THURSDAY, FEBRUARY 26, 1903.

THE LIVING SUBSTANCE—A THEORY.

Die Biogen-hypothese. By Prof. Max Verworn. Pp. iv+114. (Jena: Fischer, 1903.) Price 2.50 marks.

THE author of the well-known work on "Allgemeine Physiologie" is always interesting in his physiological writings, whether one admits the validity of his conclusions or not; and the volume before us, though highly speculative in its nature, cannot fail to attract attention, no less on account of the intrinsic importance of the subject than by reason of the lucidity with which a difficult topic is handled.

The Biogen-hypothese is nothing less than an attempt to frame a working hypothesis that shall render intelligible the *modus operandi* of a living organism and to explain in a comprehensive manner the general nature of the physical and chemical processes involved. Such an explanation, as the author himself insists, can only be regarded as a temporary expedient in the present condition of our knowledge, but the author of a theory or hypothesis is amply justified in propounding it if he is enabled thereby to indicate definite lines of investigations, whatever the influence the results thereby obtained may exercise on the theory itself.

The various hypotheses that have been put forward to account for the facts of metabolism are briefly discussed and the nature of the respiratory process is specially considered. It seems quite clear from the results of numerous investigators that whatever the nature of the sequence of chemical events, the carbohydrates are proximately the substances that are most intimately affected. These carbohydrates might be derived directly from the store of accumulated reserve products, or an analogous atom group might be split off from the more complex proteid-like bodies. On the whole, the latter seems the more probable view, and thus dissimilation and assimilation form a constantly oscillating series of phenomena that give rise to the processes described as metabolism.

The biogen is regarded by Verworn as a real chemical or physical entity, consisting of various groups of atoms held together round a central benzene nucleus. Dissimilation, or katabolism, occurs when certain atom-groups are split off from the biogen, and normally these represent carbohydrates or some similar bodies, a view which is by no means new and one that finds support, for example, in the behaviour of muscle when it is made to do work. For it is well known that the excessive amount of carbon dioxide excreted in such circumstances is not accompanied by a correspondingly increased excretion of nitrogenous waste-products. On the contrary, the nitrogenous remainder of what Verworn terms the biogen regenerates itself by seizing upon the available sugars or other carbohydrates. A distinction is drawn between this "functional" dissimilation and the "destructive" dissimilation that follows on extreme starvation; for in the latter case the nitrogen-containing remainder of the biogen undergoes further decomposition, and then the simpler groups thus produced no longer possess the faculty of regeneration at all and so are unable to reproduce the living substance once more.

As to the cause of the lability of the biogen, Verworn strongly champions the view that it is the result of the incorporation of oxygen in the molecule, and that when irritability ceases, on arresting the supply of this gas, it is not due to the possible inhibitory action of the accumulating waste products, but that in the absence of oxygen the conditions of adequate lability are not provided. The arguments are largely based on the behaviour of frogs that have been poisoned by strychnine and in which an artificial circulation by means of salt solution is maintained. This can be so arranged as to provide or withhold oxygen from the tissues. In the latter case, stimulation ceases to excite contraction in the muscles, though on readmitting oxygen, tetanus is easily produced on the application of suitable stimuli. If a long interval of time is allowed to elapse during which no food is being conveyed to the tissues, starvation, and consequent reduction in the number of labile biogens, ensues. Hence stimuli gradually provoke weaker and weaker responses. If once more the supply of oxygen is cut off, loss of excitability again supervenes, but this passes away again on readmission of oxygen. Verworn seems to conclude that because this return of excitability recurs at once, both in the unstarved and starved tissue, the inhibition effect of the deprivation of oxygen cannot be ascribed to the accumulation of waste products, since in the former case this should have been of much greater magnitude in correspondence with the much larger amount of waste substances, and, therefore, the *rôle* of the oxygen must have been that of a labilising agent, directly producing the condition for explosive decomposition in the active biogens. But it is not shown whether the influence of waste products upon the hypothetical biogens may not be a proportionate one, in which case there would be perhaps no very obvious reason why any difference should be looked for in the two cases. Moreover, it is quite clear that the free oxygen does oxidise harmful waste products and reduce them to a form (*e.g.* carbon dioxide and water) in which they may be either innocuous or at least readily escape from the tissues. The accumulation of alcohol in plant tissues in the absence of oxygen is a case in point, and readmission of oxygen has the immediate result of increasing the output of carbon dioxide at the expense of the alcohol abnormally present in the tissues.

The biogen hypothesis gives a plausible account of growth and the production of fresh living material by supposing that the molecule is capable of polymerisation and then of falling into simpler substances once more. But this view would seem further to imply that the more highly polymerised bodies do not differ essentially in their properties from the more simple ones. In endeavouring to locate the seat of the biogens in the cellular organisation, it is concluded that they exist in the cytoplasm but not in the nucleus. The evidence for this is based on observations adduced to show that enucleated protoplasm can exhibit metabolic activity, and further, that the oxidative charges are more especially obvious in the cytoplasmic, rather than in the nuclear, constituents of the cell. But perhaps one may reasonably question the

advisability of endeavouring to go so far. We are as yet far too ignorant of the nature of the relations existing between cytoplasm and nucleus to be able to draw any safe general conclusions respecting them. What we do know suffices to prove that, probably as the result of interchange of material, the relations are at least of a very intimate nature.

It is, of course, impossible within the limits of so short a notice to attempt to do anything like full justice to the skilful treatment that Prof. Verworn has brought to bear on his subject. It must suffice to repeat that it is thoroughly well worth reading, and whatever may be thought of the tenability of the hypothesis itself, one can hardly deny that it does fulfil the important condition of enabling one to link together in a suggestive manner a large number of very complicated phenomena.

SCIENCE AND PRACTICE.

The Lighthouse Work of Sir James Chance, Bart. Pp. x + 162. (London: Smith, Elder and Co., 1902.) Price 5*s.* net.

THE optics of lighthouse lenses form a sufficiently fascinating subject, and its interest, apart from its practical importance, has attracted able men from Augustin Fresnel down to John Hopkinson. Among these, James Timmims Chance deservedly holds a prominent place, and his biographer has earned our thanks by the account he has given in the pages under notice of Chance's life and work.

Sir James Chance, a son of Mr. William Chance, of Birmingham, one of the partners in the glass-making firm of Chance Bros. and Co., was born in 1814. After gaining honours in various subjects, including Hebrew, at University College, London, he entered Trinity College, Cambridge, and in 1838 he graduated as seventh wrangler. Immediately after this he entered his father's firm, of which he remained a partner for fifty years, being head of the firm for twenty-five. He was made a baronet by her late Majesty on the occasion of her last distribution of birthday honours. He died on January 6, 1902.

In old days, parabolic reflectors were used for lighthouses; the employment of lenses is due to Augustin Fresnel, who in 1819 erected the first dioptric system at the Tour de Cordouan; the system was extended by his brother Leonor and other distinguished men in France, and in Great Britain by the family of Stevenson, by Airy and by Faraday. With the two latter Mr. Chance became intimately associated about the year 1859.

His firm had manufactured lighthouse lenses for some years previously. Before this, the industry had been crushed out in England by Excise regulations; an Order in Council was required to permit of their manufacture, and a duty amounting to some 300 per cent. on the cost of the glass was enforced. In consequence, Messrs. Swinburne and Co., of South Shields, who for a few years had manufactured lenses, gave up the work in 1845. In 1850 Messrs. Chance took it up. They engaged a French expert, M. Tabouret, who had worked for Fresnel himself, and he exhibited in the Exhibition of 1851 an apparatus of the first order, made at Messrs. Chance's Spon Lane works. In the years that followed, the work prospered, the plant was increased and the optical part of a number of lighthouses was manufactured. M. Tabouret left the firm in 1853.

In 1859 the work of the Commission to inquire into the condition of the lights, buoys and beacons of the United Kingdom began. Airy and Faraday had charge of the scientific side of the inquiry. Mr. Chance's assistance was called in as a manufacturer of great experience, and it was soon found that in him the Commission had an adviser who could render services of the highest value. His mathematical training enabled him to understand and develop the theory of the subject, his practical experience showed him what was possible. He had already introduced improvements into the method of grinding the annular lenses which form the system, and its various components had reached a high degree of perfection.

