Sand-Blast.

AMONG the many remarkable anticipations contained in T. Young's lectures on natural philosophy (1807) is that in which he explains the effect of what is now commonly known as the sand-blast. On p. 144 he writes :—"There is, however, a limit beyond which the velocity of a body striking another cannot be increased without overcoming its resilience, and breaking it, however small the bulk of the first body may be, and this limit depends on the inertia of the parts of the second body, which must not be disregarded when they are impelled with a considerable velocity. For it is demonstrable that there is a certain velocity, dependent on the nature of a substance, with which the effect of any impulse or pressure is transmitted through it; a certain portion of time, which is shorter accordingly as the body is more elastic, being required for the propagation of the force through any part of it; and if the actual velocity of any impulse be in a greater proportion to this velocity than the extension or compression, of which the substance is capable, is to its whole length, it is obvious that a separation must be produced, since no parts can be extended or compressed which are not yet affected by the impulse, and the length of the portion affected at any instant is not sufficient to allow the required extension or compression. Thus if the velocity with which an impression is transmitted by a certain kind of sound be 15,000 ft. in a second, and it be susceptible of compression to the extent of 1/200 of its length, the greatest velocity that it can resist will be 75 ft. in a second, which is equal to that of a body falling from a height of about 90 ft."

Doubtless this passage was unknown to O. Reynolds when, with customary penetration, in his paper on the sand-blast (*Phil. Mag.*, vol. xlvi., p. 337, 1873) he emphasises that "the intensity of the pressure between bodies on first impact is independent of the size of the bodies."

After his manner, Young was over-concise, and it is not clear precisely what circumstances he had in contemplation. Probably it was the longitudinal impact of bars, and at any rate this affords a convenient example. We may begin by supposing the bars to be of the same length, material, and section, and before impact to be moving with equal and opposite velocities v. At impact the impinging faces are reduced to rest, and remain at rest so long as the bars are in contact at all. This condition of rest is propagated in each bar as a wave moving with a velocity a, characteristic of the material. In such a progressive wave there is a general relation between the particle-velocity (estimated relatively to the parts outside the wave) and the compression (e), viz., that the velocity is equal to ae. In the present case the relative particle-velocity is v, so that $v=ae$. The limit of the strength of the material is reached when e has a certain value, and from this the greatest value of v (*half* the original relative velocity) which the bars can bear is immediately inferred.

But the importance of the conclusion depends upon an extension now to be considered. It will be seen that the length of the bars does not enter into the question. Neither does the equality of the lengths. However short one of them may be, we may contemplate an interval after first impact so short that the wave will not have reached the further end, and then the argument remains unaffected. However short one of the impinging bars, the above calculated relative velocity is the highest which the material can bear without undergoing disruption.

As more closely related to practice, the case of two spheres of radii r, r', impinging directly with relative velocity v, is worthy of consideration. According to ordinary elastic theory the only remaining data of the problem are the densities ρ, ρ', and the elasticities. The latter may be taken to be the Young's moduli q, q', and the Poisson's ratios, σ, σ', of which the two last are purely numerical. The same may be said of the ratios q'/q, ρ'/ρ, and r'/r. So far as dimensional quantities are concerned, any maximum strain e may be regarded as a function of r, v, q, and ρ. The two last can occur only in the combination q/ρ, since strain is of no dimensions. Moreover, $q/\rho=a^2$, where a is a velocity. Regarding e as a function of r, v, and a, we see that v and a can occur only as the ratio v/a, and that r cannot appear at all. The maximum strain then is independent of the linear scale; and if the rupture depends only on the maximum strain, it is as likely to occur with small spheres as with large ones. The most interesting case occurs when one sphere is very large relatively to the other, as when a grain of sand impinges upon a glass surface. If the velocity of impact be given, the glass is as likely to be broken by a small grain as by a much larger one. It may be remarked that this conclusion would be upset if rupture depends upon the *duration* of a strain as well as upon its *magnitude*.

The general argument from dynamical similarity that the maximum strain during impact is independent of linear scale, is, of course, not limited to the case of spheres, which has been chosen merely for convenience of statement. RAYLEIGH.

The Earth's Contraction.

THE conclusion of the Rev. Osmond Fisher (NATURE, February 26) that if the moon originated as a detached portion of the earth, the earth's radius at the time (even allowing for the much more rapid rate of rotation indicated by Sir G. H. Darwin's researches) must have been about three times its present one, leads to a very interesting speculation, namely, as to whether the earth's radius may not have contracted very considerably *within the time represented by the known geological formations*. There is, I think, observational evidence which warrants us in believing this to have been the case.

Prof. Heim estimated the linear compression required to produce the Alps at seventy-four miles, which means a reduction of the earth's radius by twelve miles, or 0·3 per cent. Taking the whole of the existing mountain ranges, we may roughly estimate a total reduction of ten times this amount, or 3 per cent., as being indicated since the middle of the Tertiary epoch. Yielding of the earth's crust by intense folding has probably always taken place in particular areas, but it is a fact that as a whole the rocks show more and more folding, faulting, and overthrusting the farther back we go into the geological record, and the mountains formed in the older epochs have long since been removed by denudation, which was naturally most active where the plication was most intense. Taking the rock-structures alone into consideration, would any geologist who has worked extensively amongst the oldest fossiliferous rocks affirm that the evidences are against a contraction of the earth's radius of the order of 20 per cent. since they were deposited? A contraction of this magnitude would be accommodated by a continuous folding of the crust into anticlines and synclines at angles of 37° with the horizontal, and most accounts

of the tectonics of the earlier Palæozoic rocks describe folding and shearing which approach this average, though, of course, there are some extensive areas where the disturbance has been much less. When we come to the Archæan rocks the case is even stronger.

A very simple calculation shows that the amount of contraction suggested above implies only a rate of shrinkage so slow that if going on at present it would fail to be detected by the most refined geodetic measurements repeated after a century. A contraction of the earth's radius of only three inches a year, which would cause a 20 per cent. diminution of the radius in about twenty million years (and this is probably a low estimate for the age of the Cambrian strata) would only change the absolute length of geodetic lines by less than one part in a million in a hundred years. Observations of the lunar parallax, which afford another theoretical means of detecting changes of the earth's radius, would have to be repeated at intervals of twenty-five thousand years in order to detect a single second of diminution, even if we could assume the moon's mean distance to be constant throughout this period.

If the hypothesis of a continuous contraction of the earth's radius at an average rate of somewhere about three inches a year throughout geological time is entertained, it not only furnishes a plausible explanation of the prevalent folding of the ancient rocks, but also tempts one to indulge in a number of other speculations, such as, for instance, how far the flying-powers of the great Mesozoic reptiles may have been influenced by the lesser value of gravity at the earth's surface with a larger terrestrial radius and a greater speed of rotation. But collateral issues may well rest until the main point has been argued, and as to this I should like the opinion of geologists whose experience of the older formations has been greater than my own. I am at present surveying in a disturbed country where I should certainly have had to correct my base-line very considerably for dislevelment if I had measured it along the planes of stratification of the rocks, and this circumstance has suggested the question to my mind on reading Mr. Fisher's letter.

JOHN BALL.

Wadi Shellal, Sinai, March 31.

Zoological Classification.

THE complaint, thus entitled, of Mr. H. C. Williamson in NATURE for April 9, p. 135, is a fairly common one just now, and his way of putting it suggests some remarks from the other side.

The zoological classification of this or any other day is "satisfactory" in proportion, first, as the principles of that classification commend themselves to the general intelligence of zoologists; secondly, as the classification is in agreement with those principles. The multiplication of the units to be classified, whether subspecies, species, or genera, can have no bearing on the validity of the classification.

The object of classification is the arrangement, but not the nomenclature, of the units.

The older genera have been subdivided, not merely because the number of species has proved unwieldy (indeed, if the necessary bases be absent, such genera cannot be split, however much it be desired), nor merely because it has proved possible to group the species (for in this case subgeneric divisions are adequate), but because study has shown that the species formerly included in a genus have not really the close interrelationship which such inclusion implies, but are of very diverse descent. In nomenclature as affected by classification most of the serious difficulties which happen to have come under my own notice are due to our increased, but still imperfect, knowledge of origins.

The real trouble and source of disagreement between zoologists is that some (and especially the "applied" workers) look at taxonomy with the eyes of the old school, which regarded only the amount of resemblance in structure, while others follow the new school which seeks to express history and relationship. In a word, there are two sets of principles, and our classification is, if not halting between the two, at least passing rather lamely from one to the other. And as for nomenclature, the trouble is that the Linnean system was devised for a classification on the old principles, and one often doubts how far it is applicable to the new method.

When the nature of our difficulties is clearly understood, nobody will propose to effect progress by such retracing of our steps as "the extinction of half at least of the genera." In ordinary writing one practical way of getting round the difficulty is half hinted at in Mr. Williamson's last sentence; it is to use the family name. Thus we can speak of a Cidarid, a Terebratulid, a Phacopid, a Pentacrinid. Or the transition may be eased by using the old name with some such *caveat* as *sensu lato, e.g.* Rhynchonella (s. l.), Antedon (s. l.). In writing the "Guide to the Fossil Invertebrate Animals in the British Museum" the conflict between accuracy and intelligibility was settled by adding the older better-known name within square brackets after the correct or modern generic name, *e.g. Dalmanites* [*Phacops*] *caudatus*.

F. A. BATHER.

Natural History Museum, April 11.

Electric Emissivity at High Temperatures.

WE have recently conducted at the National Physical Laboratory some experiments on the emission of electricity from a number of substances at very high temperatures—between 2000° C. and 2500° C. The experiments were carried out in a carbon-tube resistance furnace at atmospheric pressure. Among the substances tried were the alkaline earths and a number of metals. In every instance the temperature was sufficient to vaporise rapidly the substance under test, and, under these conditions, very large amounts of electricity were emitted. For example, barium oxide emitted negative currents of the order of 4 amperes per sq. cm., while boiling tin gave currents of about 2 amperes per sq. cm. No external potential was applied in any of the experiments.

We hope to publish very shortly a full discussion of the results.

G. W. C. KAYE.
W. F. HIGGINS.

National Physical Laboratory, Teddington, Middlesex, April 22.

An Optical Illusion.

SOME days ago I was reading, the sunrays falling aslant on my forehead, it being about five o'clock p.m. After having read awhile, the letters showed a vivid red, the paper itself retaining its white colour. The rays did not fall on either of the two sides of the page.

When I used my hand to shade the eyes, the letters *immediately* became black again. On removing my hand, it took them some seconds to change from black through dark red to bright red. I may add that I am short-sighted, but was reading without spectacles.

I should feel obliged if some reader of NATURE would give me an explanation of this.

J. W. GILTAY.

Delft, Holland, April 11.

THE NATIONAL BOTANIC GARDENS OF SOUTH AFRICA.

IT is perhaps difficult to appreciate in their due proportion the various factors that have been instrumental in founding these National Botanic Gardens. At the same time it is necessary to make the attempt; for their future development must be influenced, if not controlled, by the ideals entertained by those who for many years have been working for what has at length been achieved.

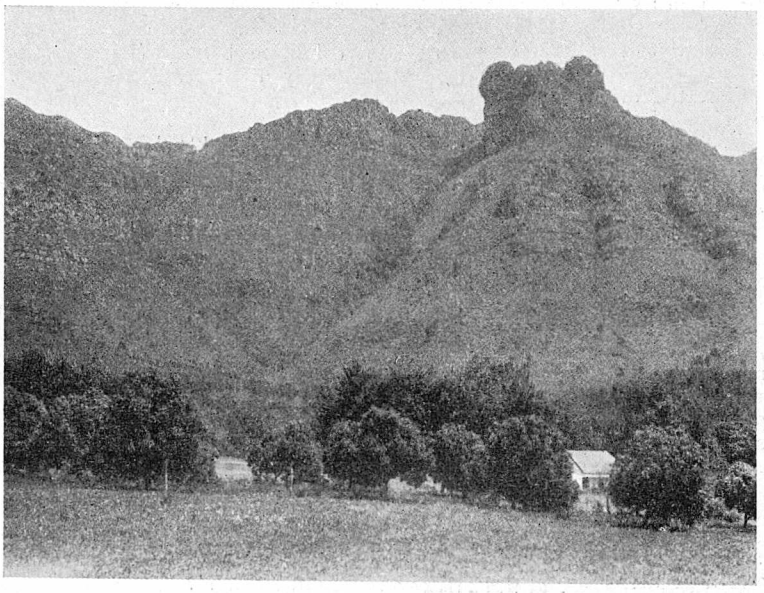

FIG. 1.—National Botanic Gardens. Looking westwards from within the eastern boundary. Curator's house on the right; in front of it, part of the Camphor Avenue running obliquely across the picture. The western boundary runs immediately beneath the steep rocks about 1200 ft. above the curator's house.

Among these factors a very important place must be assigned to the keen interest displayed by almost the whole white population in the remarkable vegetation of the country. The manifestation of this interest has in many cases endangered the existence of ornamental species. Most districts furnish examples of the disastrous effects of reckless wood-cutting or ill-judged burning. Public opinion has awakened somewhat tardily to the necessity for conservative action. Recent legislation has given a measure of protection to certain of the threatened forms. But it is now generally realised that the problem is too big to be solved by the protection of a few favourites. That the reservation of areas is more adequate to the circumstances than the protection of individual species is recognised. And further, there has gradually been developed a tendency to adopt the positive measure of introducing native plants into cultivation in South African gardens. There can be no doubt that the movement to establish a national botanic garden has received great impetus from the widely felt desire to see this tendency accelerated. Its first mission is to lead the way in the preservation and cultivation of South African plants, and in the improvement of those of them that, for various reasons, are worthy of improvement.

Kirstenbosch possesses exceptional facilities for dealing with these problems. Of its total area of about 600 acres,[1] approximately two-thirds is well-stocked with native species, representing all the more important plant associations of the region. Half this area is clothed with indigenous forest, the rest mainly with low bush in which proteas, heaths, orchids, restiaceæ, and many striking compositæ and leguminosæ are conspicuous. This area is admirably suited for development into a most instructive miniature of what would be called in America a "national park."

During the six months ending on December 31 last, about 1500 species, the vast majority not indigenous to Kirstenbosch, have been sent in by correspondents from various parts of the coast-region between Damaraland and Zululand, the Karoo and Upper Region, Swaziland, Transvaal, Bechuanaland, Rhodesia, and British East Africa.