But, though this was so, the distribution of light effected by means of the lens system was, in many cases, entirely wrong. At that time Messrs. Chance were not allowed even to tender for the frames to hold the lenses, although they had to make these in order to adjust the system in their workshop. They had no share in the erection or adjustment of the light, which was done usually by contractors with little or no optical knowledge, and the result was failure. One of the most glaring instances was the Whitby light, of which Airy reported:—"The dioptric part of the apparatus is beautiful. The glass is of the best quality. . . ." The adjustments, however, were all wrong.

"My impression is," he writes, "that in the north lighthouse three-fourths of the light is absolutely thrown away, and in the south lighthouse nine-tenths of the light is absolutely thrown away. . . . When with a ruler I covered the part of the flame which merely gave light to the sky, it was absurd to see how little was left for the useful part. . . . It really gave me a feeling of melancholy to see the results of such exquisite workmanship entirely annihilated by subsequent faults in the mounting and adjustment."

In the end, Mr. Chance was given a free hand. Airy again reports, at a later date,

"The said constructor"—Mr. Chance—"is willing to go heartily into the improvement of the Whitby light, therefore leave all others and rest on it."

And this wise advice was taken.

A method of adjustment—it seems sufficiently obvious, and had been used previously—was suggested by Airy and employed in setting up the lenses. Each portion of the lens system is to be employed in forming an image of some part of the lamp flame on the distant horizon or on some part of the sea between the lighthouse and the horizon. Conversely, if the adjustment is correct, a real image of that part of the horizon will be formed by the lens system on the corresponding part of the flame, and can be seen by an observer looking into the lens system from behind.

Airy's method consisted in adjusting the lenses in turn until the image of the horizon formed by each occupied its proper position with regard to the flame.

It is clear that the adjustment will depend in part on the position of the lighthouse, especially on its height above sea-level, and that a system of lenses put together without any reference to this was bound to be wrong.

The results were entirely satisfactory, and the Whitby light when reconstructed gave admirable results.

A good deal of correspondence followed with some members of the Commission as to the form of lamp and the best height for the principal focus of the system above the wick, and as time went on various other improvements were introduced; but Mr. Chance's position was now assured, and is evidenced by the long list of splendid lights we owe to him.

One of the improvements worked out in collaboration with Mr. Thomas Stevenson is the dioptric mirror, whereby the rays which leave the lamp at the back are totally reflected by suitable curved prisms and issue in the direction in which the light is required to travel.

The whole book, however, is most interesting, and forms a striking illustration of the application of science to industry. Mr. Chance realised the need of this, and his success was the consequence.

His contributions to the mathematical side of the subject are summed up in two papers read before the Institution of Civil Engineers in 1867 and 1879. The first deals with lighthouses in general; its value as a reprint is, however, impaired by the omission of the careful figures by which it was illustrated; in the second, the question of the application of the electric light to lighthouses is considered. Electric light was employed at the South Foreland in 1872 and at the Lizard lighthouse in 1878. The apparatus in the latter case was designed by John Hopkinson, who on Mr. Chance's retirement became scientific adviser to the firm. R. T. G.

THE INFINITIES OF MATHEMATICS.

Die Grundsätze und das Wesen des Unendlichen in der Mathematik und Philosophie. Von Dr. Phil. Kurt Geissler. Pp. viii + 417. (Leipzig: Teubner, 1902.) Price 14 marks.

EVERY serious inquiry leads, sooner or later, to metaphysics, and thus to antinomies which no merely logical process can reconcile. The pure mathematician is one of the first to reach this conclusion, because his methods are mainly logical, and the notions with which he deals are few and abstract. Why is it, then, that (as a rule) he regards the philosopher with a mixture of pity and disdain, and rarely takes part in any strictly metaphysical discussion? Each is vitally concerned with number, space and time; why do the conclusions of the one appeal so little to those of the other? Leaving the philosopher to answer for himself, we may endeavour to construct the mathematician's apology.

It is mainly that, while he reaches the fundamental paradoxes as soon as the metaphysician, his attitude towards them is different. As it seems to him, the philosopher, after an imperfect analysis, tries to save the situation by a still more imperfect transcendental synthesis. To swamp all distinctions in the Absolute, while assuring us that the distinctions persist, is a childishly simple course, especially when adopted by someone who has a very vague conception of the distinctions which he proposes to abolish. Surely it is reasonable to examine our concepts as carefully as we can, to discover, if possible, which are simple and which are derived or composite. Until we do this, we have no right to say what are the ultimate logical inconsistencies, still less how we propose to reconcile them. The presuppositions of arithmetic and geometry have recently been analysed with great care, and definite results of primary importance have been obtained; the philosophical bearing of these conclusions is obvious, and henceforth no metaphysical theory that ignores them will be accepted by mathematicians. Difficulties remain, of course; some have emerged which were previously unsuspected; but at any rate the ground has been cleared of many merely sophistical paradoxes, and the real issues have been made clearer.

Dr. Geissler's book is rather pathetically disappointing; he has evidently tried to master modern critical theories, but has failed in the attempt. The whole arrangement of the work is unsatisfactory, starting as it does with a vague spatial intuition, and constantly mixing up arithmetical difficulties with those of geometry. In the forefront of all discussions of mathematical infinity must be put the notion of the arithmetical continuum; this, at any rate, is precise and definite. From it we get the concept of a continuous real variable, and thence can proceed to the differential and integral calculus treated by the method of limits. This involves the use of a fluent differential, but there are no serious logical difficulties. Dr. Geissler's attitude is anything but precise, and not always consistent; he appears to try to establish the existence of infinitesimals of different orders as actual entities, and this partly by geometrical considerations. In this region of thought geometrical intuition is wholly untrustworthy; and it is doubtful whether any satisfactory analytical theory can be constructed on the basis of what we may call fixed infinitesimals. It is certain, for instance, that in the arithmetical continuum there is no natural series of orders of infinitesimals. What is the precise nature of geometrical continuity, and how far it can be expressed by arithmetical means, is a very difficult question, upon which Dr. Geissler does not help to shed any light.

One important point the author does emphasise, though sometimes with more zeal than discretion. The terms *infinite* and *infinitesimal* have no precise meaning except in relation to a context and to certain presuppositions. Thus, in projective geometry, the statement that all points at infinity lie in a plane is a convenient summary of a set of facts about parallels; on the other hand, in the theory of algebraic functions, we assume that in the plane of the complex variable there is only a single point (not a line) at infinity. Each statement is true in its context, and out of its context it means nothing at all. If, with Dr. Geissler, we set off equal finite segments continually along a Euclidean straight line, we may assert the possibility of any

number of finite segments at infinity; to enumerate them we require transcendent integers, but there is nothing illogical in the conception, provided that we use it consistently. But we must not criticise one conception by the results of another with which it is radically incompatible.

To show how weak the author's logic is, it is sufficient to refer to his discussion of the old fallacy of Achilles and the tortoise. Here it is established that an indefinite number of successive intervals of time can be found, for each of which the tortoise is ahead; and it is falsely concluded that the sum of these intervals of time tends to an indefinitely long period. Instead of pointing out this simple fact, Dr. Geissler argues that the division of the initial interval between Achilles and the tortoise is illegitimate! ("Man darf sich nicht einbilden, es liege schon im Wesen einer Strecke AB auf ihr in irgend einer Weise Strecken zu tragen.") In fact, his hankering for infinitesimals, in the sense of indivisibles, makes all his treatment of limits and convergence quite unsatisfactory.

It is a matter for real regret that Dr. Geissler has so completely failed to contribute anything of value to the discussion of his subject. The development of mathematics since the time of Kant has surely provided some new material for speculation; how long must we wait for a philosopher competent to deal with it? Even De Morgan failed to appreciate Rowan Hamilton's conception of algebra as the science of pure time; the truth of this idea (except, perhaps, for group-theory) is becoming daily more evident. But while analysis is thus practically reduced to a subjective construction, there are elements in geometry which refuse to be so assimilated. Not all mathematicians are geometers, but those who are will sturdily maintain that, in some sense or other, there are geometrical data which are not expressible in terms of arithmetic. The present tendency towards critical analysis may, we hope, be succeeded by renewed interest in pure geometry. Then, perhaps, something more may be done towards distinguishing its primary axioms.

The analytical doctrine of the infinite has been sketched in a very interesting manner by Dr. Hobson in his recent presidential address to the London Mathematical Society; this deserves to be widely read, because it presents the main discoveries of Dedekind, Cantor, &c., in a form which does not assume any advanced mathematical knowledge on the part of the reader. G. B. M.

PRACTICAL PHYSIOLOGY.

Practical Physiology. By A. P. Beddard, J. S. Edkins, Leonard Hill, J. J. R. Macleod and M. S. Pembrey. Pp. xiv + 495 (London: Edward Arnold, 1902.) Price 15*s.* net.

THE aim of the authors of this text-book has been to provide medical students with a course of physiology which shall not only give them sufficient mental training—practical Chinese or Greek would do this—but also ensure that this training shall be of substantial use in their after medical career. In some respects, this aim has been carried out in an admirable manner. Many of the articles are clearly written and well illustrated, and some of the sections—notably those on circulation, blood gases and physiological optics—contain valuable information not readily accessible to the student in any of the existing text-books. Other parts hardly maintain this high level, and the chapters on muscle and nerve in particular are noticeably deficient, even allowing for the author's expressions of dissent in the preface, and it is curious to see a text-book of 495 pages in which only two are devoted to the description of the galvanometer and capillary electrometer together, and where three lines contain the major part of the information on the electromotive phenomena of the heart!

The book is divided into four parts; the first two of these, comprising the more elementary exercises, are, on the whole, very good. The labour involved in preparing new illustrations and tracings must have been considerable, and the authors are justly to be congratulated on the result of their exertions. In addition to the experimental exercises already noticed, the section on physiological chemistry merits favourable comment, and as a pleasing matter of detail, the drawings of crystals are particularly accurate.

There are certain places, however, which might be subjected to a little revision in the next edition. While the authors reject Von Fleischl's hæmoglobinometer on the ground of inaccuracy, the directions given for the use of the Thoma-Zeiss hæmocytometer will in practice lead all but the very careful student to far more serious errors of estimation. With a little skill, the method for the detection of albuminuria by heat could be carried out so as to show no trace of albumin even when it was present in considerable amount, as acid albuminate would readily be formed under the conditions recommended. "Ethylic acid," on p. 180, is a pretty obvious misprint for "ethyl alcohol." We think that the information on p. 72 is a little out of place, but perhaps this is a matter of opinion.

The "advanced" portion of the text-book is hardly so well written as the "elementary," though the articles on optics and on Haldane's methods for determining oxygen capacity and mass of the blood could hardly be surpassed. Here, moreover, is to be found the largest part of the "comedy of errors" which is inseparable from a first edition. Constantine was an Emperor who reigned at Constantinople; the alloy of manganese and iron used for thermoelectric work was not called after him. The directions for preparing sarcolactic acid, on pp. 442–3, would be improved by the substitution of the word "phosphoric" for "sulphuric," and the method, on p. 426, for decomposing proteids contains more than one serious error, and should be re-written throughout.

But besides these smaller matters, there is an authoritative method adopted of disposing summarily of controversial points by *ex cathedrâ* utterances; we think that a text-book writer might, in a fairly complete work such as this, at least mention the possibility of different views being held by other physiologists, absurd though this may seem to him.

It is a pity that an index was not included in the book;

the few pages that are dignified by the name are merely a mockery to anyone who is not one of the authors.

However, even with these easily remedied defects, the book is a good and useful one which can be recommended to the student as one to be added to his library.

OUR BOOK SHELF.

Studies in the Cartesian Philosophy. By Norman Smith, M.A. Pp. xiv + 276. (London: Macmillan and Co., Ltd.; New York: The Macmillan Company, 1902.) Price 5*s.* net.

THE title of Mr. Smith's book conveys an adequate idea of its scope. The author indicates the lines of his treatment thus:—"In Descartes' system, as we have tried to show, there are three fundamental tenets, viz. the doctrine of representative perception, a very peculiar form of rationalism, and the conception of spirit as an active creative agency" (p. 115). The main portion of the book (pp. 1–115) is devoted to Descartes, with appendices on "Arnauld's denial of the doctrine of representative perception" and on Descartes' views of perception, time and consciousness (pp. 115–136). The rest of the book deals with Cartesian principles in Spinoza, Leibniz and Locke, with Hume's criticism and "the transition to Kant."

The author's treatment is lucid throughout; the main lines of criticism are stated clearly, and, on the whole, adequately. This is especially true of the chapters on Descartes and Locke, where the author has allowed himself to treat the subject at greater length. As to Descartes, the author says, "his philosophy of nature I have reserved for further consideration, and in this present volume limit myself, as far as possible, to his metaphysics" (preface, p. vi). His reason for thus dividing the subject is that Descartes' "metaphysical teaching is perverted by principles wholly at variance with his own positive scientific views" (preface, p. i.). This point is specially brought out in contrasting Descartes' physical and metaphysical views of motion (pp. 70–71).

With regard to the salient features of Descartes' teaching, Mr. Smith considers that the *cogito ergo sum*, so far from being "the really ultimate element in his system," is "simply one consequence of the doctrine of representative perception which is itself a consequence of his dualistic starting point" (p. 14). The importance of "method" as "not merely an instrument for constructing knowledge" (p. 23) and the relation of method to Descartes' view of intelligence is well brought out; the same may be said of the author's treatment of the deductive mathematical method and its fallacies. In "the proof of the existence of God," Mr. Smith thinks "Descartes' scholasticism came to a height." He rightly treats some of the Cartesian arguments as purely "official" (p. 64). But we cannot say that he is altogether clear upon the relation of the system as a whole to God; it may be disputed whether Descartes ever meant by God "the all-comprehensive absolute reality." Certainly we can recognise the universality of the criterion without identifying the system with its maker. The author's argument is scattered and somewhat divided between what Descartes really meant and what he really said.

The discussion on Locke is an excellent chapter; the treatment of "substance" and "the unknown" may be specially mentioned (v. p. 195). The treatment of Spinoza and Leibniz, though suggestive, is too brief. As the value of this book lies not so much in its originality as in the accurate exposition of certain lines of thought which have dominated modern philosophy, the author should not have allowed the recent works on these philosophers to cramp his own treatment. The section on Berkeley suggests the same criticism. Yet the many good qualities of the book should recommend it to all students of philosophy. It is adequately furnished with references and has a good index. G. S. B.

Die progressive Reduktion der Variabilität und ihre Beziehungen zum Aussterben und zur Entstehung der Arten. By Daniel Rosa, Professor of Zoology in the University of Modena. Authorised Translation from the Italian by Dr. H. Bosshard. Pp. 106. (Jena: Gustav Fischer, 1903, published 1902.) Price 2.50 marks.

PROF. D. ROSA begins his interesting essay by saying that cuttlefishes might envy the obscurity which multitudinous evolutionist-pamphlets—likened to "ink-squirts"—have given to the troubled waters surrounding the rock of the theory of descent; but this somewhat cynical outlook has happily not hindered him from publishing (in 1899) the booklet before us or from having it translated into German by Dr. H. Bosshard. We have both versions of the essay, and, so far as we can judge, the translation is exceedingly well done.

In his first chapter, Rosa pictures organic evolution as a long-drawn-out "substitution process," in the course of which many groups, having reached their acme, give place to others springing from a lower level of the phylogenetic stem and retaining a capacity for abundant and far-reaching variation. As a group becomes more perfect, it tends to nirvana; its variations are reduced in number, or, in any case, in range; and the extinction of "lost races" like Graptolites, Trilobites, Ammonoids, Pterodactyls, &c., is causally associated with a progressive reduction of variation. It has to be admitted, however, that we do not really know much about the scope of variation in the last days of lost races.

In the second chapter, Rosa inquires whether the progressive reduction of specific variations is wholly due to natural selection or in part also to internal organismal conditions. He emphasises two points:—(1) that an organ which disappears in the course of evolution never reappears along that line of descent, that an organ which has become retrogressive never reacquires the capacity of progress; and (2) that in many cases, there is a constancy or fixity in the numerical relations of parts, *e.g.* segments, limbs and digits, from which the type seems quite unable to free itself. These two sets of facts point to a progressive reduction of variability, especially in types towards the ends of the phyletic branches. This theory is corroborated by detailed reference to the limitations which structural and functional differentiation seems to impose upon the variability of tissues and cells. Evolution is dominated by the "law of progressively reduced variability."

The third chapter is less of a unity, for the author has been impelled to speak briefly "de omni re scibili et de quibusdam aliis." Rosa attaches little importance to individual fluctuations; he relies upon general changes or mutations of the idioplasm occurring throughout the species. He has done useful service in indicating the tendency to reduction of variability in highly evolved types; his essay is very interesting and suggestive, pleasantly free from dogmatism or verbal polemics; but we must wait for more detailed data, and admit that "Thatsachen, nicht Ansichten, entscheiden." J. A. T.