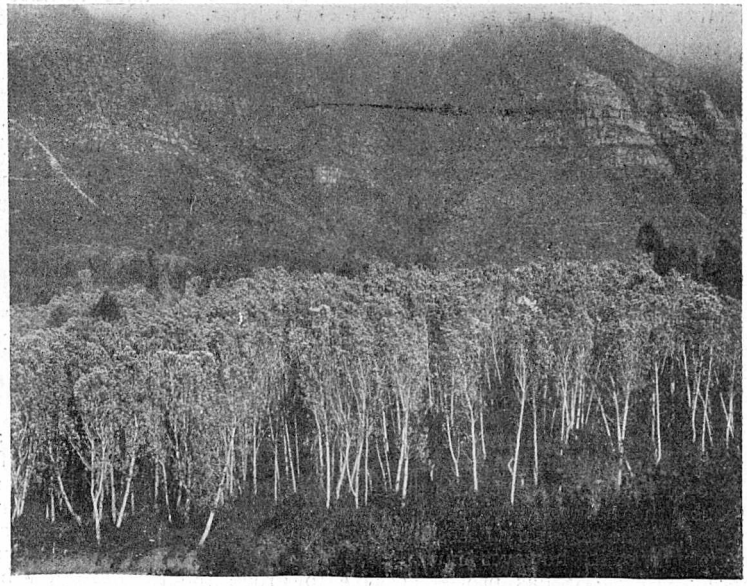

FIG. 2.—National Botanic Gardens. Looking westwards near the southern boundary. A silver tree forest (*Leucadendron argenteum*).

Among these contributions a large proportion are succulents. Probably a greater variety of South

[1] Since the establishment of the gardens an additional area of about 200 acres has been added at the southern end of the original Kirstenbosch estate.

African bulbs and ground orchids than has yet been brought together in one place is already established in the nursery. Most of these were introduced here during the winter rains, which have been followed by an exceptionally wet summer. The results are such that any doubt that may have been entertained as to the possibility of establishing here a representative collection of South African—one may almost say African—plants is set at rest.

Most of those who have taken an active part in the foundation of these gardens will not be satisfied merely with the collection and cultivation of South African plants. The educational effect of such a collection will nevertheless not be small. The great extent of the country and the sharpness of its physical divisions militate against the slowly growing sense of national unity. The presentation, even on a small scale, of typical representatives of its regional floras to the view of many who of necessity are acquainted with but little of its area, must do something towards the obliteration of hard dividing lines.

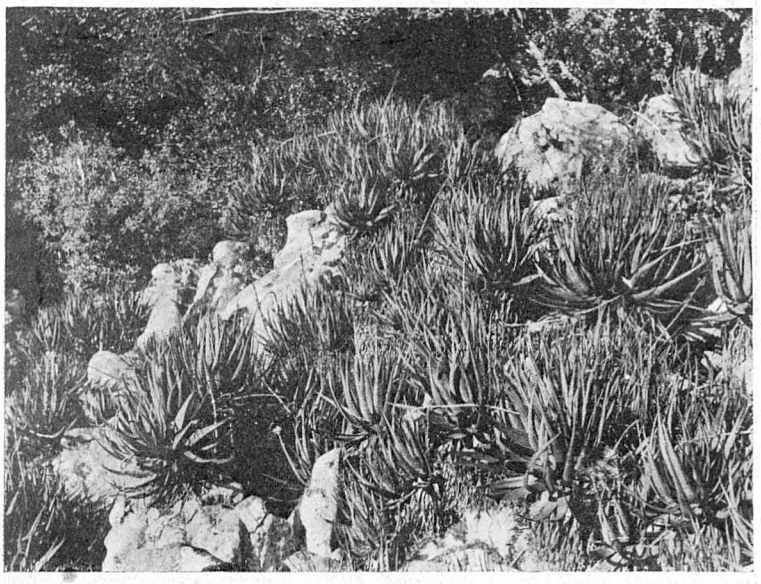

FIG. 3.—National Botanic Gardens. Group of *Aloe succotrina*. This is part of a very remarkable plant association about five acres in extent, on a steep slope strewn with large blocks of Table-mountain sandstone, 1500 ft. s.m. Associated with the aloes are lichen-covered trees of *Olea verrucosa*, *Cunonia capensis*, *Maurocenia frangularia*, *Plectronia* sp., etc., and a number of moisture-loving annuals, ferns and mosses.

From a purely scientific point of view, the importance of the National Botanic Gardens depends upon the use that is made of them for purposes of investigation. It is clearly realised that they will fall short of justifying their existence if they fail to make adequate provision for the proper study of the material they contain. Whether this provision will come through the much-needed university, or partly or entirely by private benefaction, or through some other channel, remains to be seen. The work at present in progress is ordered on the assumption that such provision will be made in the near future.

Since the publication of Pappe's "Floræ capensis Medicæ Prodromus" (1850), it has been known that a very large number of native species are, or have been, in use locally for medicinal or other domestic purposes. Plants yielding essential oils and other products of probable or possible economic value are numerous. While much of the work of acclimatisation, which in tropical countries has been done by the Botanic Garden, is here receiving adequate attention in the departments of agriculture and forestry, there are yet very many exotic plants worthy of attention, the possibilities of which await investigation. Among these the drug- and perfume-yielding species of the Mediterranean region are conspicuous. The economic garden, for which some twenty to thirty acres have been reserved, should therefore become an important part of the establishment.

The functions assigned to the National Botanic Gardens cover a wide range. At present much of the equipment which will make it possible to fulfil them is to seek. But the gardens exist in response to a popular demand, and popular support to make their future secure will not be wanting.

WAVES IN SAND AND SNOW.[1]

DR. VAUGHAN CORNISH has written a charming book, full of interesting observations. He starts with descriptions of waves and ripples in blown sand, and passes later to the similar forms produced under water, giving many good photographs to illustrate their various characteristics. Whether the waves are large or small, or whether formed by wind or water, it is obvious that the same causes are at work, and the author rightly distinguishes these waves from drifts and sand banks, the latter having their lengths parallel to the direction of the average stream, while the ridges of the waves are at right angles to it. The origin of the lateral drift which gives rise to sand-banks was first explained by W. Froude and independently by Prof. James Thomson about the same time.

Snow waves and snow drifts, and other forms of accumulations of snow, are described in chapters iii. and iv., and these also are well shown by photographs. The phenomena of snow are much more complex than those of sand, both on account of the variable size of the snow-flakes and particles and of the varying conditions as to moisture and temperature in which they are deposited. In some states snow particles cohere on contact; in others when the temperature is low they behave more like a dry powder, and it re-

[1] "Waves of Sand and Snow and the Eddies which Make Them." By Dr. Vaughan Cornish. Pp. 383+plates. (London: T. Fisher Unwin, n.d.) Price 10*s.* net.

quires a pressure applied for some time to make them stick together. The resulting forms taken by accumulations near obstacles differ considerably in consequence.

One of the most interesting observations in the book relates to the natural sifting which sand undergoes whilst being blown hither and thither by the wind. One sample of desert sand was passed by the author through a series of wire gauze sieves of graduated mesh; a single sieve with a 1/48 in. mesh retained 94 per cent. of the total, the sieve above with a 1/24 in. mesh stopping 2 per cent. and the one below with a 1/96 in. mesh stopping 4 per cent. Practically, therefore, 94 per cent. of the sand grains had linear dimensions of between 0·02 and 0·01 in.

It would have been of interest if this sorting test had been carried further, for several phenomena of sand, notably "singing sand," and also the extraordinary roar which is sometimes heard when a slip occurs in a slope of blown sand, must depend on the uniformity of the size of the grains. Darwin in his voyage of the *Beagle* refers in chapter xvi. to a hill in Chile known as "El Bramante," on account of the roaring sound produced by the slipping of sand, and also states that the same circumstances are described in detail by Leetzen and Ehrenberg as the cause of the sounds which have been heard by many travellers on Mount Sinai. I have had a description from a friend who, with a party, was descending a slope of blown sand drifted against a cliff in the Nile valley. So far as could be seen, only a small surface flow of sand started by their footsteps appeared to be in motion, but the noise gradually increased to a loud roar, and the whole mass of the drift seemed to vibrate. This implies that each grain was doing the same thing at the same time for a considerable depth, which could scarcely happen were there not a fairly close uniformity in their size.

How the sorting is carried out by the wind does not clearly appear. Dr. Cornish's explanation is that the predominant size of grain is reached when mutual attrition ceases. If this is correct, it might be possible to determine the size in terms of the hardness of the material and the $\sqrt{\text{mean square}}$ velocity of impact. There is no doubt a definite size for which the whole work of impact could be taken up by elasticity and without rupture. The whole question, however, of the way in which dust is raised by the wind is rather obscure. Presumably the wind in contact with the ground must move parallel to its surface, and it seems probable that particles drifting along the surface can only be raised above it by impact more or less oblique with others which are stationary or moving with a different velocity. Once they are lifted into the eddying current their further distribution does not present the same sort of difficulty.

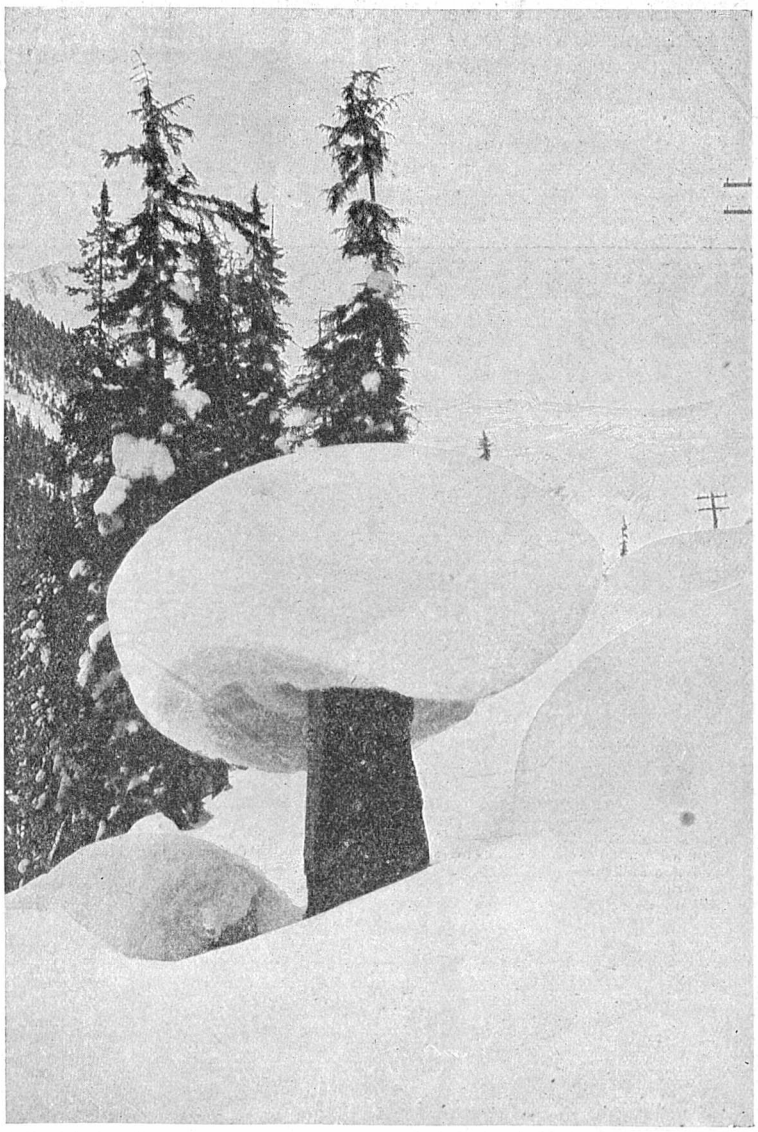

FIG. 1. – A nine-foot snow-mushroom seen from below. From "Waves of Sand and Snow."

Any structure which shows a "period" always presents interesting problems, but the periods and wave-lengths which Dr. Cornish deals with must not be confused with those belonging to stable systems, such as water waves, etc. The latter are definite in the same way and for the same reason as the period of a pendulum.

The sand waves are products of instability, and in all quasi-periodic structures which originate in this way the amplitude and wave-length are

independent. In this they differ from stable systems which are isochronous. In the unstable systems a change, however small, tends to increase until a limit is reached at which a breakdown of some sort occurs. Instances might be given in great variety in which instability leads to a quasi-periodic motion or arrangement. Geysers which boil over at fairly constant intervals, the whistling of the wind (here the period is the rate of production of eddies round small obstacles), and the ladder-like shavings taken off various materials by cutting tools, are all cases in point, although drawn from such different quarters.

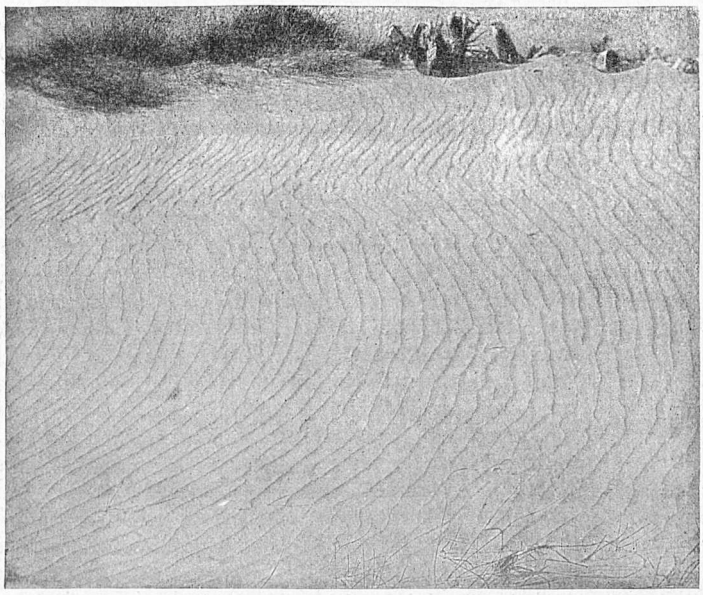

FIG. 2.—Aeolian sand-ripples at Southbourne. From "Waves of Sand and Snow."

Notice of many of the matters of which the author treats, such as snow mushrooms, and the ridges trodden out by cattle, must be omitted for want of space, and although it must be said that the explanations are not as good as the descriptions, the book is to be recommended as the most interesting collection of observations concerning the whole subject which has yet appeared.

A. MALLOCK.

MUTATIONS OF BACTERIA.