Steel Ships: their Construction and Maintenance. A Manual for Shipbuilders, Ship Superintendents, Students and Marine Engineers. By Thomas Watson. Pp. xiv + 290. (London: Charles Griffin and Co., Ltd., 1901.) Price 18*s.* net.

THE title of this work led us to hope that a long-felt want had at length been supplied; but we regret to have to say that on reading it we were disappointed. Mr. Watson does not appear to have the scientific

knowledge or the range of practical experience requisite for the task he has undertaken. He attempts within the narrow limits of eight chapters running to 286 pages—of which one chapter of only sixteen pages is devoted to "maintenance"—to deal with such great subjects as the manufacture of steel and iron; the quality, strength and tests of these materials; the classification of ships and the assignments of their loadlines; the various methods of ship construction; the strength of ships and the stresses to which they are subjected at sea; the types of ships and the construction of typical vessels; the details of construction of ships and their fittings; and the maintenance of ships during their employment at sea. These are all most important subjects, and greatly need adequate treatment by someone who thoroughly understands them and can make them understood by others. Mr. Watson has certainly failed to do what is required.

The various points are treated in this work chiefly with reference to cargo steamers built to Lloyd's rules, and there is little in some of the chapters except what is contained in those rules. The "laying off" of a vessel upon the mould loft floor, and the manner of giving out particulars of the forms of the various parts of the structure to the workmen, is described in two pages, in a general manner that conveys no really useful information. Similarly, the launching arrangements, and the calculations requisite for them, are only glanced at in a very brief and sketchy manner. The subject of bilge keels is dealt with in twenty lines, and the question of how to place these properly in position upon the ship is dismissed with the remark that they "should be placed so as to give the least possible resistance to propulsion." A student would like to have some guide to that position! In dealing with the subject of vibration of steamships, the author recommends, as a provision against it, the strengthening of parts of the structure in and near the engine-room; and he makes no reference to the most important precaution of all—which has been much studied of late by marine engineers—that of designing the engines so as to obtain as perfect a balance as possible of the reciprocating parts.

The chapter upon "Stress and Strength" is very unsatisfactory, owing to an apparent want of scientific grasp of this difficult and intricate subject. We hope that the "shipbuilders, ship superintendents, students and marine engineers" for whom this work is said to be intended will soon be supplied with fuller and more exact information than is here presented to them.

Elementi di Geografia Fisica, Fisica Terrestre e Meteorologia, ad uso delle Scuole Classiche, Tecniche, Normali ed Agrarie. By Prof. Francesco Porro. Pp. viii + 280. (Turin, Rome, &c.; G. B. Paravia & Co., 1902.)

PROF. PORRO dedicates his little book "a mio figlio Giannino," a distinct novelty in school-book prefaces. The book itself devotes more space to the atmosphere, the oceans and glaciers than is usual in elementary works on physical geography. The features of the land are dealt with in much less detail, while the usual introduction on astronomical matters one expects to find in an English school book of the kind, and the usual appendix on biological matters, are omitted altogether. The result is that it is possible, in a limited space, to give a very satisfactory outline of the departments which are selected for treatment.

Prof. Porro writes as a lover of nature, with a subdued enthusiasm that should prove contagious. He has a good knowledge of the literature of his subject, makes his references accurate, and knows how to choose really instructive photographs and to construct helpful diagrams as illustrations.

H. R. M.

LETTERS TO THE EDITOR.

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Cambridge Mathematics.

PROF. GREENHILL'S notice (p. 338) of the German translation of my "Calculus" is pleasant enough reading. He says I follow the method of Squeers, "Spell winder! Now go and clean it." He is nearly right, but in truth I act on the belief that the average English boy loves to learn by doing things first and thinking about them afterwards, and so my method is rather the reverse of that of Squeers. Again, "the book, as a series of events connected by a slight thread of continuous theory, suggests a mathematical Pickwick." This is acute and severe and good humoured and kindly. I hope that Cambridge men, as they believe in Prof. Greenhill's great knowledge and good sense, will also see his kindly feeling, and that they will not think me presumptuous in urging them to consider his advice seriously. It will be gathered that I do not myself think that my course of mathematics for engineers is more than a promising effort. I am very much alive to its defects. But I know that the idea on which I have been working is a good one; I carefully developed that idea in opening the discussion at the Glasgow British Association meeting (published by Messrs. Macmillan). It is an idea as well known as the commonest copy-book maxim, but it is as much ignored at our colleges and schools as the sixth and eighth Commandments were in Blackbeard's ship. Anyone who studies how Prof. Forsyth has transformed my copy-book-maxim-ideas of elementary mathematics teaching so that they have become acceptable to all the schoolmasters of the country, and have in a few months been adopted by many examining bodies, must see that it is useless for anybody outside Cambridge to do more than say more and more strongly and persistently how much Cambridge is ignoring certain obvious truths; how Cambridge is neglecting its duty of leadership of this country in mathematics teaching.

I have pointed out how the engineer needs mathematics in all his work; how he needs the ideas of the infinitesimal calculus, and yet how mathematical symbols have been made hateful to him, his very desire for mathematical knowledge having in many cases been taken a devilish advantage of by self-sufficient dull pedants. How the engineer, clear-eyed and eager to use tools which he knows by trial will never fail him, and scornful of all method which he has by trial found to be mere pretence, has got to loathe mathematics and theory;—is it not written in the pages of every engineering journal that is published? And yet we know that all engineering is built upon mathematics, that all great advances in engineering are made by those practical engineers who accidentally become able to compute, to use the more celestial weapon. When, as at the Royal College of Science, there is an endeavour made to construct a syllabus suitable for the mathematical instruction, not merely of the average, but also of the highest kind of engineer and physicist, the necessity for making sacrifice and obeisance to outside standards well-nigh defeats our efforts. We ask Cambridge to help us towards that freedom without which there can be no true education.

Cambridge leads England in mathematics, and she is at present very far, not only from my ideal of leadership, but also from the ideal of Prof. Greenhill, who knows the state of the mathematical world many times better than I do. I ask Cambridge men, our best mathematicians, the men

without whom nothing can be done, the men whom we all admire so much that we almost forget their faults—I ask them to translate our poor ideas, our platitudes, our truisms, our copy-book maxims as to what ought to be done, into actual performance. The wonderful papers or books that they are now writing, can these make their names glorious for more than fifty or a hundred or a few hundreds of years? Is this fame to be weighed against the greater reward we offer? They have the chance of causing mathematics to be made a mental tool always ready for use by the engineer and physicist, the pioneers of thought and civilisation in this stage of the world's history. We ask them to take a high view of the value of their opportunities; really to lead the vanguard in the attack now at last being organised against the general ignorance of our people.

Let them think of all the university colleges and engineering schools of the country, and consider how disgust at useless routine has led to general neglect of duty in teacher and taught. I know of a college where two senior wranglers in succession have taken charge of the education of the average student, and there has been no teaching of mathematics for many years. I know of another college where another senior wrangler does his best to maintain the old tradition that a man paid to teach ought to know nothing of teaching, ought to care nothing for teaching, and ought to feel insulted if the persons who pay him his salary happen to mention efficiency of teaching in his presence. I acknowledge that these professors are of the salt of the earth; they have done great service to science by their own work; they ought to be encouraged to do more and more of the work that they are specially fitted to perform, but I do say that it is a shame to sacrifice all their students because it happens that Cambridge has not enough endowment for such men. Fifty years ago it did not matter to us if 90 per cent. of the undergraduates at Cambridge made fun of mathematics. It matters to us now very much indeed that the most important weapon that any modern nation can have, the power to compute, should be jeered at by the very men, the engineers, who could make most use of it if they only knew how. This is my excuse for what seems a great presumption in criticising Cambridge and in asking that my ideas shall have a careful consideration. I want to see schemes drawn up for the education of all kinds of civil and military engineers. The courses of study must be made interesting and useful. I do not wish to find that a sailor who has worked out all Napier's and Gauss's analogies has never measured a distance with a tape line on a terrestrial globe, or that he cannot do "the day's work," as it is called, without using seven or six figure logarithms.

It is surely an awful thing that many earnest men, because they have faith in us, should be induced to spend years in making ropes of sand. At the end of long academic courses an examiner finds the best students to be quite satisfied with sand-rope making, and mathematics will be as much detached from their professional work as the game of patience is detached from the daily avocation of the lady who plays it. As for the average men who hate the whole thing, they are better off; I mean, of course, if they manage to pass their examinations, for they can look before and after, and need not pine for what they never had.