VARIOUS alterations in the morphology and in physiological characters of certain bacteria have been obtained by many observers. Thus *Bacillus coli*, the plague bacillus, and other organisms show considerable variation in the size of the cells on different culture media; the *Bacillus prodigiosus*, which forms a brilliant red pigment when grown at ordinary temperatures, completely loses the power of pigment production after cultivation at blood heat, at which temperature (98° F.) it grows as luxuriantly as at 65° F. Twort and Penfold have "educated" the typhoid bacillus to ferment sugars which ordinarily it does not attack, and Revis has obtained marked varieties of *Bacillus coli*, morphological and physiological, by prolonged culture in various media. Minchin holds that if there be no syngamy (sexual reproduction, *e.g.* conjugation) among bacteria, as seems to be the case, the so-called species of bacteria are to be regarded as mere races or strains, capable of modification in any direction.

A marked instance of the artificial production of mutations of *Bacillus anthracis*, a particularly well-defined and stable bacterial species (Fig. 1), is described by Mme. Victor Henri (*Compt. rend. Acad. Sci.*, vol. clviii., No. 14, 1914, p. 1032). The method employed was to expose an aqueous suspension of sporing anthrax in a quartz tube to ultra-violet radiations for times varying from one to forty minutes, and afterwards subculturing.

Whereas the majority of the organisms was killed by this treatment, the ultra-violet rays being markedly bactericidal, a few survived. Of the latter, while most presented a normal aspect, a few showed characters decidedly different from the typical anthrax bacillus. The principal of these were (*a*) coccoid forms (Fig. 2) which remained stable during a period of two months; (*b*) thin filamentous forms (Fig. 3), not taking Gram's stain, not liquefying gelatin, nor curdling milk, and producing an infection different from anthrax

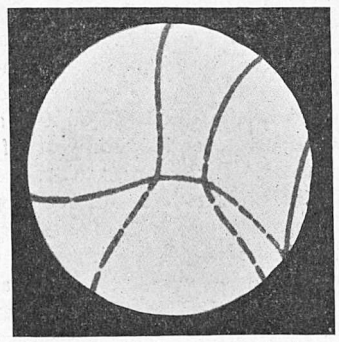

FIG. 1.

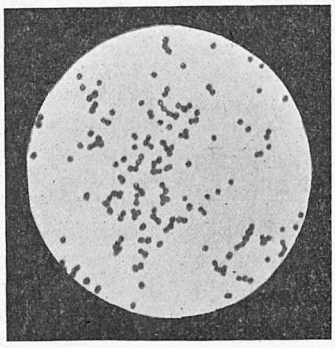

FIG. 2.

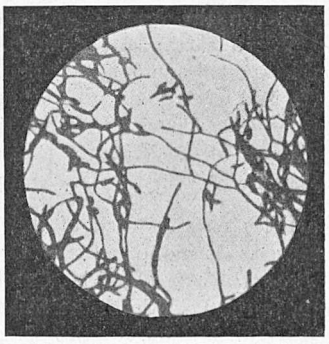

FIG. 3.

on inoculation. This form remained absolutely fixed after daily subculture for more than eighty days; but, though stable *in vitro, in vivo,* after passage through an animal, Gram-positive coccoid forms made their appearance, and subsequently, after subculture in broth, a certain number of bacillary forms, approximating to typical anthrax, were obtained. These experiments open up wide possibilities in the transformation of micro-organisms. R. T. HEWLETT.

NOTES.

THE first of the two annual soirees of the Royal Society will be held in the rooms of the society at Burlington House on Wednesday, May 13.

THE twenty-second James Forrest lecture of the Institution of Civil Engineers will be delivered on Tuesday, May 5, by Mr. F. W. Lanchester, upon the subject of "The Flying Machine from an Engineering Standpoint."

PROF. C. S. SHERRINGTON, Waynflete professor of physiology in the University of Oxford, has been elected a member of the Royal Danish Academy of Sciences, in the class of natural sciences.

THE death is announced, at fifty-eight years of age, of Prof. Adolf Fischer, director of the Museum for Asiatic art, founded last October at Cologne, and consisting almost entirely of collections made by Prof. Fischer himself during repeated journey to the Far East.

THE death on March 19 is announced of Prof. G. Mercalli, one of the leading Italian seismologists. Mercalli, who was born at Milan in 1850, is known chiefly for his researches on regional seismology, for his observations on Vesuvian phenomena, and for his scale of seismic intensity, which, in Italy, has displaced the widely used Rossi-Forel scale. In conjunction with Prof. T. Taramelli, he issued the principal reports on the Andalusian earthquake of 1884 and the Riviera earthquake of 1887. In 1897, were published his valuable monographs on the earthquakes of Liguria and Piedmont, and of southern Calabria and the Messinese district. At the time of his death he was director of the Vesuvius Observatory and professor of seismology in the University of Naples.

TWO articles on the work of the late Prof. Milne have appeared this month, one by Dr. C. Davison, in *Science Progress,* the other by Comte de Montessus de Ballore, in the Bulletin of the Seismological Society of America (vol. iv., pp. 1–24). The former contains a brief account of his life and a summary of the principal work accomplished by him. The latter is more bibliographical in form. Milne's papers are classified and briefly described under fourteen headings, such as earthquake-catalogues, earth tremors and pulsations, aseismic buildings and practical seismology, relations between earthquakes and variations of the vertical and changes of latitude, etc. Both writers claim for Milne the chief share in the growth of seismology.

THE twelfth annual meeting of the South African Association for the Advancement of Science will be held at Kimberley from Monday, July 6, to Saturday, July 11, inclusive, under the presidency of Prof. R. Marloth. The sections and their presidents will be as follows:—A, Astronomy, Mathematics, Physics, Meteorology, Geodesy, Surveying, Engineering, Architecture, and Irrigation, Prof. A. Ogg; B, Chemistry, Geology, Metallurgy, Mineralogy, and Geography, Prof. G. H. Stanley; C, Bacteriology, Botany, Zoology, Agriculture, Forestry, Physiology, Hygiene, and Sanitary Science, Prof. G. Potts; D, Anthropology, Ethnology, Education, History, Mental Science, Philology, Political Economy, Sociology, and Statistics, Prof. W. Ritchie.

THE precise physical cause which has brought the publicity of newspaper paragraphs to the shrinkage of the Caspian Sea must be, pending the official investigation by Prof. Shokalski, a matter for conjecture. That the surface of the sea stood formerly, and at no remote geological date, at a much higher level, and that its extent was much greater, is well known. Again, the level is subject to recognised fluctuations, both annually and over longer periods. The discharge of the several great rivers into the sea strives constantly but often unsuccessfully to keep up with the loss by evaporation. The level usually stands highest in the middle of the year, and lowest at the beginning. As to the fluctuations of longer period, observations extending from 1851 to 1885 showed maxima of height in 1868–69, in 1882, and in 1885, and minima in 1853 and 1873; these oscillations appear to have had an extreme range of some 42 in. The present fall may be associated with this phenomenon; a scientific investigation towards the close of last century led to the conclusion that no perceptible permanent shrinkage was in progress.

A SUMMARY of the weather for the first three months of the year has been given by the Meteorological Office in its Weekly Weather Report for the period ending April 4. The mean temperature for the whole period is shown to be in excess of the average in every district of the United Kingdom. In the east and north-east of England the excess of temperature amounted to 3°, and in the midland counties and in the south-east, north-west, and south-west of England the excess was 2°. In all other districts which comprise Scotland, Ireland, and the Channel Islands, the excess of temperature was only 1°. There was an excess of rainfall over the entire kingdom except in the north-east of England, where the fall was only 95 per cent. of the average. In the south-east of England the rainfall for the three months was 160 per cent. of the average, in the east of England 145 per cent., in the Channel Islands 143 per cent., in the south-west of England 142 per cent., in Ireland, north and south, 140 per cent., and in the east and west of Scotland 122 and 123 per cent. respectively. In the midland counties the fall was only 107 per cent. of the average. There was a slight deficiency of sunshine over the whole kingdom, except in the north of Scotland, where there was a slight excess. At Greenwich the mean temperature for the three months to

the end of March was 42·5°, which is 2·5° in excess of the average, and the temperature was above the normal on fifty-seven days out of the ninety. The aggregate rainfall was 6·92 in., which is 142 per cent. of the average, and is 2·05 in. above the normal. The duration of sunshine was 216 hours, which is an excess of 29 hours.

THE first course of a series of lectures arranged by the National Academy of Sciences, Washington, under the William Ellery Hale foundation, is being delivered by Sir Ernest Rutherford, at the National Museum, Washington, on April 21 and 23. The series of lectures is to cover several years on the general subject of evolution, the intention being to present a clear outline of the broad features of inorganic and organic evolution in the light of recent research. The subjects of Sir Ernest Rutherford's lectures are the constitution of matter and the evolution of the elements. The second course in the evolution series will be given at the autumn meeting of the academy by Dr. W. W. Campbell, director of the Lick Observatory; and a distinguished European geologist will be invited to give the third course at the annual meeting of the academy next year. Taking the earth from the hands of the astronomer, he will show how its surface features have been altered in the process of time. Later lectures, preserving the continuity of the series, will then enter the field of organic evolution and illustrate the bearing of recent investigations in palæontology, zoology, and botany on the evolution of plant and animal life. The evolution of man will form the subject of another course, and the series will close with an account of the rise of the earliest civilisations, coming into touch with the modern times in the life of the Nile Valley. In all cases the lectures will be given by leading European and American investigators, whose personal researches have contributed largely towards the development of the fields of science which they represent.

THE second reading of a Bill to prohibit experiments on dogs was carried in the House of Commons on Friday last, April 17, by a majority of forty-two, the voting being 122 for the second reading and 80 against. It was stated on behalf of the Government that an amendment will be moved in Committee to abolish the proposed prohibition and to allow experiments only in cases where no other animal but a dog is available for the purpose. The Bill was brought in by Sir F. Banbury, one of the members for the City of London. The motion for the second reading was seconded by Colonel Lockwood, member for the Epping Division of Essex. Mr. Rawlinson, Cambridge University, moved the rejection of the Bill; and the amendment was seconded by Sir P. Magnus, London University, and supported by Sir H. Craik, Glasgow, and Aberdeen Universities. Before the second reading was taken, a memorial signed by more than three hundred eminent physicians, surgeons, and other scientific investigators, protesting against the measure, was addressed to the Home Secretary. The memorial is in the following terms:—"We desire to express to you our strong conviction that the Dogs Protection Bill, which is put down for second reading on Friday, 17th inst., would inflict very severe injury, not only on medicine and surgery, but also on the study of the diseases of animals. We think that we have some right to ask you to oppose this attack on the advancement of medical science and practice; especially as the Final Report of the Royal Commission on Vivisection does not advise the prohibition of experiments on dogs. We are absolutely certain that such experiments are necessary for the complete study of many problems of physiology, pharmacology, and pathology."

THE discovery of a prehistoric workshop floor, with flints, and other fragments, was incorrectly said in a note last week (p. 169) to have been made at St. Albans, instead of Ipswich, though the latter place was mentioned later in the paragraph.

IN the *Times* of April 11 Mr. H. St. George Gray gives his final report of the results of excavations at Maumbury Rings, Dorchester. The great earthwork has now been investigated. In prehistoric times there existed an immense circular ditch, having a medial diameter of 169 ft. This was adapted by later Roman settlers for use as an amphitheatre. In some respects Maumbury resembles Avebury, and the fosse in both cases may have been intended to prevent animals and the ordinary public from trespassing on a spot reserved for ceremonies conducted by the privileged. The excavations now in progress at Avebury may result in strengthening a comparison between these two important prehistoric enclosures.

IN part i., vol. xxxvi., of the Transactions of the Bristol and Gloucestershire Archæological Society for 1913, Miss I. M. Roper discusses the delineation of flowers in stone in Bristol Church architecture. Such carvings appear only sporadically in Anglo-Saxon work, as at Britford, near Salisbury, and on Acca's Cross at Hexham. But they become numerous at the close of the Norman period, from A.D. 1175 to A.D. 1200. The designs are naturally conventional, but display much appreciation of botanical forms. It is possible in some churches to recognise the campanula, trefoil, and vine-leaf. The magical use of the holy herb, now known as yellow avens or herb bennet, constantly appears. Such flower ornamentation appears on the tower of St. Mary Redcliffe, A.D. 1292, and in the choir of Bristol Cathedral, A.D. 1298–1332. In the latter the oak-leaf is a common subject, and we also find the maple, beech, ivy, and hawthorn. Among herbaceous plants may be recognised the yellow water-lily, white bryony, and the buttercup. Miss Roper identifies the familiar ball-flower type of ornament with the ripe fruit of the juniper. Excellent as most of the carving is, its best efforts naturally bear no more than a coarse resemblance of nature's handiwork.

WE have received the first progress report of the Thompson-McFadden Pellagra Commission. It includes a study of the epidemiology of pellagra by Capt. Siler and Surgeon Garrison, in which it is stated that observations on the habitual use of the more common foodstuffs failed to discover any points of difference between pellagrins and non-pellagrins.

THE Journal of the Royal Society of Arts for March, 1914 (vol. lxii., No. 3199) contains a paper by Prof. Bottomley on the bacterial treatment of peat. The raw peat is treated in three stages—first, the raw peat is moistened with a culture solution of the special "humating" bacteria, and the mass is kept at a constant temperature for a week or ten days; during this time the bacteria act on certain organic constituents of the peat, and gradually convert a large amount of the humic acid present into soluble humates; secondly, the "humating" bacteria having done their work are destroyed by sterilising the peat by live steam; thirdly, the sterilised peat is treated with a mixed culture of nitrogen-fixing organisms—*Azotobacter chroococcum* and *Bacillus radicicola*—and after a few days' incubation at 26° C. is ready for use. The material so obtained possesses astonishing fertilising properties, and extensive trials with satisfactory results have been carried out at Kew.

BULLETINS No. 10A and 10B of the Eugenics Record Office contain a report of "the committee to study and to report on the best practical means of cutting off the defective germ plasm in the American population." The former of these discusses the scope of the committee's work, which indeed covers the whole of "negative" eugenics and extends beyond it. The first problem is, of course, to decide what is defective germ plasm and how it manifests itself in the life and character of the individual who bears it. The committee has gathered little fresh knowledge in this field, and their treatment of the questions involved is rather unsatisfactory. For example, the most conspicuous feature of their discussion on criminality is an elaborate classification of crimes, which has not the merit of being logical, since qualities such as "incorrigibility" and conditions such as "prostitution" are included in it, whereas a crime must necessarily be an act. Bulletin 10B is a more useful work, as it contains an account of the American Sterilisation Laws, and of Bills which have been brought forward in State legislatures for this end without reaching the statute-books. An excellent summary of the laws was communicated to the last Eugenics Congress by Mr. Van Wagenen, in the form of a preliminary report of the committee, but the report now under notice is much fuller, and contains, in addition to the items mentioned, a record of the legal proceedings which have arisen out of the laws.

THE *Psychological Review* for March contains an interesting paper by E. K. Strong, illustrating the application of psychological experiment to problems of commercial interest. The special problem under investigation was the relative efficacy of the one-page advertisement in four months compared with two half-page advertisements every two months, and with four quarter-page advertisements every month. This problem involved the consideration of two distinct points: the effect of increase in the size of an advertisement and the effect of continued repetition of an advertisement on the reader's memory. The advertisements for the experiment were carefully chosen so that they were not likely to be seen save in the test; other suitable precautions were also taken. The 288 advertisements selected were divided by the experimenter into four sets corresponding to the four monthly issues of a magazine. The four sets were shown to the subjects at intervals of a month. One month later the subjects were tested, by their ability to select from an equal number of advertisements previously seen and unseen, as to their remembrance of what had been shown them. The writer concludes (1) that the value of space in advertising as affecting permanent impressions increases approximately as the square-root of the increase in area, (2) that when the interval of time between successive presentations is very long (a month), space used in advertising is more effective when used in a large advertisement than if presented in small advertisements repeated with greater frequency.

THE twenty-seventh annual report of the Marine Biological Station at Port Erin records that the number of workers in 1913 was seventy-two, and that all the available work-places were fully utilised during the Easter vacation. Though some relief was obtained by converting part of a large apparatus-room into a laboratory for bio-chemistry, extension of the laboratory accommodation will evidently be required in the near future. Besides the usual work in the laboratory and the shore-collecting, the students attending the course during the Easter vacation had the advantage of demonstrations of oceanographic work on Prof. Herdman's S.Y. *Runa*. The work of the fish hatchery has proceeded as in previous years; more than seven and a half millions of plaice larvæ were hatched, taken out to sea, and liberated, and the difficult work of rearing young lobsters has been carried on with some success. The report records the captures (many of which have already been noticed in the columns of NATURE) made during the cruise of the *Runa* in the Hebridean Sea in 1913; these include 259 species of Foraminifera, several new to Great Britain, a preliminary list of which is given by Messrs. Heron-Allen and Earland.

WE have received the report of the Rugby School Natural History Society for 1913, in which the secretary takes a thoroughly optimistic view of the present position and future prospects of that body. An article on the architectural works of Robert Adam and the "Adelphi" affords much interesting reading.

ACCORDING to a statement issued by the Smithsonian Institution, the nearly complete skeleton of a dwarf horned dinosaur (Ceratopsia) has been discovered recently in the Montana Cretaceous. The skull measures only 22 in. in length, against from 6 to 8, or even 9 ft., in the larger members of the group, the whole size of the new form being only about one-fourth that of the latter.

THE most interesting item in vol. x., part 1, of the Records of the Indian Museum is the description by Dr. W. M. Tattersall, in an article on Indian brackish-water crustaceans of the family Mysidæ, of a new genus and species from Bombay, for which the name *Indomysis annandalei* is suggested. So distinct is the genus that its inclusion in the subfamily to which it is most nearly related involves a modification

in the definition of that group. It is "distinguished by the combination of characters afforded by the unjointed antennal scale, the short entire quadrangular telson, and the form of the pleopods in the male."

AN important contribution to our knowledge of the zoology of the Austro-Malay Archipelago is made by the appearance in vol. xix. of *Bijdragen Tot de Dierkunde* of the full scientific results of Dr. L. F. de Beaufort's journey in that region during the years 1909 and 1910. As we learn from the introduction, by Dr. de Beaufort, the main object of the expedition was to collect the fresh-water fauna of Buru, Ceram, Waigeu, and other islands, and thus complete, so far as possible, the work initiated by Prof. Max Weber, who was the first to collect systematically the fishes and other members of the fresh-water fauna of Sumatra, Java, Celebes, and other Sunda islands. But collecting, although not indiscriminate, was by no means restricted to the rivers and lakes, as may be seen by reference to the list of contents, which comprises ten articles by specialists, including one, with a coloured plate, on the fishes by Dr. de Beaufort, with remarks on the zoogeography of the region.

THE aforesaid article by Dr. de Beaufort on the fishes of the eastern islands of the Austro-Malay Archipelago is supplemented by one in the same fasciculus on those of Celebes by Prof. Max Weber. This issue also contains the results of Dr. C. Kerbert's study of the various local forms of long-beaked echidnas of the genus Zaglossus (Proëchidna), to which reference has been made previously in NATURE. It is illustrated by a plate showing the marvellous similarity between the walking pose of these strange beasts and that of a giant land-tortoise.

AT the price of one penny, the London County Council has issued "A Handbook to the Collections Illustrating a Survey of the Animal Kingdom," in the Horniman Museum and Library, Forest Hill. Although the text conveys a large amount of information, it would have been better suited to its purpose if a larger use had been made of the vernacular and fewer technicalities employed. It would also have been well to avoid the misstatement (p. 58) that the lower teeth of a dog are equal in number to the upper; whilst the merest tyro in natural history ought to be aware that Sibbald's fin-whale (p. 71) does not belong to the same genus as the Greenland whale. It is, moreover, unnecessary to add to the brain-worry of students by introducing so-called orders, like Ancylopoda (p. 65), which have long since been abolished.

THE *Bulletin Hydrographique* of the International Council for the Study of the Sea for the year July, 1911, to June, 1912, records the hydrographical observations carried out in the North Sea and adjacent waters during the period named. The observations do not appear to have been carried out upon as extensive a scale as in former years, and a chart of surface salinities for the North Sea is only provided for one month, viz., May, 1912. The mean surface temperatures are more fully shown in a series of charts which give the surface isotherms for periods of ten days, three charts being given for each month. A number of sections showing the conditions in the North Sea below the surface are also provided, based chiefly on Scottish and English work. The Finnish and Danish investigators contribute the results of numerous gas analyses of sea-water, the measurements given referring to the amounts of oxygen present at different depths at certain stations in the Gulf of Finland, in the Belts and Kattegat, and at the Faroes.

THE fauna of the great Ringk bing Fjord, on the west coast of Jutland, in the neighbourhood of Holmsland, forms the subject of an elaborate memoir by Dr. A. C. Johansen, published at Copenhagen in the volume entitled "Mindeskrift for Japetus Steenstrup," 1913. The subject has been treated by several previous writers, notably by Rambusch, in his "Studier over Ringkøbing Fjord," published in 1900, while a large amount of literature relating to the fisheries has appeared. Of all these sources of information the author has availed himself to the full, especial interest attaching to the physical changes recorded as having taken place between the middle of the seventeenth and the middle of the nineteenth century.

AN important study in European geography was contributed to the *Bulletin international de l'Académie des Sciences de Cracovie* during 1912 by L. Sawicki, entitled "Beiträge zur Morphologie Siebenbürgens." The explanatory method is followed, and a broad view may be gained of the changes that have taken place in the eastern Carpathian mass since the coastal plain of the Pontian sea was uplifted and a consequent system of westward-running rivers was established on its slope. This system was greatly interfered with by volcanic outpourings and cone-building in the Hargitta region, and the present young gorges of the Maros and the Alt are due to the escape of water that was ponded back in a series of lakes, and thus kept for a time from flowing westward. The same author describes glacial landscapes in the Westbeskiden, where the somewhat feeble local ice has left more evidence in the way of cirques and moraine-barriers than has previously been observed.

THE ninth paper by Dr. E. van Rijckevorsel on the periodicity of secondary maxima and minima in meteorological phenomena appears in No. 16 of the *Mededeelingen en Verhandelingen* of the Royal Meteorological Institute of the Netherlands. As any subsequent papers on this subject will be continued in the same publication, a brief statement of some of the results hitherto arrived at is given in the present number. In the yearly march of temperature certain small maxima were found about every ten or eleven days, which were constant in time and space. These zigzag curves ("Zacken") were also shown to exist for air-pressure, rainfall, etc., with important modifications relating to the occurrence of maxima and minima in different seasons. The author assumes that these zigzags are only special cases in a whole series of small periodical variations, and he has undertaken the laborious task of investigating these variations in detail.

IN a recent number of the *Annalen der Physik* there appears an important paper by Prof. Quincke on "Electrische Schaumwände der Materie." The subject-matter is a continuation of the work which has been done on the structure of "foam" walls and chambers, but in particular he points out an analogy between these and the electrical "dust" figures, which he regards as being due to the formation of foam chambers by electrical emanations of positively or negatively charged particles. Ordinary foam chambers made by precipitation or other methods he regards as being of two kinds: (1) those formed quickly in viscous fluids, and which may take a variety of forms, (2) those formed slowly in less viscous fluids, and which consist of globular cells connected by tubes. When the charged knob of a Leyden jar is presented to a cake of resin, he supposes that an electrical emanation of charged particles is emitted, and these particles are attracted to the plate of resin. By their impact they melt the resin locally to form an oil-like substance which solidifies around the charged particle, and thus produces a "foam" chamber with electrified walls. These chambers are rendered visible by dusting with the usual mixture of red lead and sulphur. He regards those upon which the sulphur is deposited as being similar to type (1), and those upon which the red lead settles as being similar to type (2).

NEARLY all the optically-active carbon compounds that have been prepared hitherto have been substances of relatively complex composition. The two simplest, lactic acid, $CH_3.\mathbf{C}H(OH).CO_2H$, and *sec.*-butyl alcohol, $CH_3.\mathbf{C}H(OH).C_2H_5$, contain three and four carbon atoms respectively; in each case also three of the four radicles attached to the asymmetric carbon atom **C** are compound radicles, and only one (the hydrogen atom) is simple. Special interest attaches therefore to the two simple substances, ammonium *d*- and *l*-chloroiodomethanesulphonates,

$$\mathbf{C}HClI.SO_3.ONH_4,$$

which have been prepared and separated in an optically-active form by Prof. Pope and Mr. Read (Trans. Chem. Soc., 1914, vol. cv., p. 811). In these substances three of the radicles are simple, and only one is compound; none of the four radicles contains a carbon atom, and the percentage of carbon amounts to less than 5 per cent. The two acids were separated by fractional precipitation from the ammonium salts by the addition of brucine; after reconverting into the ammonium salt the dextro-acid gave the molecular rotation $[M]_{5461}$ +43°. The active material is remarkably stable; the optical activity is not changed by boiling alone or with acids or alkalis, or by heating with water in a sealed tube to 130–150°.

Engineering and the *Engineer* for April 17 contain articles dealing with electric power supply in London. Messrs. Merz and McLellan have investigated this subject recently, and have presented a report to the London County Council. Apart from traction stations there are seventy generating stations at present in London, containing 585 engines. The report states that there are practically only two ways of effecting important economies in electricity generation in London; first, to allow the extension of eight or ten of the best existing stations, and gradually to abandon all the others; secondly, to abandon all sites in or near the metropolitan area, and to concentrate the production of electricity for all purposes well outside. The primary distribution system throughout London should be standardised. Assuming all existing stations for the supply of light and power to be in the hands of one authority, the final conclusions are that it would pay to shut them all down, sell most of the plant, and generate all energy on sites down the river. Considering only the central area, it is estimated that the saving in working costs with this scheme would be about 18 per cent., or 170,000*l.* a year.

THE editor of the new quarterly, *Isis,* devoted to the history and organisation of science, asks us to say that the annual subscription is 30 francs per annum, and not 24 francs as stated in a note in NATURE of April 9 (p. 143).

A COPY has been received of the second supplement, 1911–13, to the catalogue of Lewis's Medical and Scientific Circulating Library, 136 Gower Street, London, W.C. A classified index of subjects, with the names of those authors who have written upon them, is included.

OUR ASTRONOMICAL COLUMN.

COMET 1914*a* (KRITZINGER). — The following ephemeris of comet 1914*a* (Kritzinger) is published by Prof. Kobold in *Astronomische Nachrichten,* No. 4727 :—

12h. Berlin M.T.

	R.A. (true) h. m. s.	Dec. (true) ° ′	Mag.
April 23 ...	17 38 35 ...	+8 45·2 ...	9·5
24 ...	42 30 ...	9 40·7	
25 ...	46 27 ...	10 36·6	
26 ...	50 25 ...	11 32·7 ...	9·4
27 ...	54 23 ...	12 29·0	
28 ...	17 58 23 ...	13 25·4	
29 ...	18 2 24 ...	14 21·9	
30 ...	18 6 27 ...	+15 18·3 ...	9·3

THE VARIABLE 081041, −41° 3911, H.V. 3372.—Prof. E. C. Pickering communicates some interesting facts relative to the spectrum and magnitude of the star C. DM. −41° 3911, this star having previously been found by Mrs. Fleming to be peculiar, and also later independently by Miss Cannon. In identifying this object Miss Mackie has found that it is a variable, and in this paper the magnitudes are given for the period 1890 to 1912. The nature of the variation is indicated by a curve. Prof. Pickering describes the object as a very curious one. At first sight it might appear to be a variable star with a period of about twenty years, and varying from the eleventh to the fourteenth magnitude. He points out that ordinary variables of long period have a very different spectrum and undergo all their changes in less than two years. In this case the variations may prove to be irregular and to resemble those of the three stars of the class of R. Coronæ. The position of the star for 1900 is R.A. 8h. 10·8m., and declination −41° 24′, and additional observations of both its magnitude and spectrum are required to settle the peculiarity above mentioned.

THE SOLAR CONSTANT OF RADIATION.—No one interested in this subject should fail to read an address delivered before the Philosophical Society of Washing-

ton by Prof. C. G. Abbot, the retiring president, and reported at length in *Science* of March 6. The address forms a valuable aperçu of the subject from Herschel's pioneer actinometric observations down to the experiments made late last summer under the joint auspices of the Smithsonian Institution and the U.S. Weather Bureau on the employment of *ballons-sondes* in pyrheliometric investigation. With regard to the solar constant, the mean value of 690 measurements made in connection with the Astrophysical Observatory of the Smithsonian Institution during the period 1902–13 is stated to be 1·933 calories per sq. cm. a minute, a value which is probably accurate to 1 per cent. It will be noted that this period covers one sun-spot cycle, and it is also stated that the Mount Wilson measures indicate that the solar radiation is more intense at spot maximum than at minimum, the sun thus showing affinity with variable stars of the *o*-Ceti type.