The nation feels that its common sense has been outraged, and it is not merely elementary education that is going into the melting-pot. Is Cambridge going to hold aloof from the little army of men who think that the melting and solidifying processes need to be guided? Has Cambridge no interest whatsoever in the nature of the possible crystallisation?

There is no great engineering school the mathematics of which ought not to be in charge of as fine a mathematician as a salary of 1500*l.* or 2000*l.* a year can tempt; is this man to be a Cambridge man?

Let Cambridge make no mistake as to the issue now before us. We know she can do what we want if she likes to set herself to it, and we are willing to coax her, for we owe her much. We shall take care that her very highest ideals are not interfered with; if she makes mathematics popular, pleasant and useful to practical people, she will receive back again such great pupils in pure and applied mathematics as she does not dream of now.

JOHN PERRY.

Radio-activity of Ordinary Materials.

IN connection with Mr. Strutt's article on this subject in this week's NATURE, I may mention that I have received for publication from Prof. McClennam and Mr. Burton, of the University of Toronto, the manuscript of a paper read before the American Physical Society in December last, on the saturation current in cylinders of the same size but of different materials. The cylinders used were 25 cm. in diameter, and were made of zinc, tin and lead; the current in the lead cylinder was about twice that in the zinc, and about 50 per cent. greater than in the tin. The authors found that the current in the cylinders was considerably reduced by immersing the cylinders in a large cistern full of water, indicating that part of the ionisation is due to very penetrating radiation which gets through the sides of the cylinder. I may take this opportunity of stating that I have found that lead apparently gives off an emanation similar to that emitted by radium, for if lead acetate or lead nitrate be dissolved in distilled water, and air very slowly bubbled through the solution, the air coming out has greater conductivity than if it had been bubbled through the distilled water alone, and it retains this additional conductivity for many hours. We hope to investigate the effect of other metals in solutions and to determine whether or not it is due to the radio-active impurities in the salts.

J. J. THOMSON.

Cavendish Laboratory, Cambridge, February 21.

Fall of Coloured Dust on February 22–23.

I HAVE received this morning from two of the observers of the Royal Meteorological Society samples of red or muddy rain which fell on Sunday night or Monday morning.

Mr. C. Grover, of the Rousdon Observatory, Devon, on Monday morning, February 23, found that the windward sides of the thermometer screens were conspicuously marked with a deposit of reddish or rusty coloured mud, so thick as to attract attention at once. There was the same appearance on the anemometer tower—the window ledges, the iron ladder and the white painted wooden shelf thirty feet above the ground being all marked with the same deposit. The rainfall was only 0·02 inch.

Mr. J. W. Phillips, of Haverfordwest, says that rain fell between 6 and 9 a.m. on Monday, and that when the rain gauge was examined the water was found to have a sediment of dust. The quantity of rain measured was 0·31 inch. Mr. Phillips says that the phenomenon has been noticed in other parts of the country.

The deposit at Rousdon was apparently much thicker than at Haverfordwest. The fall must have extended over a wide area.

WM. MARRIOTT.

Royal Meteorological Society, S.W., February 24.

Chapman's Zebra.

IN the course of some studies of the genus Equus, I obtained a number of measurements of the skulls of zebras and quaggas through the kindness of Mr. J. A. G. Rehn. The measurements were based on specimens contained in the collection of the Philadelphia Academy of Natural Sciences. Upon comparing these data, I found that the measurements for *Equus chapmani* did not approach most nearly those of *E. burchelli*, of which *chapmani* is supposed to be a variety. Roughly speaking, if the resemblance to *burchelli* were expressed by 4, that to *E. zebra* would be expressed by 6, that to *E. grevyi* by 3, and that to *E. quagga* by 1.[1] In particular, *E. zebra* and *chapmani* had the zygomatic breadth and the breadth between the orbits above much less than in *burchelli*. The specimen of *chapmani* was said to be from Zanzibar. Part of the facts observed may be due to immaturity, and Mr. Oldfield Thomas warns me that the precise identification of *E. chapmani* is a matter of doubt; but from what I have been able to learn, it seems not impossible that *E. chapmani*, as represented by Prof. Ewart's "Matopo," may be a valid species. As it is quite out of the question for me to settle this matter, I venture to commend it to such of your readers as have better opportunities.

T. D. A. COCKERELL.

East Las Vegas, N.M., U.S.A., January 23.

[1] These figures are based, not on the absolute measurements, but on the measurements expressed in percentages of the total length of the skull.

AMERICAN MAGICAL CEREMONIES.

THE Dwamish Indians of Cedar River, Washington Co., U.S.A., believe that when a man is seriously ill in the winter his spirit departs to the under-world, which is an exceedingly attractive place in cold weather. It is only at that season that the spirit of a sick man leaves the body for the nether world; during the summer-time, the spirit travels from place to place on earth, and even when a man dies in the summer his spirit waits until the winter is well advanced before it retires under-ground. One of the favourite methods in the summer of compelling the spirit of a sick man to return to the body is by singing, but in the winter, the spirits of the officiating shamans have to journey to the under-world in order to bring back the recalcitrant spirit, and even they find it hard to tear themselves away from the pleasant home of the dead.

The ceremony takes place in the dance-house. A rectangular space, measuring about 10 feet by 20 feet, is marked off by vertical slabs. This is called the canoe, and inside are placed, in an upright position, small

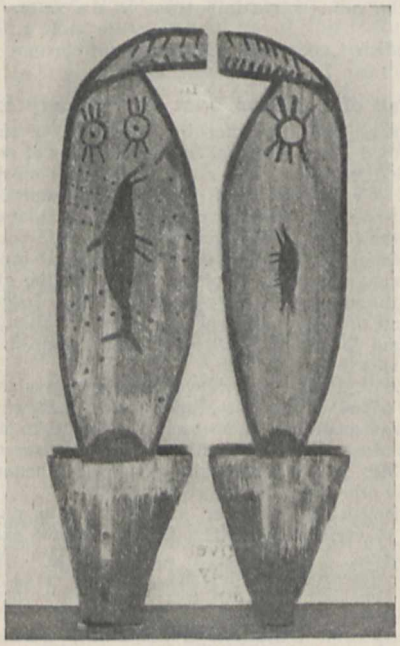

FIG. 1.—Painted slabs of wood for sides of spirit boat.

painted human effigies; these very materially assist the shamans to compel the spirit to return. The shamans, each of whom has a long pole, enter the canoe and begin by singing, which is accompanied by the beating of rattles and drums by the friends of the invalid; at the same time, the shamahs make paddling movements with the poles. This is kept up all night; by noon of the next day, they are supposed to have entered the under-world, where the struggle for the possession of the spirit of the sick man begins and lasts for a day and a half. At the end of the fourth day, one of the shamans intimates to the friends of the sick man that they have been successful, and, as a matter of fact, in the instance specified the sick man mended speedily.

Two of the painted boards that form the spirit boat are shown in the accompanying figure; the snout-like projection and a single eye, or a pair of eyes, are on all of them, but the decoration of the body of each board varies. In the first figure, a cetacean is drawn, and the shape of each board suggests that it is also a cetacean. Dr. G. A. Dorsey's account of this ceremony is the first that has been published, and as it is now almost extinct, it is fortunate that he was able to record this vanishing magical rite. The paper from which this abstract was taken was published, along with other original articles and various notes of ethnographical interest, in vol. iii. of the *Bulletin* of the Free Museum of Science and Art of the University of Pennsylvania.