THE ACTION OF GRAVITY ON GASEOUS MIXTURES.—M. G. Gouy, in a recent communication to the Paris Academy of Sciences (*Comptes rendus*, vol. clviii., pp. 664–8) extends to the terrestrial atmosphere his researches on gaseous mixtures which during 1912 led him to the conclusion that pressure could not be the cause of the general displacement of the Fraunhofer lines towards the red. We may direct attention to the fact that the suggestion he then made that perhaps the explanation of this phenomenon would be found in the Doppler effect has received striking confirmation on purely spectroscopic grounds very recently in the work of Mr. Evershed (NATURE, March 19, p. 69). The present paper affords a mathematical demonstration of the impossibility of stratification according to density by the action of gravity on the gases in the earth's atmosphere where the pressure exceeds that of a Crookes tube as the final result indicates that under these conditions the effect of gravity on the composition of the air is too slow to produce sensible effects.

GROWTH AND CULTIVATION OF HOPS.[1]

THE close attention which is being given in many foreign countries to the scientific study of plants of economic importance is evidenced in the two reports on the hop lately published by Dr. J. Schmidt. Although the cultivation of hops in Denmark is at present restricted to about 100 acres, Dr. Schmidt, of the Carlsberg Laboratory, Copenhagen, was recently commissioned to visit this and other countries with the object of collecting information on the most modern methods of cultivation, and also to collect data and material likely to prove of value in the work of breeding improved varieties of hops for cultivation in Denmark. In 1910 the physiological department of the Carlsberg Laboratory began a series of investigations on the hop plant (*Humulus lupulus*, L.), with a view of obtaining information of theoretical and practical interest regarding this plant. These reports by Dr. Schmidt are the first-fruits of this work.

In the first report, the growth in length of the stem and its diurnal periodicity is dealt with. One of the first problems for investigation that presented itself was to ascertain if the foreign varieties of hops obtained from southern regions which are being grown in the experimental garden attached to the Carlsberg Laboratory have a different rate of growth in the northern climate of Denmark from the wild-growing plant of that country. In the course of making these investigations, which are not yet concluded, the experiments detailed in this first report were made.

Dr. Schmidt was at the outset inclined to the belief —a belief, by the way, which is firmly held by the practical hop-growers of Kent—that the growth of the hop stem, or "bine," would be strongest during the night. Observations on a number of plants soon showed, however, that the reverse is the case. The least growth took place during the six hours 9 p.m. to 3 a.m., which proved that darkness was not the dominant factor of growth. It might have been expected that the growth-promoting factor of darkness would first show itself as an "after-influence," and that consequently the greatest growth would be during the following morning period, 3 a.m. to 9 a.m. It was found, however, that the strongest growth occurred during the period 3 p.m. to 9 p.m., immediately preceding the darkest period, the value for the rate of growth increasing evenly from the minimum of the latter period to the maximum of the afternoon period.

In the two main series of experiments, which were carried out in 1911 from the end of April, to the end of June, and in 1912 during July, the plants, growing in an unheated glasshouse, were kept as far as possible under natural conditions. The measurements were made continuously at 6 o'clock in the morning, 12 o'clock noon, 6 o'clock in the afternoon, and at 12 o'clock at night. The diurnal oscillations of temperature were followed by means of a thermograph.

Further experiments made seemed to show conclusively that the influence of the temperature on the rate of growth under natural conditions predominates over the influence of humidity; as the author remarks, "the growth-promoting power, which high humidity is known to have under natural conditions, is 'covered' by the influence of the temperature, so that it appears as if only the temperature was of any importance for the rate of growth of hop-stems."

The results of the investigations are summed up as follows:—"The growth in length of hop-stems under natural conditions has a very distinct diurnal period, the rate of growth being smallest during the night, greatest during the day. This periodicity is determined by outer factors, among which the temperature has such a predominant influence that under natural conditions it determines the rate of growth."

The second report deals with investigations into the rotational movement of the hop-stem. In experiments with vigorous three-year-old hop-plants, in an unheated glasshouse, the stems were found to show, during May and June, a rotational movement amounting on an average for one to two weeks' observations to about 120° an hour, or one-third of the rate of the minute hand of the clock. The following table records the facts observed with two hop-plants, one (No. 14) obtained from Germany, the other (No. 36) from England:—

	No. of whole days under observation	Total rotation in degrees	No. of turns	No. of turns in 24 hours (Average)	No. of degrees an hour (Average)
Plant No. 14					
Shoot *a* ...	9 ...	24865 ...	69 ...	7·7 ...	115
,, *b* ...	9 ...	25875 ...	72 ...	8·0 ...	120
,, *c* ...	11 ...	29810 ...	83 ...	7·5 ...	113
Plant No. 36	13 ...	37600 ...	104 ...	8·0 ...	120

The rotational movement proved to have a very distinct daily periodicity, the rate being greatest during the day, least at night. This daily periodicity is determined by external factors, among which the temperature is of such dominating importance that

[1] Johs. Schmidt: (1) "The Growth in Length of Hop-stems and its Diurnal Periodicity" (*Comptes rendus des travaux du Laboratoire de Carlsberg*, 10me vol., 2me livraison, 1913).
Idem. (2) "The Rotational Movement of Hop-stems and its Diurnal Periodicity" (*l.c.*, 3me livraison, 1913).

its variation under natural conditions is determinative for the rate of rotation.

A graphic comparison of the fluctuations in the rate of rotation and degree of humidity showed that there was no connection between them under the (natural) conditions prevailing when the observations were carried out.

From some laboratory experiments with pot-plants it appeared that the rotational movement is not different, or at any rate not essentially different, in the dark and in scattered daylight.

An endeavour was made, with the minimum temperature (which "lies in the neighbourhood of 4°") as starting point, to obtain an expression of the relative quantities of heat, which were of importance for the rate of rotation. The numbers obtained, which are called "active quantities of heat," show that there is a very complete agreement between fluctuations in these and in the rate of rotation, the fluctuations showing a perfect synchronisation under the conditions observed.

Comparative experiments with twining bean-plants, and with *Lonicera periclymenum*, L., showed that a similar daily periodicity in the growth in length and rate of rotation of the stem occurred and that temperature is here also the determining factor. The author concludes by remarking:—"It is probable that the growth movements in many plants living under climatic conditions such as ours, where great temperature fluctuations occur in a diurnal period, have a diurnal periodicity which follows that of the temperature." E. S. S.

EDUCATION IN INDIA.[1]

IN the two substantial volumes before us Mr. Sharp gives an exceedingly able and comprehensive summary of the educational work done in India in the period 1907–12. The value of this record is enhanced by the inclusion of a Resolution of the Government of India dated February 21, 1913, summarising its educational policy, and forming a masterly exposition of its aims. A member of the Council of the Government of India has now been appointed with special charge of education, and the first incumbent of the post is Sir Harcourt Butler, who is to be congratulated on this very able summary.

The impression gained from the volumes is that education in India has now entered on a new and hopeful page of its history, for the progress made in the past five or ten years has been very great. Every effort is being made not only to widen the area of education, but also greatly to improve its methods, while in the forefront the formation of the character of the pupils is rightly insisted on. There are also clear signs that in the future efforts will be made to raise the status of those engaged in education, and to make their position such that the post of a teacher will be much sought after, and not taken as a last resource, as is largely the case at the present time.

India is sometimes pictured as a single country, but it really shows far greater complexities in education than Europe itself. It is computed that there are about thirty-eight million children of school-going age in the area dealt with in this report, while there are only 176,225 educational institutions of all classes, and in these six and three-quarter million pupils are under instruction. Almost all of these are boys, and the most trustworthy figures show that in 1911–12 for every mille of population of school-going age there were 268 boys and 47 girls under education. Five years previously these figures were 227 and 32 respectively. This really represents rather rapid progress, though compared with civilised Europe, India is still very far behind in the education of its masses.

Until recent years more attention was paid to the development of higher education than to that of the masses, but this has been largely changed during the past ten years, and now primary education is being largely fostered.

The type of higher education at first introduced was unpractical, largely literary, and tended to superficial knowledge, and in a large proportion of the students it did not fit them for their work in after life. Various efforts at reform were made, but the first effective movement came from Lord Curzon when Viceroy of India, who in 1901 summoned a representative conference which dealt with the whole subject of education from the university down to the primary stage. Numerous far-reaching reforms were formulated, and the history of many of the reforms is illustrated in the work under review.

One of the results of the conference was the Universities Act of 1904, under which regulations were framed, which came into force about the beginning of the period which is dealt with in Mr. Sharp's volumes. This Act was most bitterly opposed, but it is now admitted that it has produced a general and most important improvement in both university and secondary education, for some of the universities in India have large powers over the secondary schools which prepare candidates for university education, as they regulate the courses of study and even have powers of inspection, etc. It is probably true to say more progress has been made during these five years in improving and consolidating secondary and university education than in any previous quinquennium, for institutions which were working inefficiently have ceased to be recognised and have disappeared, while others have been helped and made more efficient. Indeed, the report indicates there have been great improvements in the courses of instruction in colleges and schools, also in thoroughness of study, in the more practical requirements in the study of, and examination in, science subjects, and finally in considerable improvements in discipline and in the formation of character, due to the students being compelled to live in recognised hostels (on which much money has been spent) or in messes under proper supervision.

The reforms due to the Educational Congress of 1901 included a large extension and improvement in primary education and its more efficient inspection, and a recommendation that greater attention should be paid to the teaching in and through the vernaculars. Both these reforms have made large progress during the past five years, and are undoubtedly leading to sounder education. Attention is now also being paid to manual training and nature-study. An endeavour to obtain more trained teachers in all stages of education is occupying considerable thought, and efforts are being made to effect this, but when it is stated that there are 215,518 teachers in India, who all ought to be trained, the magnitude of the problem is seen to be almost overwhelming.

Increased attention has also been given to female education, which, owing to the peculiar difficulties arising from the customs of the people themselves, has always been, and still is, in a very backward condition. As the result of this increased attention during the five years, the number of girls at school has increased by 47·7 per cent., but even this large increase only brings up the percentage of girls at school to the population of girls of school-going age to 5·1 per cent. Strenuous efforts are being made to

[1] Progress of Education in India in 1907–12. Sixth Quinquennial Review, by H. Sharp. Vol. i., pp. xvii+284+index; vol. ii., pp. 292. (Calcutta: Superintendent Government Printing, India, 1914.) Prices, vol. i., 6s.; vol. ii., 3s.

render female education more popular and effective, and on their success the future progress of India in a large measure depends.

It is remarked that during the five years a very great change has taken place in the feeling of the population of India towards education, and it is now much more popular than it was. Indeed there was a proposal to make primary education compulsory in India generally, but this has been negatived, though it is being adopted in Baroda.

Much more money is now being spent on education. In 1907 the cost of education was said to be 559 lakhs of rupees, and in 1912 it had risen to 786 lakhs, of which the Government contributed a very large proportion. With this liberal policy there is no doubt very rapid progress will be made, for the cost of educating individual pupils in India is still small. Thus the annual cost of a primary-school pupil is about six shillings, of a secondary-school pupil about 1*l.* 12*s.*, and of a pupil reading for a university degree about 11*l.* 5*s.*, and yet with these small individual sums a fair training is being given in the case of university and secondary education, though the primary education is still very defective.

THE MOUNT WILSON SOLAR OBSERVATORY.

IT is always difficult to condense in a few lines the essence of the work accomplished during a year at the Mount Wilson Solar Observatory. The report for the past year, just issued by the director, is a concentrated essence by itself, and as it covers forty-five pages the difficulty of the task will at once be grasped. The director commences the report by summarising the principal results obtained during the year, and the brief paragraphs which compose this summary, each of which is practically restricted to an important piece of research work, number no fewer than *seventy-two*. Space does not permit one to refer even to the more important of these, but many have already received notice from time to time in our astronomical column, and are therefore familiar to our astronomical readers. Perhaps the most important result is that concerning the magnetism of the sun. Observations of the Zeeman effect at various solar latitudes have indicated that the sun is a magnet, and that the magnetic poles are at or near the poles of rotation. Further, the polarity of the sun corresponds with that of the earth, a conclusion, as the director, Prof. Hale, remarks, which may prove to have an important bearing on theories of terrestrial magnetism. The first approximate value for the vertical intensity of the sun's general field at the poles is given as 50 gausses, which is about one-hundredth of the intensity of the most powerful sun-spot fields, and about eighty times that of the earth's field.

One of the most interesting items usually associated with these reports is the work of construction in hand, and this report shows an astonishing amount of work in progress. The fact that the 100-in. disc has been proved to be serviceable for a reflecting telescope has given rise to a great increase of activity. The grinding of the mirror and the 60-in. plane mirror for testing it have been pressed forward, and the requirement for larger shop tools necessitated by the construction of many parts of the 100-in. telescope mounting and the auxiliary instruments to be used with it have even demanded an increase in the already large shop floor-space. The work involved in the preparation of the foundations for this telescope and of the building and the eventual transport of the instrument to the mountain-top has necessitated the adoption of especially powerful motor trucks in place of the mule teams.

Other important work in hand is the construction of a large ruling-machine, embodying the general principles of Rowland's successful ruling-machines. An idea of the accuracy attained after the grinding and polishing of the screw will be gathered from the statement that no periodic errors were found greater than 0·000001 in., and no appreciable error of run could be detected. The maximum error in the teeth of the wormgear did not exceed 0·001 in., a quantity too small to produce appreciable ghosts.

To gain a more complete insight into the contents of the report the reader must be referred to the report itself. The fact that such rapid advances are being made in both solar and stellar physics is due to the happy combination of an energetic and able director, a keen and active staff, a good observing site, and an annual grant (for 1913) of 33,126*l.* for construction, investigations and maintenance.

[1] Annual report of the director of the Mount Wilson Solar Observatory 1913. Carnegie Institution of Washington.

MARINE INVESTIGATIONS.

THE report on the Danish Oceanographical Expeditions, 1908–10, to the Mediterranean and Adjacent Seas, under the superintendence of Johs. Schmidt, No. 2, contains two memoirs, one by Dr. Kyle, on flat fishes, and one by Dr. Schmidt, on experiments with drift-bottles. Dr. Kyle's paper is an important contribution, and deals with the following genera in a very comprehensive way :—Arnoglossus, Bothus, Solea, and Symphurus. The much disputed question as to the number of species of Arnoglossus occurring in European seas is very elaborately discussed, and Dr. Kyle's conclusions differ in several respects from those of previous authors. He recognises five species, the specific names being used, however, in a different sense from that which has been adopted by recent writers on the subject. The species are *Arnoglossus grohmanni*, Bonap., non auctorum, *A. thori*, nov. nom., *A. laterna*, Will., *A. imperialis*, Raf., and *A. rüppelli*, Cocco. Of these *A. thori* is the species which has generally been called in this country *A. grohmanni*. Dr. Kyle discusses not only the adult characters, but also the larval and post-larval stages of this genus and of the other genera of which he treats. The paper is well illustrated with text figures and plates, and will be of the greatest value to future workers. An excellent bibliography of the subject is added. Dr. Schmidt's experiments with drift-bottles show that there is an easterly drift of the surface water from the entrance of the Mediterranean, especially along the north coast of Africa, so that water from the Atlantic is being constantly carried into the Mediterranean. The velocity of this drift may reach eighteen to twenty miles a day.

The Central Bureau of the International Council for the Study of the Sea has issued vol. xvii. A of the "Rapports et Procès-verbaux des Réunions" (English edition), which contains the first part of Prof. Heincke's long-delayed general report upon the investigations on the plaice. This part of the report is confined almost exclusively to a discussion of the statistics obtained from commercial fishing vessels, and is further limited in scope by the fact that the English statistics are alone considered. The report is, in fact, little more than a renewed attempt to discuss the conclusions to be derived from these English statistics, matters which had already been dealt with by the officers of the Board of Agriculture and Fisheries. It is doubtful whether Prof. Heincke's methods of dealing with the statistics are in any way an improvement upon those followed in this country, and, probably from want of adequate trained assistance, it seems clear that the work has not been car-

ried out with that accuracy of detail which is, we believe, attained by the statistical department of the English Board. In this connection Prof. Heincke states (p. 66):—"The appendix to this report contains a number of these tables drawn up by me from the English measurements. Close inspection will show, that here and there inaccuracies and errors have crept in during the preparation of the tables. Thus, in the case of large numbers which are the sum of many measurements, smaller or larger differences may be present between the English data and my tables. These small discrepancies will perhaps be excused, when the enormous amount of calculating work is considered; I do not believe that any essential error is present, which might lead to erroneous conclusions." In the opinion of the writer of this note there can be no excuse for a slovenly and inaccurate treatment of statistical data, and figures should not be published until errors such as those alluded to by Prof. Heincke have been eliminated.

SURFACE COMBUSTION.[1]

DURING his researches upon flame,[2] Sir Humphry Davy discovered, in 1817, that the constituents of a combustible mixture will combine slowly below the ignition temperature; this led him to inquire whether, seeing that the temperatures of flames far exceed those at which solids become incandescent, a metallic wire can be maintained at incandescence by the combination of gases at its surface, without actual flame. He thereupon tried the effect of introducing a warm platinum wire into a jar containing a mixture of coal-gas and air rendered non-explosive by an excess of the combustible constituents; the wire immediately became red hot, and continued so until nearly the whole of the oxygen had disappeared.

During the twenty years which followed Davy's discovery, several distinguished chemists (William Henry and Thomas Graham in this country, but more particularly Dulong and Thénard, and independently Döbereiner in France) experimented upon the slow combination of gases at temperatures below the ignition point, in contact with hot solids, whereby it was established (1) that hot solids, and pre-eminently metals of the platinum group, have the power of inducing gaseous combustion at relatively low temperatures; and (2) that hydrogen is, of all combustible gases, the most susceptible to this action.

The mechanism of this induced slow surface combustion formed the subject of a celebrated controversy between Faraday and De la Rive in 1834–5. De la Rive held the view that it consists essentially in a series of rapidly alternating oxidations and reductions of the surface; Faraday, on the other hand, contended that the function of the surface is to condense both the oxygen and the combustible gas, thus producing in the surface layers a condition comparable to that of high pressure. But, owing to lack of crucial experiments, no satisfactory theory of the phenomenon could be evolved, nor, with the exception of the famous "Döbereiner lamp," was there any practical outcome of this early work. In 1836 interest in the subject suddenly dropped, and was not revived for half a century.

Meanwhile, the researches of Deville upon the dissociation of steam and carbon dioxide at high temperatures led to the notion, which was strongly upheld by the late Frederick Siemens, that inasmuch as incandescent surfaces promote dissociation, they must necessarily hinder combustion. This, of course, is fallacious; we now recognise that if, as Deville proved, an incandescent surface accelerates the dissociation of steam, it must, according to a principle enunciated by Ostwald, of necessity accelerate the combination of oxygen and hydrogen in like degree, provided always that the surface remains chemically unaltered.

A notable demonstration of the possibility of realising a flameless incandescent surface combustion in contact with metals other than those of the platinum group was given by Thomas Fletcher in a lecture at the Manchester Technical School so far back as 1887.[3] He injected a mixture of gas and air on to a large ball of iron wire, flame being used at first in order to heat the wire to the temperature necessary to induce a continuous surface combustion; on extinguishing the flame, by momentarily stopping the gaseous mixture, the combustion continued without any flame, but with an enormous increase of temperature. Fletcher grasped three important points, namely, (1) that "this invisible flameless combustion is only possible under certain conditions"; (2) "that the combustible mixture shall come into absolute contact with a substance at high temperature . . ."; and (3) that "in the absence of a solid substance at a high temperature, it is impossible to cause combustion without flame"; but, so far as I am aware, he did not follow up the matter beyond this point, either in its theoretical aspects or practical applications, and his work had but little influence upon contemporary opinion or practice.

My own investigations upon surface combustion began in 1902 with a systematic attempt to elucidate the factors operative in the slow combination of hydrogen and of carbon monoxide in contact with various hot surfaces (*e.g.* porcelain, fire-clay, magnesia, platinum, gold, silver, copper, and nickel oxides, etc.) at temperatures below 500°.[4] Into the details of these earlier experiments, which preceded and led up to the technical developments about which I shall speak later, I do not propose to enter; it will be sufficient for my present purpose if I say that it was proved beyond all question:—(1) That the power of accelerating gaseous combustion is possessed by *all* surfaces at temperatures below the ignition point in varying degrees, dependent upon their chemical characters and physical texture; (2) that such an accelerated surface combustion is dependent upon an absorption of the combustible gas, and probably also of the oxygen, by the surface, whereby it becomes "activated" (probably ionised) by association with the surface; and (3) that the surface itself becomes electrically charged during the process. Finally, certain important differences between homogeneous combustion in ordinary flames and heterogeneous combustion in contact with a hot surface from a chemical point of view were established, so that there can be no longer any doubt as to the reality of the phenomenon.[4]

If hot surfaces possess the power of accelerating gaseous combustion at temperatures below, or in the neighbourhood of, the ignition point, the same power must also be manifested in even a greater degree at higher temperatures, and especially so when the surface itself becomes incandescent. Indeed, there are experimental grounds for the belief that not only does the accelerating influence of the surface rapidly increase with the temperature, but also that the differences between the catalysing powers of various surfaces, which at low temperatures are often considerable, diminish with ascending temperatures until at bright incandescence they practically disappear.

Such considerations as I have thus briefly explained

[1] From a discourse delivered at the Royal Institution on Friday, February 27, by Prof. W. A. Bone, F.R.S.

[2] Collected Works, vol. vi., p. 8.

[3] Journal of Gas Lighting, 1887, i, p. 168.

[4] Bone and Wheeler, Phil. Trans. Roy. Soc., 1906 (A. 206, pp. 1–67), also further (unpublished) results (1905–12) in collaboration with Messrs. G. W. Andrew, A. Forshaw, and H. Hartley, which are summarised in *Berichte der Deutschen Chem. Ges.*, 1913.

convinced me some years ago that if an explosive gaseous mixture be either injected on to or forced through the interstices of a porous refractory incandescent solid under certain conditions, which will be hereafter explained, a greatly accelerated combustion would take place within the interstices or pores, or, in other words, within the boundary layers between the gaseous and solid phases wherever these may be in contact—and the heat developed by this intensified combustion would maintain the surface in a state of incandescence *without any development of flame*, thus realising the conception of *flameless incandescent surface combustion*, as a means of greatly increasing the general efficiency of heating operations wherever it can be conveniently applied.

There are critics who, whilst admitting the accelerating influence of an incandescent surface upon gaseous combustion, are sceptical about the process being really flameless. The force of such objections largely disappear when we get into close quarters with the phenomenon, and realise how extremely slow a transaction flame combustion really is when considered in terms of molecular time. Take, for example, the case of such a quick-burning mixture as electrolytic gas ($2H_2+O_2$). When this is ignited at atmospheric pressure, the flame is initially propagated by conduction with a uniform slow velocity of 20 metres a second, and during this initial period of "*inflammation*," the total duration of chemical change in each successive layer is something like the order of 1/50 second, an interval of at least one hundred million times as long as the average interval between successive molecular collisions in the gas. Even after "*detonation*" has been set up in the mixture, when the combustion is propagated from layer to layer as a wave of adiabatic compression, at a velocity of 2820 metres a second, the total duration of chemical change is still of the order of 1/5000 or 1/10,000 second, or about a million times as long as the interval between successive molecular collisions.

The New Processes of Incandescent Surface Combustion.

Leaving the theoretical aspects of the subject, I will now describe some of the more important features of two processes of incandescent surface combustion evolved at the works of Messrs. Wilsons and Mathiesons, Ltd., in Leeds, under my direction, with the assistance of Mr. C. D. McCourt, in which a homogeneous explosive mixture of gas and air, in the proper proportions for complete combustion (or with air in slight excess thereof), is caused to burn without flame in contact with a granular incandescent solid, whereby a large proportion of the potential energy of the gas is immediately converted into radiant form. The advantages claimed for the new system, now known as the "Bonecourt" system, are:—(1) The combustion is greatly accelerated by the incandescent surface, and, if so desired, may be concentrated just where the heat is required; (2) the combustion is perfect with a minimum excess of air; (3) the attainment of very high temperatures is possible without the aid of elaborate regenerative devices; and (4) owing to the large amount of radiant energy developed, transmission of heat from the seat of combustion to the object to be heated is very rapid. These advantages are (as I believe) so uniquely combined in the new system that the resultant heating effect is, for many important purposes not only pre-eminently economical, but also easy of control.

Diaphragm Heating and its Applications.

In the first process the homogeneous mixture of gas and air is allowed to flow under slight pressure through a porous diaphragm of refractory material from a suitable feeding chamber, and is caused to burn without flame at the surface of exit, which is thereby maintained in a state of red-hot incandescence. The diaphragm is composed of granules of firebrick, or other material, bound together into a coherent block by suitable means; the porosity of the diaphragm is graded to suit the particular kind of gas for which it is to be used. The diaphragm is mounted in a suitable casing, the space enclosed between the back of the casing and the diaphragm constituting a convenient feeding-chamber for the gaseous mixture which is introduced at the back. Such a mixture may be obtained in either of two ways, namely, (1) by means of suitable connections through a Y-piece with separate supplies of low pressure gas and air (2 or 3 in. W.G. is sufficient), or (2) by means of an "injector" arrangement connected with a supply of gas at a pressure of 1 to 2 lb. per sq. in.; the gas in this case draws in its own air from the atmosphere in sufficient quantity for complete combustion, the proportions of gas and air being easily regulated by a simple device.

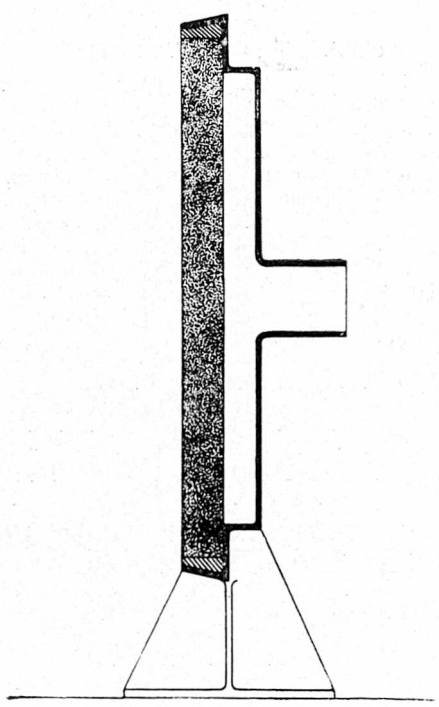

FIG. 1.—Diaphragm.

We will now start up a diaphragm (Fig. 1). Gas is first of all turned on and ignited as it issues at the surface; air is then gradually added until a fully aerated mixture is obtained. The flame soon becomes non-luminous, and diminishes in size; a moment later, it retreats on to the surface of the diaphragm, which at once assumes a bluish appearance; soon, however, the granules at the surface attain an incipient red heat, producing a curious mottled effect; finally, the whole of the surface layer of granules becomes red-hot, and an accelerated "surface combustion" comes into play. All signs of flame disappear, and there remains an intensely glowing surface throwing out a genial radiant heat which can be steadily maintained for as long as required.

Whilst the diaphragm is in operation before you, I may point out some of the more striking features of the phenomenon which it presents. First, the actual combustion is confined within a very thin layer—$\frac{1}{8}$ to

¼ in. only—immediately below the surface, and no heat is developed in any other part of the apparatus. Kindly observe that while the front of the diaphragm is intensely hot, the back of the apparatus is so cold that I can lay my hand on it. Secondly, the combustion of the gas, although confined within such narrow limits, is perfect, for when once the relative proportions of gas and air have been properly adjusted, no trace of unburnt gas escapes from the surface. Thirdly, the temperature at the surface of the diaphragm can be instantly varied at will by merely altering the rate of feeding of the gaseous mixture; there is practically no lag in the temperature response, a circumstance of great importance in operations where a fine regulation of heat is required. Fourthly, a plane diaphragm such as this may be used in any position, *i.e.* at any desired angle between the horizontal and vertical planes. Fifthly, the diaphragm method is amenable to a variety of combustible gases —coal or coke oven gas (either undiluted or admixed with water gas), natural gas, petrol-air gas, carburetted water gas are all well suited in cases where unimpeded radiation is required. Finally, the incandescence in no way depends upon the external atmosphere. When once the diaphragm has become incandescent, and the proportions of air and gas supplied in the mixing chamber at the back have been properly adjusted, the surface will maintain its incandescence unimpaired, even in an atmosphere of carbon dioxide.

I need scarcely point out to you the many obvious purposes, domestic and industrial, to which "diaphragm heating" may be applied. In the domestic line the boiling of water, grilling, roasting, and toasting are at once suggested, and although the best existing types of gas fires are thoroughly hygienic and efficient, I think that the diaphragm may come in for the heating of apartments; at any rate experiments are being carried out in that direction.

Incandescent Surface Combustion in a Bed of Refractory Granular Material.