Also to Dr. Dorsey, but in this case in collaboration with Mr. H. R. Voth, are we indebted for a very interesting and exceedingly well illustrated account of the Soyal ceremony of the Oraibi, one of the six Hopi villages in Arizona. On the first day of the ritual, feather standards are erected, cornmeal is spread over them, and a small pinch of the meal is thrown towards the rising sun. The performers smoke ceremonially during the whole day, and card and spin cotton. The second and third days are employed in a similar manner. On the fourth day, various sacred objects are exhibited and certain feathers are provided. These are tied on sticks to construct what are termed *bahos*; the *bahos* are prayed and smoked over, and holy water is obtained from a spring; nine songs are sung at ceremonies which combine

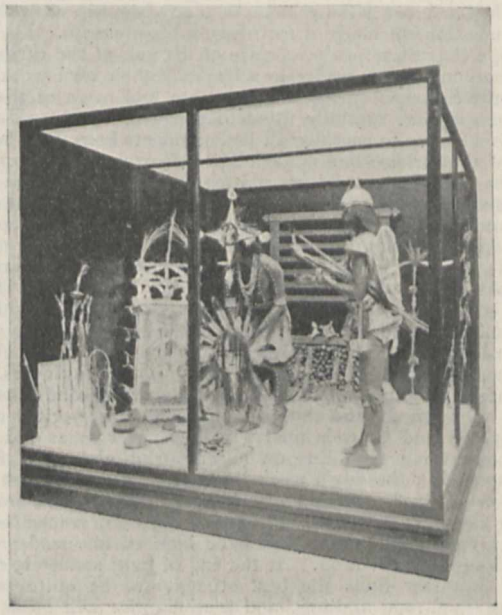

FIG. 2.—Case in the Field Columbian Museum illustrating the Soyal altar and the sun ritual.

prayer with the offering of cornmeal. On the fifth and three following days, the people fast. A considerable part of the fifth day is spent in practising various *katcina* dances. The Hawk priest screeches and performs most fatiguing dances. On the sixth day, the rite of offering cornmeal to the dawn is again performed; there are no important ceremonies on this day, but many preparations are made. All the men begin the seventh day by making prayer offerings (*bahos*) and objects composed of maize husks, to which feathers are fastened; these are termed *hihikwispi*, or "something breathed upon." On the following day, each performer takes his *hihikwispi*, holds it to the rising sun and says, "I breathe on this"; he then runs to his house, where all breathe on it, and so the *hihikwispi* are carried from house to house; this ceremony is a charm for the protection against sickness of the respiratory organs. Later a shrine is decorated before which smoke is "planted," and rain clouds are represented by six black semicircles; a fertility ceremony is performed before, and more particularly after, the fetching of water from a spring. Masks are worn

on this day; again there are bird dances, which keep on all through the night. Before daybreak on the following morning, the climax of the whole ceremony is reached; in front of the fire which burns before several altars, the Star priest twirls a sun symbol and is sprinkled with sacred water from a medicine bowl by the priest who represents the War-god; later in the day, the *bahos*, or prayer sticks, are deposited in various shrines around the villages. The four subsequent days are spent in rabbit hunting, and a big feast concludes the ritual.

Dr. Dorsey and Mr. Voth have wisely published a detailed account of what takes place, but their descriptions would have been of greater value to students of comparative religion if more explanation had been given as to the significance of the various rites. It is obvious that the details described are full of symbolism, the meaning of some of which can be readily guessed, but we do not want to make guesses, we need to be told definitely what the natives themselves understand by their rites. This memoir appears in vol. iii. of the

FIG. 3.—Katcina dancing on a sand picture in front of the candidates for initiation into the Powamu fraternity.

Anthropological Series of the publications of the Field Columbian Museum of Chicago.

Following this is a memoir, by Mr. H. R. Voth, on the Oraibi Powamu ceremony. Mr. Voth has been for many years a missionary to the Hopi, and so has had exceptional facility for studying their customs, and it will be evident he has not wasted his opportunities. One of the items in the preliminary ceremony is a prayer and ritual for the protection of plants and corn against destructive sandstorms. Later the uninitiated boys and girls have their hair cut. Characteristic features of the Powamu ceremony are the making of coloured sand pictures or mosaics and the dancing of masked men, *katcinas* (Fig. 3). An important part of the ceremony consists in the flogging of the boys and girls who are being initiated into the Powamu fraternity; each child has a male and female sponsor, who for ever after are called his or her "father" or "mother"; they are never relatives, nor can they be of the same clan as the actual father and mother of the child, but both must be of the same clan. Before the whipping of the children, an ancient migration saga is narrated. This careful study of a ceremony that is doomed to disappear is illustrated by a large number of well executed plates, which greatly enhance the value of the paper. The extensive collections made by Mr. Voth are in the Field Columbian Museum, and under his direction there have been erected in the museum wonderful cases illustrating Hopi altars and sand pictures, and life-sized models of priests in the act of performing various ceremonies.

Those who wish to study the secular and religious life of the Hopi Pueblo Indians must visit the museum in Chicago, for there they will find very extensive collections well arranged and fully labelled. In all probability, these will be accessible to future students when, in the not far distant time, sacred objects and picturesque ritual will have passed away and become forgotten in their native pueblos. A. C. H.

THE FATA MORGANA OF THE STRAITS OF MESSINA.

JUST as the Brocken is noted for its "spectre," so the Straits of Messina have long been known as presenting, under certain exceptional atmospheric conditions, a fine display of the appearances known as Fata Morgana. On his appointment in 1899 to the chair of physics at the Technical College of Reggio, Dr. Vittorio E. Boccara undertook a historical and critical study of the phenomena, and the results of his investigation are published in the *Memorie* of the Italian Spectroscopists' Society, xxxi., 10.

Among the ancients, the name of Aristotle is mentioned, but his references to the Fata Morgana are doubtful. Cornelius Agrippa spoke of reflections in the air of mountains, animals and other objects; Homer, Apollonius Polycletus, Damascius and Pliny also alluded to apparitions in the air, but their descriptions are not precise. Allusions to the Fata Morgana are also contained in the historical writings of Tommaso Fazzello (1550), Giuseppe Carnevale (1591) and Marc' Antonio Politi (1617), but the first attempt at a description of the phenomena was given by Father Angelucci in a letter published in 1671 by Athanas Kircher, in which he described the appearances seen on the morning of Assumption Day (August 15), 1634. These effects Kircher attributed to reflection by crystals in the air, and stated that he had been able to reproduce them artificially before a large audience.

In 1773, Father Antonio Minasi published a "dissertation on the phenomenon commonly called Fata Morgana," in which he distinguished hree different forms, namely, marine morgana, aëria. morgana and iridescent morgana. Minasi illustrated his descriptions by a remarkably good drawing showing the three phases.

In a treatise published at Naples in 1824, Captain Pietro Ribaud described the marine morgana of July, 1809, and gave a detailed account of the meteorological conditions necessary for its formation. In addition to calm, hot weather, we notice that Ribaud considered it necessary that the vapours exhaled under the heat of the sun from the heterogeneous substances, antimonious, vitreous, oleaginous, saline and other, contained in quantity in the shores and earths of Calabria and Sicily should not be carried away by the wind. Also the most favourable time for the morgana is about the turn of the tide.

The first to explain the morgana by refraction was Prof. Salvatore Arcovito (1838), who, however, considered the phenomenon similar to parhelia. Cacopardi never saw the morgana himself, but followed the views of Minasi and Kircher. Regaldi saw the phenomenon on

July 20, 1848, and describes how parts of the coast suddenly appeared, standing, so to speak, in the middle of the channel.

Coming to recent times, we have a description in the *Zagàra* for 1871 by an anonymous writer. A white streak of mist passing across the Sicilian coast melted like a transparent veil, revealing arches, towers and colonnades floating on the sea, houses, and woods of many colours.

Not less explicit is Prof. Filippo Capri, who described in the *Zagàra* the Fata Morgana of June 20, 1874, which occurred between 8 and 9 a.m. The weather was so hot as to ruin the crop of bergamot fruit, and the phenomenon, as on other occasions, was preceded by a white mist. Buildings were seen to become elongated, while the shores, with their villas and trees, became detached like islands and then disappeared. In answer to the invitation for an explanation, Dr. Diego Corsa repeated Minasi's erroneous opinions, but this point of view was attacked by Prof. Canale, who, however, did not venture to formulate a theory of his own, having only seen the phenomenon once.

Prof. Boccara speaks from personal knowledge of three displays of the Fata Morgana under its three different

FIG. 1.

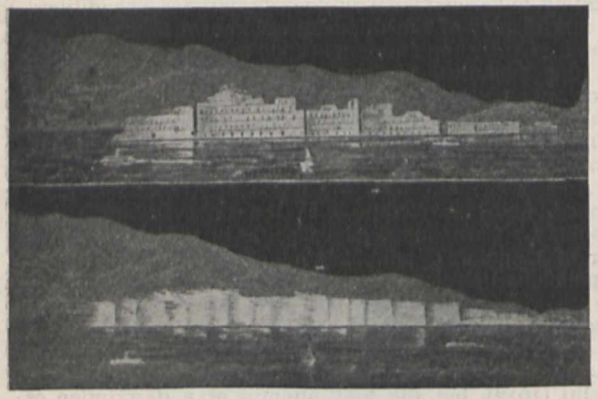

FIG. 2.