The second process is applicable to all kinds of gaseous or vapourised fuels; it consists essentially in injecting, through a suitable orifice at a speed greater than the velocity of back-firing, an explosive mixture of gas (or vapour) and air in their combining proportions into a bed of incandescent granular refractory material which is disposed around or in proximity to the body to be heated (Fig. 2).

This process is capable of adaptation to all kinds of furnace operations, as, for example, to the heating of crucibles, muffles, retorts, and to annealing and forging furnaces generally. Moreover, it is not essential that the bed of refractory material should be very deep; indeed a quite shallow bed suffices to complete the combustion. Neither is it necessary that the bed shall be disposed *around* the vessel or chamber to be heated; for if contact with the burnt products is not objectionable, a shallow bed may be arranged *within* the heating chamber itself; or the refractory material may be equally well packed into tubes, or the like, traversing the substance or medium to be heated. The last-named modification is, as we shall see later, specially important in relation to steam-raising in multitubular boilers.

By means of this process much higher temperatures are attainable with a given gas than by the ordinary methods of flame combustion without a regenerative system, and, as a matter of fact, we have found that with any gas of high calorific intensity (such as coal gas, water gas, or natural gas) the upper practicable temperature limit is determined by the refractoriness of the material composing the chamber to be heated (*i.e.* the muffle or crucible) rather than by the possibilities of the actual combustion itself. When I tell you that in a crucible fired by coal gas on this system we have melted Seger-cone No. 39, which according to the latest determination of the German Reichsanstahlt melts at 1880° C. (3416° F.), and also that we can easily melt platinum, you will appreciate the possibilities of the method in regard to high temperatures with gas-fired furnaces.

Surface Combustion as Applied to Steam Raising.

I now come to an important application of the new process to the raising of steam in multitubular boilers; not that the application of surface combustion is limited to boilers of the multitubular type, but because our investigations have so far been principally made with these.

Our first experiments in Leeds were made with a single steel tube 3 ft. in length and 3 in. in diameter, packed with fragments of granular refractory material, meshed to a proper size, and fitted at one end with a fire-clay plug, through which was bored a circular hole, ¾ in. in diameter, for the admission of the explosive mixture of gas and air at a speed greater than that of back-firing. The tube was fitted into an open trough, in which water could be evaporated at atmospheric pressure.

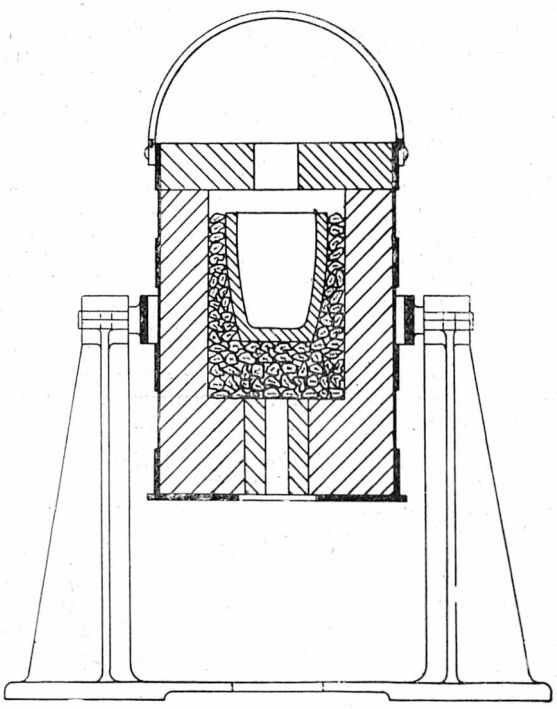

FIG. 2.—Crucible furnace.

Such a tube may be appropriately termed the fundamental unit of our boiler system, because boilers of almost any size may be constructed merely by multiplying the single tube, and as each tube is, so to speak, an independent fire or unit, the efficiency of the whole is that of the single tube, or, in other words, the efficiency of the whole boiler is independent of the number of tubes fired.

Experimenting with such a tube, it was found possible to turn completely a mixture of 100 cu. ft. of coal gas plus 550 cu. ft. of air an hour, and to evaporate about 100 lb. of water from and at 100° C. (212° F.) an hour (20 to 22 lb. per sq. ft. of heating surface), the products leaving the further end of the tube at practically 200° C. This meant the transmission to the water of 88 per cent. of the net heat

developed by the combustion, and an evaporation per sq. ft. of heating surface nearly twice that of an express locomotive boiler. The combustion of the gas was completed within 4 or 5 in. of the point where it entered the tube, whilst the temperature of the products leaving the tube was about 200° C. Of the total evaporation, no less than 70 per cent. occurred over the first linear foot of the tube, 22 per cent. over the second foot, and only 8 per cent. over the last foot. This points to a very effective "radiation" transmission from the incandescent granular material in the first third of the tube, where the zone of active combustion is located, although it should be remarked that the *loci* of actual contact between the incandescent material and the walls of the tube are so rapidly cooled by the transmission of heat to the water on the other side that they never attain a temperature even approaching red heat. The granular material in the remaining two-thirds of the tube serves to baffle the hot products of combustion, and to make them repeatedly impinge with high velocity against the walls of the tube, thus materially accelerating their cooling, and either preventing or minimising the formation of the feebly-conducting stationary film of

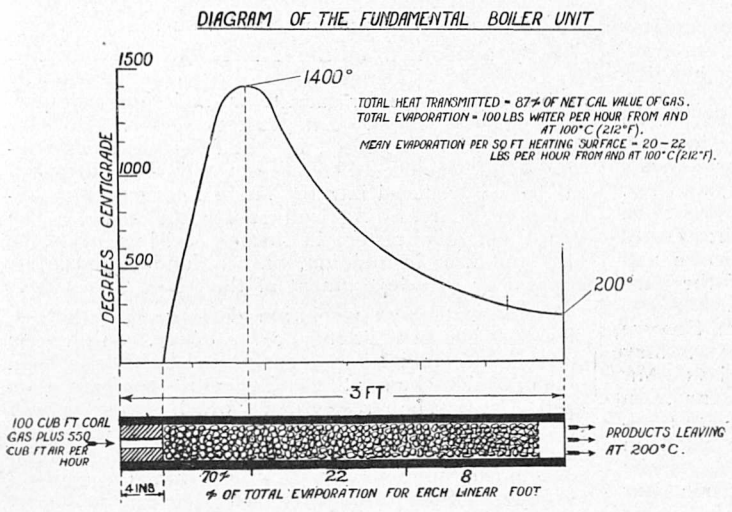

FIG. 3.—Fundamental boiler unit.

relatively cold gases which in ordinary boiler practice clings to the tube walls, seriously impairing the heat transmission.

Having thus satisfied ourselves of the efficiency of the fundamental unit as an evaporator, we proceeded to construct our first experimental boiler, made up of ten tubes, each 3 ft. long and 3 in. in diameter, fixed horizontally in a cylindrical steel shell capable of withstanding a pressure of more than 200 lb. per sq. in. The gaseous mixture was forced through the tubes under pressure from a special feeding chamber attached to the front plate of the boiler; the products of combustion, after leaving the boiler, passed through a small feed-water heater containing nine tubes, each 1 ft. long and 3 in. in diameter, filled with granular material to facilitate the exchange of heat.

This combination of boiler and feed-water heater proved remarkably successful in every way; its thermal efficiency was 94 per cent., with an evaporation of from 21 to 33 lb. per sq. ft. of heating surface per hour.

The 110*-Tube Boiler at the Skinningrove Ironworks.*

Six months' continuous experience with our first experimental unit gave us great confidence in its trustworthiness, so that when in the early months of 1911 we received an inquiry from the Skinningrove Iron Co., Ltd., for a boiler of about ten times the capacity of the experimental unit, to be fired by means of the surplus gas from their new Otto by-product coking-plant, we had no hesitation in accepting a commission to install our first large boiler there, under a strict guarantee as to its output and efficiency.

The plant was successfully started up on November 7, 1911, for a month's trial run—day and night continuously—after which it was opened up for an official inspection by the representative of a Boiler Insurance Company. Everything worked without a hitch during this trial; steam was generated at 100 lb. gauge pressure, from a feed-water of about 4° of hardness, whilst the average temperature of the waste gases leaving the feed-water heater was reduced to 80° C. (say 175° F.), a sure indication of the high thermal efficiency of the plant. When, at the conclusion of the month's trial, the boiler was opened up for inspection, the combustion tubes were found to be in good condition and free from scale; indeed, owing to the extremely high rate of evaporation, the scaling troubles experienced with other types of multitubular boilers appear to be completely obviated, the scale being automatically and continuously shed from the tube in thin films (about 1/30 in. thick) as fast as it is formed; a very important advantage, as anyone who is plagued by scaling troubles will appreciate. An independent trial of the plant on July 29, 1912, gave a thermal efficiency of 92 7 per cent.

Within the last few months the firm of Krupps have put down a boiler in connection with one of their coking plants in the Ruhr district of Westphalia, from the plans of the Skinningrove plant. This boiler has been running successfully since October last, and about three weeks ago underwent its official steam trials, which were carried out by the Bergbauliche Verein. Pending the official publication of the results in the German technical Press, I am precluded from giving any details now, but, I am informed, that they have entirely confirmed the Skinningrove trial.

I have perhaps said enough already about the boiler and its working to convince you that it combines high thermal efficiency and concentration of power, in a unique degree, and perhaps I may be permitted to summarise the other important advantages which may be claimed for it. First, from the constructional point of view, nothing could be simpler or more compact than a cylindrical shell only 4 ft. long by 10 ft. in diameter, traversed by straight tubes, supported on a casting, and requiring neither elaborate brickwork setting nor expensive chimney flues and stack. Secondly, it has a further advantage over all multitubular boilers in that the front plate can never be heated beyond the temperature of the water, however much the firing may be forced, a circumstance which, coupled with the extremely short length of the tubes, implies an absence of strain and greatly reduces the risk of leaky joints. Thirdly, the high rate of mean evaporation obviates scaling troubles, and the very steep evaporation gradient along each tube causes a considerable natural circulation of water in the boiler, a factor of great importance from the point of view of good and efficient working; in this connection I may remind you that under normal working conditions we obtain a *mean evaporation* of 20 lb. per sq ft. of heating surface an hour, and can, if need be, force this up to 35 lb.; of this total evaporation,

70 per cent. occurs over the first *third* length of the tube, 22 per cent over the *second* third, and only 8 per cent. over the last third. Fourthly, inasmuch as each tube of the boiler is, so to speak, an independent combustion unit, capable of being shut off or lit up without affecting the others, and as it only takes five minutes after lighting up a cold tube to attain its maximum steam output, it is obvious that not only is such a boiler highly responsive to rapid variations in the load, but also it works with equal efficiency at both small and big loads; indeed, within very wide limits, its efficiency is practically independent of the load.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ABERDEEN.—Lord Elgin has been elected Chancellor of the University in succession to Lord Strathcona.

LONDON.—The following courses of advanced lectures, addressed to students of the University and to others interested in the respective subjects, to which admission is free without ticket, are announced in the issue of the *London University Gazette* of April 8:—Five lectures on the earlier Palæozoic land plants at University College, by Dr. D. H. Scott, on Wednesdays, May 6 to June 3; two lectures on plant pigments at University College, by Prof. R. Willstätter, professor of chemistry in the University of Berlin, on Monday, May 4, and Tuesday, May 5; two lectures, in French, entitled "La Catalyse, et mes divers travaux sur la Catalyse," at King's College, by Prof. Paul Sabatier, of the University of Toulouse, on Thursday, May 14, and Friday, May 15; eight lectures on the rate of the blood-flow in man in health and disease, in the Physiological Laboratory of the University, South Kensington, by Prof. G. N. Stewart, professor of experimental medicine, Western Reserve University, Cleveland, U.S.A., on Tuesdays, May 5–23; eight lectures on oxidation in the tissues, at University College, by Dr. C. Lovatt Evans, on Fridays, May 8 to June 26; four lectures on the regulation of the composition and volume of the blood, in the Physiological Laboratory of Guy's Hospital, by Dr. J. S. Haldane, on Thursdays, May 7–28; four lectures on the gaseous exchanges of the body, in the Physiological Laboratory of King's College, by Prof. T. G. Brodie, professor of physiology in the University of Toronto, on Monday, June 8, Wednesday, June 10, Monday, June 15, and Wednesday, June 17; three lectures on the morphology of the cranial muscles in vertebrates, in the Zoological Department, University College, by Prof. F. H. Edgeworth, professor of medicine in the University of Bristol, on Monday, May 4, Tuesday, May 5, and Wednesday, May 6; five lectures on the measurement of social phenomena, at the London School of Economics and Political Science, by Dr. A. L. Bowley, University reader in statistics, on Mondays, April 27 to May 25.

Among the public lectures, to which admission is free without ticket, announced to be delivered at University College during the third term of the present academic year, the following may be mentioned:—Four lectures on the ethnology and pathology of the ancient Egyptians, by Dr. D. E. Derry, beginning on May 5, at 5 p.m.; a lecture on Ptolemy's map of Germany and the Cimbric Chersonese, by Prof. Gudmudd Schütte, on May 11, at 5 p.m.; an introductory lecture on recent discoveries in Egypt, by Prof. Flinders Petrie, on May 21, at 2.30 p.m.

GLASGOW.—The following doctorates were among the degrees conferred on April 20:—Doctor of Philosophy (D.Phil.): L. J. Russell; thesis, "The Development of the Philosophy of Leibniz, 1666–86." Doctors of Science (D.Sc.): Margaret B. Moir; thesis, "The Influence of Temperature on the Magnetic Properties of Carbon Steels; Sensitive Magnetic State induced by Thermal Treatment and by Strain; Magnetic Properties of Chrome Steels at Ordinary and Low Temperatures: Permanent Magnetism of Chrome Steels; with other papers." F. Mort; thesis, "North Arran: a Physiographic Study; with others papers." Maggie M. J. Sutherland; thesis, "Camphenanic Acid, its Isomers and Derivatives; with other papers."

Science states that a contribution of 10,000*l.* from Mrs. E. H. Harriman to the endowment fund of Barnard College, Columbia University, is announced toward the million dollar fund now being raised for the twenty-fifth anniversary of the institution. The amount now promised is 110,000*l.*

MR. H. NORMAN EDGE has been appointed honorary lecturer on meteorology to the Lancashire (Navy League) and National Sea Training Homes. As increased attention is now being given to the subject of marine meteorology, and a number of vessels keep a four-hourly log, the instruction in the keeping of the meteorological log to boys being prepared for a seafaring life is of real practical value.