FIG. 1.—Aërial Morgana of June 27, 1900.
FIG. 2 shows the white mist just before the commencement of the phenomenon.

forms—namely, an aërial morgana on June 27, 1900, witnessed by himself, Captain Vincenzo Ponzi, of Chiaggia, and Prof. Enrico Puccini; a marine morgana on July 2, 1901, also seen by Prof. Puccini; and a multiple morgana on March 26, 1902. The first is well shown by the author's sketch in Fig. 1, Fig. 2 giving an idea of the white mist seen just before the occurrence of the phenomenon, and which disappeared when the occurrence took place. In it, the houses on the Italian coast at Gallico and the point of Catona are seen to be considerably elongated in a vertical direction, and, so to speak, projected on the Sicilian coast beyond, the straits appearing to be converted into a gulf. In the marine morgana of 1901, a cloud again formed just previously, and the appearance was presented of arches standing below the sea line in an upright position, their bases having no visible foundation. These arches corresponded to some railway arches above the cemetery of Messina, but were more brilliant and larger than the real arches. Of the third or multiple morgana, Prof. Boccara has given an illustration in Fig. 3, which, however, represents simultaneously various phases of the phenomena which were in reality seen in succession. Thus the three houses at the left were not all visible at the same instant; when one appeared, the other disappeared. The white band with vertical dark stripes was attributed to the wall of the citadel at Messina, and it appeared to blot out the houses of the town.

Prof. Boccara attributes all these phenomena to variations in atmospheric density, which produce refraction effects. It may be suggested to the mathematician that consideration of the principle of least time for the path of a light ray affords an easier way of thinking of the conditions necessary for the phenomenon than is given by the sine law of refraction. The term Fata Morgana is used by the author exclusively in connection with apparitions in which the images are erect. When inversion takes place, so that the phenomena are due to reflection, the effect is a mirage, a phenomenon also seen not unfrequently on the Sicilian coast.

The neighbourhood of Reggio is peculiarly adapted to the display of the Fata Morgana both by its topographical peculiarities and by the meteorological conditions not unfrequently existing there These conditions are, a morning hour, hot weather, extreme clearness of the air, combined, however, with a thin veil of mist over the Sicilian coast, and a calm air or slight wind from the north, as conditions for the marine morgana. For the aërial morgana, the best time of day is from 10 a.m. to 1 p.m., with a stratum of light cloud on the coast of Sicily, sea calm or nearly so, a high temperature and

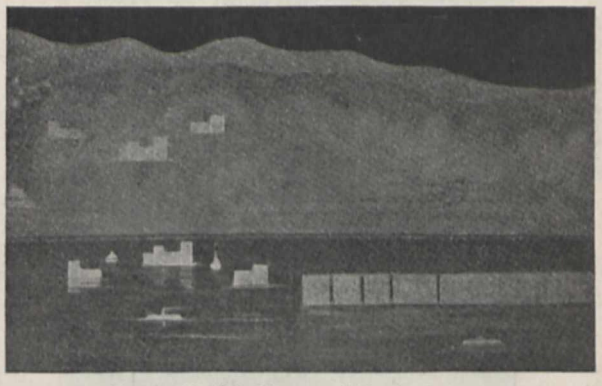

FIG. 3.—Multiple Morgana of March 26, 1902.

wind as before. A multiple morgana is, or course, of much rarer occurrence than the simple form, and the one seen in March, 1902, was less marked than one observed about twenty years previously by Prof. Scerbo and Signor Aloi, of which a sketch is reproduced in Dr. Boccara's paper. G. H. B.

INDIAN RAINFALL.

EVERYONE acquainted with the rainfall statistics of India is familiar with the appendix to the third volume of the *Indian Meteorological Memoirs*, which was published in the year 1888, when Mr. H. T. Blanford was Meteorological Reporter to the Indian Government. This appendix contained the monthly and yearly rainfalls for each station which possessed a rain-gauge, and the period over which the observations extended was in some cases, such as Bombay, Madras and Calcutta, very long, the last year in which the observations from all stations were included being that of 1886.

Since that epoch many years have passed, and the time had evidently arrived for this volume to be brought up to date and the whole mass of useful rainfall data collected together under one cover. We are glad to say that this large piece of work has now been completed and published (1902), and forms the fourteenth volume of the *Memoirs*.

Under the able editorship of the present Meteorological Reporter and Director-General of Indian Observatories, Sir John Eliot, this new volume contains all the available data up to, and including, the year 1900, and it is to this volume that inquirers of Indian rainfall statistics will now turn. Several minor changes will be found to have been made in the tables, such as zero (0) instead of (...) when no rain had fallen during a month, the authorised orthography, &c., but the most valuable addition is undoubtedly the insertion of two extra columns for each station giving the total rainfall for each monsoon.

India, as most people know, receives its rain mainly at two periods of the year, namely, during the summer months when the south-west monsoon is blowing, and during the winter months when the north-east monsoon is blowing. In any investigations on the variation of rainfall due to extra-terrestrial origins or involving atmospheric circulation, it is of the greatest importance to be able to treat the monsoon rainfalls separately. Again, some stations are more favourably placed, geographically, to depend chiefly for their yearly rainfall on one or other of the monsoons, or both; thus Bombay's rainfall is entirely due to the south-west monsoon, while the wind which gives Madras its rain is the north-east; further south, in southern India, several of the places are more fortunate, and secure their rains from each monsoon in turn, so that if one monsoon fails them, they still have a chance of obtaining their rain from the other.

In dealing with such a large area of country as is covered by the Indian Meteorological Department, it was found desirable to adopt a grouping of the months for each monsoon that would be general to the whole of India, with the least detriment to some individual areas.

Thus the months finally settled upon were as follows:—N.E. monsoon, December to April; S.W. monsoon, May to November. The two columns, therefore, that are inserted for the first time in this volume show the total rainfall at stations during the five months ending April 30 of the year in question, and the total rainfall of the seven months ending November 30 of that year.

The fact that this volume contains no less than 709 pages and weighs 5lb. 14½oz. in its paper cover, will give the reader some idea of the mass of rainfall statistics it contains and of the labour involved in bringing the information together. The volume should serve as an admirable model for other countries to adopt, and it would be to the advantage, not only of Great Britain and her Colonies, but also of many foreign countries in various parts of the world, to coordinate their rainfall observations in a similar manner, so that such records, which are well worth making, are ready at the hand of any investigator who at the time may be working up the subject.

WILLIAM J. S. LOCKYER.

THE AFFORESTATION OF THE BLACK COUNTRY.

IN the spring of 1892, when marking trees for cutting in the Belgian Ardennes (Chateau de Mirwart), I noticed that a portion of the wood, alongside a meadow and a watercourse, had the irregular shape of spoil heaps. On inquiry, I found that some 200 years before iron-smelting had been carried on at the spot, and that the heaps consisted of old slag and other débris, such as may be expected under a rudimentary process of iron-smelting. The heaps were stocked with oak and ash trees, some of them of considerable size and value, others of smaller dimensions. I marked the large trees for sale, leaving all middle-sized and smaller trees. The latter girthed up to 4 feet at 5 feet from the ground, while the trees marked for cutting girthed 6 feet, and even more. I considered this a very interesting case, but as I did, at that time, not know the Black Country, it did not strike me to utilise my experience for the benefit of the English mining districts.

Towards the end of the same year, Mr. W. R. Fisher visited me at Mirwart, and when he saw the above mentioned case, it struck him to apply it to the Black Country. He subsequently visited that locality and urged its afforestation on more than one occasion. The honour of having brought the subject prominently before the public belongs to Mr. Fisher.

I have just read an account of a meeting at Birmingham, presided over by Sir Oliver Lodge, to inaugurate a society for promoting the afforestation of the Black Country. As the result of the meeting, a resolution was carried, a committee was formed, and Mr. Herbert Stone was elected hon. secretary of "The Black Country Tree-planting Society."

The area in question is believed to be 14,000 acres, covered with spoil and ash heaps, on which now some grass grows; it is grazed over by sheep. Sir Oliver Lodge, quite correctly, brought the probable financial results of afforestation into the foreground, while some of the other speakers referred to the importance of a sylvan environment for moral, hygienic, and æsthetic considerations, leaving the financial aspect to take care of itself. This I consider a mistake, because, with the best intentions, humanitarian considerations alone are not likely to achieve the object in view; besides, they can very well be realised, alongside of good financial results.