IT is announced in the *Times* that the late Mr. H. B. Noble, of Douglas, Isle of Man, left practically all his large estate for educational and charitable purposes in the island. The trustees of his will have decided to devote 20,000*l.* for the fostering of agriculture in the island. In connection with this gift a Bill has been introduced into the Manx Legislature constituting a Board of Agriculture for the island. The Board will administer the income arising from the gift, and will, in addition, have a fund placed at its disposal by the Government of the island.

A COMPREHENSIVE resolution dealing with the age of exemption from attendance at school, continuation classes, and child labour, was passed by the National Union of Teachers at the Lowestoft conference on April 15. The resolution, which was moved by Mr. G. Sharples, was as follows:—That all regulations recognising the half-time system, labour examinations, and other forms of early exemption from attendance at school should be abolished; that no child should be exempt from attending under the age of fourteen; that local authorities should be empowered to make by-laws requiring the attendance of children up to the age of fifteen; that all wage-earning work, and particularly all street trading, should be prohibited for all children under fourteen, both in urban and rural districts; and that a system of compulsory attendance at continuation classes should be established for children between the ages of fourteen and eighteen who are not otherwise receiving a suitable education, such a system to be accompanied by a statutory limitation of the hours of child labour.

A WEAK point in most of the Continental educational systems is that there is no easy bridge by which the public elementary and trade continuation class pupil can pass into the higher ranks of his vocation and complete his studies in the polytechnic or university. The avenue to these higher institutions is almost solely through the gymnasial secondary schools. In the facilities offered by scholarships for the transference of gifted pupils from primary schools to secondary schools and through these to universities and like places of advanced learning, we have nothing to learn from Continental methods. The scholarship systems of the education authorities of English counties and county boroughs provide the means by which any elementary-school pupil of little more than average

ability can obtain a free-place in a secondary school; and the brilliant pupil can proceed from this stage to a higher by means of senior scholarships. We are reminded of the efficiency of this educational ladder by a return just made to the Somerset County Council by the County Education Committee. It appears from this report that twenty-five out of the thirty senior county scholars referred to in it were enabled by the Education Committee's system of scholarships to pass from a public elementary school to a university or a university college. Many of the senior scholars have had remarkably successful careers since their university courses, and some have reached exceptional distinction. The return as a whole is very gratifying, and the result is due in part at least to the committee's policy of awarding scholarships of any grade only when candidates of really satisfactory merit present themselves.

MR. J. A. PEASE, Minister of Education, last week received at the offices of the Board in Whitehall, an influential deputation representing the civic, commercial, and educational life of Nottingham, and headed by the Duke of Portland, on the subject of granting the status of a university to University College, Nottingham. His Grace gave a *résumé* of the history of the college, emphasising the fact that its work would bear favourable comparison with that of the majority of the modern universities in the country. The time had now come when steps should be taken to broaden the constitution of the college, to place it in the same position as other similar institutions, and to establish it definitely as the university centre of the east midlands, spreading the responsibility for its government and maintenance over the area which it serves. Principal Heaton dwelt upon the educational work in the college itself, especially its honours, post-graduate, and research work, upon the home the college afforded to local branches of various national associations (such as Classical, Historical, English, Workers' Educational, Chemical Industry), and on the increased facilities it now offered for social intercourse among the students. The patriotic side of its work was well represented by its efficient Officers Training Corps, and the fact that it was the first college in England to form for women students a voluntary-aid detachment of the Red Cross Association. In his reply, Mr. Pease said:—"I appreciate, and the Board of Education appreciates, the desires of the people of Nottingham, their ambition, their aspiration, in connection with the formation of what one might call a full-blown university. There are schools of thought which think provincial universities have already been established in enough centres up and down our land. I am not one of those who take this view; I believe that there is work for additional universities, and I for one would be very glad to see a provincial university which would meet all requirements in connection with the wants of the people in the east midland area."

SOCIETIES AND ACADEMIES.

EDINBURGH.

Royal Society, March 16.—Prof. James Geikie, president, in the chair.—Rev. T. R. R. **Stebbing**: Stalk-eyed Crustacea Malacostraca of the Scottish National Antarctic Expedition. Most of the fifty specimens described were collected by the *Scotia* at various stations during its voyage out and home, so that not more than ten could claim to be Antarctic or sub-Antarctic in their place of capture. Six new species were described, viz., *Coryrhynchus algicola, Eupagurus modicellus, Gennadas kempi, Nauticarus brucei, Phye scotiae, P. rathbunae.*—D. W. **Steuart** and Ingvar **Jörgensen**: Note on the atmospheric electrical potential gradient in industrial districts. The experiments were carried out in the neighbourhood of Leeds. The chief feature was the magnitude of the potential gradient under certain conditions.—J. B. **Robertson**: A chemical examination of the organic matter in oil-shales. Thirteen samples had been analysed. The carbon hydrogen ratio varied from 6 to 8, the lower ratio belonging to the shale yielding the larger amount of oil produced from a definite percentage of organic matter. The ratios were lower than that of ordinary bituminous coal. The organic matter, the main bulk of which was insoluble in organic solvents, was the product of the decomposition of vegetable substance (algæ, spores, etc.), similar in nature to what was found in peat and cannel coal.

PARIS.

Academy of Sciences, April 14.—M. P. Appell in the chair.—L. E. **Bertin**: Calculation of the increase of load or of velocity obtainable by increasing the dimensions of ships. A development of some consequences of a formula given in an earlier communication.—G. **Gouy**: The absorbing power of the electric arc for its own radiations. Confirming results previously obtained with flame spectra, a complete opacity of the vapour for the line it produces is never observed. The absorptive power is between 0·5 and 0·7 for the very strong lines, and less for the weaker lines.—A. **Laveran**: New facts tending to demonstrate that Mediterranean kala-azar is identical with the Indian kala-azar. Comparative inoculation experiments were carried out on monkeys, dogs, and mice. *Macacus cynomolgus* rendered immune to the Mediterranean kala-azar is refractory to the Indian virus, whilst another animal of the same species, inoculated under the same conditions as the first, and serving as a control, rapidly contracted a fatal infection. From this it is concluded that the diseases are identical.—A. **Bilimovitch**: The canonical transformations of the equations of motion of a non-holonomial system.—L. **Dunoyer** and R. W. **Wood**: Photometry of the superficial resonance of sodium vapour under the stimulation of the D lines. Fineness of the resonance lines. The magnitude of the resonance lines was of the order of 0·03 Ångström.—Félix **Ehrenhaft**: Minimum quantities of electricity and the existence of quantities (quanta) smaller than the charge of an electron. The electrical charges of particles of mercury and gold in the colloidal state were determined, the spherical shape of the particles under examination being previously proved by the microscope. The minimum charge is not the charge of the electron.—Albert **Perrier** and H Kamerlingh **Onnes**: The interpretation of the magnetic properties of mixtures of oxygen and nitrogen. The molecular field varies inversely as the third power of the mean distance of the oxygen molecules.—R. **Fosse**: The gravimetric quantitative analysis of urea. The urea is precipitated from an acetic acid solution with xanthydrol, and the compound weighed. Its composition is definite, and can be controlled by analysis.—J. **Bergonié**: The rational distribution of meals in man in the nycthemeral cycle. The best times are shown to be 7.30 a.m. for principal meal, 4.30 p.m., and 8 p.m.

BOOKS RECEIVED.

Echinoderma of the Indian Museum. Part viii. Echinoidea (1). By Prof. R. Koehler. Pp. 258+xx plates. (Calcutta: Indian Museum.) 20 rupees.

Gibt es denkende Tiere? By Dr. S. v. Máday. Pp. xiv+461. (Leipzig and Berlin: W. Engelmann). 9.60 marks.

Die wichtigsten Lagerstätten der "Nicht-Erze." By Dr. O. Stutzer. Zweiter Teil. Kohle (Allgemeine

Kohlengeologie). Pp. xvi+345+xxix plates. (Berlin: Gebrüder Borntraeger.) 16 marks.

Ministry of Public Works, Egypt. Zoological Service. Report on a Zoological Mission to India in 1913. By Capt. S. S. Flower. Pp. viii+100+xii plates. (Cairo: Government Press.) 5s.

Mysore Geological Department. Report of the Chief Inspector of Mines for the Year 1912–13. With Statistics for the Calendar Year 1912. Pp. 59+tables. (Bangalore: Government Press.) 2 rupees.

Nedboriagttagelser i Norge. Utgit av det Norske Meteorologiske Institut, Middelvœrdier, Maksima og Minima. Pp. xxii+79+79+iv plates+maps. (Kristiania: H. Aschehoug and Co.) 3 kroners.

The Foundations of Character. By A. F. Shand. Pp. xxxi+532. (London: Macmillan and Co., Ltd.) 12s. net.

Marriage Ceremonies in Morocco. By Prof. E. Westermarck. Pp. xxi+422. (London: Macmillan and Co., Ltd.) 12s. net.

Icones of the Plants of Formosa, and Materials for a Flora of the Island. By B. Hayata. Vol. iii. Pp. iv+222+xxxv plates. (Taihoku: Bureau of Productive Industries.)

La Cémentation de l'Acier. By Prof. F. Giolitti. French translation by M. A. Portevin. Pp. 548. (Paris: A. Hermann et Fils.) 16 francs.

Traité de Physique. By Prof. O. D. Chwolson. Translated by E. Davaux. Tome Cinquième. Premier Fascicule. Champ magnétique variable. Pp. vi+266. (Paris: A. Hermann et Fils.) 9 francs.

Publications de la Société de Chimie-Physique. vii., Le Paramagnétisme appliqué a l'Etude des sels Métalliques. By Mlle. E. Feytis. Pp. 27. viii., Relations entre la constitution Chimique et la Coloration des Corps Organiques. By M. A. Meyer. Pp. 48. (Paris: A. Hermann et Fils.) 1 franc and 2 francs respectively.

Encyclopédie de Science Chimique Appliquée. Tome v. Principes d'Analyse et de Synthèse en Chimie Organique. By M. Hanriot, Prof. P. Carré, A. Seyewetz, Prof. E. Charabot, and Dr. A. Hébert. Pp. 795. (Paris and Liége: Ch. Béranger.) 30 francs.

DIARY OF SOCIETIES.

THURSDAY, APRIL 23.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—The East African Trough: J. Parkinson.

CHILD STUDY SOCIETY, at 7.30.—Raising the Standard of Child Upbringing Rev. I. C. Pringle.

CONCRETE INSTITUTE, at 7.30.—The Architect and Structural Engineering: W. E. A. Brown.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Electrification of Railways as affected by Traffic Considerations: H. W. Firth.

ROYAL SOCIETY OF ARTS, at 4.30.—The Port and City of Rangoon: G. C. Buchanan.

FRIDAY, APRIL 24.

ROYAL INSTITUTION, at 9.—The Stars around the North Pole: Dr. F. W. Dyson.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—A Visit to the Iron Districts of French Alsace: G. Evetts.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Application of Electrical Driving to Existing Rolling Mills: L. Rothera.

SATURDAY, APRIL 25.

ROYAL INSTITUTION, at 3.—Similarity of Motion in Fluids. I. The Theory of Similarity of Motion in Fluids and the Experimental Proof of its Existence: Dr. T. E. Stanton.

MONDAY, APRIL 27.

ROYAL SOCIETY OF ARTS, at 8.—Some Recent Developments in the Ceramic Industry: W. Burton.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Land of the Ibibios (Southern Nigeria): P. A. Talbot.

INSTITUTE OF ACTUARIES, at 5.—Section 72 of the National Insurance Act. Some other Features of Friendly Societies and National Insurance, including a Note on the Proposed Belgian National Insurance Act: E. B. Nathan.

TUESDAY, APRIL 28.

ROYAL INSTITUTION, at 3.—Problems of Physical Chemistry. 2. Structure of Matter at low Temperatures: Dr. W. Wahl.

ROYAL SOCIETY OF ARTS, at 4.30—The Administration of Imperial Telegraphs: C. Bright.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Some Hopi Textiles from the Pueblo of Hano: Miss B. Freire Marreco.

EUGENICS EDUCATION SOCIETY, at 8.30.—Le Mesure de l'Intelligence: Dr. Simon.

WEDNESDAY, APRIL 29.

ROYAL SOCIETY OF ARTS, at 8.—The Need for a Better Organization of Economic and Industrial Resources: C. R. Enock.

GEOLOGICAL SOCIETY, at 8.—On the Lower Jaw of an Anthropoid Ape (Dryopithecus) from the Upper Miocene of Lérida (Spain): Dr. A. Smith Woodward.—The Structure of ihe Carlisle—Solway Basin and the Sequence of its Permian and Triassic Rocks: Prof. J. W. Gregory.

THURSDAY, APRIL 30.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The lack of Adaptation in the Tristichaceae and Podostemaceae: Dr. J. C. Willis.—The Genetics of Tetraploid Plants in *Primula sinensis*: R. P. Gregory.—The Action of certain Drugs on the isolated Human Uterus: J. A. Gunn.—The Presence of Inorganic Iron Compounds in the Chloroplasts of the Green Cells of Plants, considered in Relationship to Natural Photo-synthesis and the Origin of Life: Prof. B. Moore.—The Influence of Osmotic Pressure upon the Regeneration of *Gunda ulvae*: D. J. Lloyd.—(1) *Glossina brevipalpis* as a Carrier of Trypanosome Disease in Nyasaland. (2) Trypanosome Diseases of Domestic Animals in Nyasaland. *Trypanosoma pecorum*. Part III. Development in *Glossina morsitans*: Sir D. Bruce, Major A. E. Hamerton, Capt. D. P. Watson and Lady Bruce.

ROYAL INSTITUTION, at 3.—The Last Chapter of Greek Philosophy: Plotinus as Philosopher, Religious Teacher and Mystic: The very Rev. W. R. Inge.

FRIDAY, MAY 1.

ROYAL INSTITUTION, at 9.—A Criticism on Critics: E. F. Benson.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—The Control and Organisation of the Engineering Profession: S. T. Robson.

GEOLOGISTS' ASSOCIATION, at 8.—A Geological Excursion in Matabeleland: F. P. Mennell.

SATURDAY, MAY 2.

ROYAL INSTITUTION, at 3.—Similarity of Motion in Fluids. (2) The General Law of Surface Friction in Fluid Motion: Dr. T. E. Stanton.

BRITISH PSYCHOLOGICAL SOCIETY.—The Psychology of Play with special reference to the value of Group Games in Education: Miss M. J. Reaney.—Corresponding points: Prof. C. Spearman.—An attempt at an exact Estimation of Character: E. Webb.

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