The area in question belongs, I understand, to a number of different proprietors, and this alone would probably be a great hindrance to bringing the undertaking to a successful issue. In my opinion, the adjoining municipalities, such as Birmingham, Dudley, Bilston, Wolverhampton, Darlaston, Wednesbury, Oldbury, &c., should put their heads together, devise a plan of acquiring the land in question, which cannot be of much value, and create a joint municipal forest estate, to be managed by one man. This manager might be made responsible to a joint committee, and under its orders carry out the afforestation of the area on a well-considered plan. In that case, æsthetic considerations can receive full attention, while the woods should be so laid out, as to species, &c., that a reasonable return on the outlay may be expected.

If the plan here sketched should prove to be impracticable, it would be quite worth while for the State to acquire the land and plant it up. In any case, a well-considered plan of action as regards the manner of afforestation, the species to be planted, &c., is a *sine qua non* of ultimate success, and the drawing up of such a plan should be entrusted to an expert, who is fully conversant with the management, and more especially the financial management, of forest estates. I lay stress on this, because I see it stated that sycamore, ash, lime, beech and poplar should be planted. There will, no doubt, be many places where these trees can be introduced, but the bulk of the area should be stocked with fast-growing conifers, the thinnings of which will, at an early age, give large quantities of pit timber, and thus secure favourable financial results.

W. SCHLICH.

NOTES.

In several districts of the south of England and Wales, coloured dust or sand accompanied a fall of rain on Sunday last, February 22. At Etchingham (Sussex), twelve miles from the sea, particles of dust deposited by the raindrops were left on the trees. At Swansea and other places in South Wales the puddles left by the rain were reddish in colour. Mr. A. E. Brunsden, the piermaster at Swanage, Dorset, noticed that a thick fog which occurred with the rain on Sunday morning had a peculiar yellowish tinge. On Monday morning the ironwork on the pier was found to be covered with a fine, salmon-coloured dust. Some specimens of dust collected after the fall have been sent to us by Mrs. Neville Ward, and are being examined.

In reply to a question referring to afforestation in Ireland, Mr. Wyndham remarked in the House of Commons on Tuesday "Some of the recommendations in the report of the Committee on British Forestry are applicable, in principle, to Ireland. The Irish Department is at present conducting a special survey of existing woodlands and lands suitable for forestry operations. Such a survey is necessary to enable the Department to consider the measures to be adopted to give effect to the recommendations of the report in question."

Dr. C. W. Andrews, of the British Museum, has arrived in Cairo, and started for the Fayum Desert, where, in conjunction with the officers of the Egyptian Geological Survey, it is hoped that he may be able to add largely to the collection of Eocene vertebrate remains from that district.

The anniversary meeting of the Geological Society was held at Burlington House on Friday, February 20. The medals and funds, of which the awards have already been announced, (p. 250) were presented. The president delivered his anniversary address, which dealt with the relations of geology to its fellow-sciences.

Reuter reports that the following telegram from Honolulu has been received at San Francisco:—"Mr. Schroeder, Governor of Guam, Ladrones Archipelago, is here on his way home. He reports the occurrence of a severe and prolonged series of earthquakes, accompanied by loud rumblings, which have raised the level of the island by six inches."

At the annual general meeting of the Physical Society on February 13, Dr. R. T. Glazebrook, F.R.S., was elected president for the ensuing year. Mr. H. M. Elder has found it necessary to resign the office of secretary, and Mr. W. R. Cooper has been appointed his successor. In the course of an address delivered upon taking the presidential chair, Dr. Glazebrook said that the Society should have a wider range of activity, and technical papers should not necessarily be excluded. Interest might also be aroused by arranging at times for set discussions. Attempts should be made to give advice and guidance to physicists in isolated positions about the country having time to carry out research. The address also dealt with the history of theoretical optics during the last sixty years, and the part taken by the late Sir George G. Stokes in its development.

At the meeting of the Royal Astronomical Society on February 13, the Society's gold medal was awarded to Prof. Hermann Struve, director of the Königsberg Observatory, for his work on the satellites of Saturn, published in 1898 in the publications of the Central Nicolas Observatory, Pulkowa. Prof. Turner delivered an address describing the long series of observations and the complex and laborious calculations by which Prof. Struve had determined the motions and masses of the satellites, the position of the equator of Saturn, the compression of the body of the planet, the mass of the ring, &c. The address concluded with a mention of the fact that half a century ago the gold medal had been awarded to Prof. Struve's grandfather, and a quarter of a century ago to his father, who still lives, one of the Society's oldest associates. At the conclusion of the address the chairman handed the medal to Count von Bernstorff, Councillor of the German Legation, for transmission to the medallist.

The annual general meeting of the Institution of Mechanical Engineers was held on February 20, when the annual report of the council was presented. The report points out that the completion of his sixth report to the alloys research committee has been delayed by the death of Sir William Roberts-Austen, but a large amount of his experimental work, dealing with the tempering of steel, and also with alloys of the industrial metals, is available, and is now being dealt with by the committee. No further report will be made by the gas-engine research committee until the large experimental engine has been put to work at the Birmingham University. Prof. T. Hudson Beare has been occupied at the University of Edinburgh in perfecting the apparatus for testing the value of the steam-jacket. Prof. David S. Capper has now concluded his experiments at King's College upon jacketed and unjacketed steam cylinders, and a report upon his comprehensive experiments is almost completed. The question of the standardisation of flanges has received the attention of the council, and was dealt with at the April meeting in a paper by Mr. R. E. Atkinson. A considerable number of members and others have since sent in contributions bearing on the best forms to be adopted as standards. The engineering standards committee, the constitution of which was explained in the last annual report, has held frequent meetings during the year, and its recommendations relating to standard sizes for rolled sections will be published shortly.

Mr. Hanbury, Minister of Agriculture, addressing the Lancashire Farmers' Association at Preston on February 21, said he understood that the Department of Fisheries was to be added to the Board of Agriculture.

Dr. Dempwolff, who succeeded Prof. Koch as head of the German expedition for the investigation of malaria in German New Guinea, states, according to the Berlin correspondent of the *Standard*, that he has discovered an aquatic insect which destroys the Anopheles mosquito. He proposes to cultivate these insects by artificial means, and in this way hopes to exterminate the malaria mosquito.

The French Chamber of Deputies has recently adopted a Bill intended to create a nickel coin in France. *La Nature* states that to prevent confusion with the silver franc the new nickel coin of 25 centimes will weigh seven as against the five grammes of the franc; the edge of the nickel coin will not be fluted like the silver franc; the new coin will be half as thick again as the franc. At first 16 million pieces will be struck off, and this will require 112,000 kilograms of nickel.

The "Life and Letters of Thomas Henry Huxley," by his son, Mr. Leonard Huxley, first published by Messrs. Macmillan and Co., Ltd., in 1900, and reviewed by Sir W. T. Thiselton-Dyer, K.C.M.G., in Nature for June 13, 1901, has been reissued in three volumes in the well-known "Eversley" series at 12*s.* net. The opportunity afforded by the publication of a second edition has been taken to correct various misprints, and to rectify a few errors and omissions in the first edition. In its cheaper form the book is sure to renew its popularity, and to reach a wider circle of Huxley's admirers.

THE Royal Academy of Sciences of Turin announces that one of the Vallauri prizes will be awarded by the Academy to the man of science, without distinction of nationality, who, from January 1, 1907, to December 31, 1910, shall have published the most important and most celebrated work in the domain of the physical sciences—these words being used in their broadest sense. The amount of the prize is 30,000 Italian pounds net. The prize will be awarded a year after the result has been announced. Works submitted to the Academy will not be returned, and manuscripts will not be considered.

SPEAKING at Dorchester on Monday, at the opening of a new operating theatre, Sir Frederick Treves said that the ceremony that day represented a movement the magnitude of which it was not at first easy to appreciate. Twenty-five years ago that part of surgery which dealt with operations was more or less discredited. It was singularly disappointing and, he was sorry to say, singularly unsuccessful. The amount of work that was then done through operations was comparatively small. The great development that had taken place was all due to the introduction, by Lord Lister, of antiseptic surgery, which had rendered operative treatment possible. The result had been the saving of many thousands of lives annually, and the rescue of still more thousands from a state of hopeless illness. The performance of important operative surgery was no longer limited to London and a few great cities; operative surgery had spread all over the country, and now nearly every provincial hospital had its own operating theatre. It was all part of a general movement which would result in bringing medical and surgical science to a higher level than had ever before been attained in this country.

THE *Natal Mercury* of January 9 last states that a meteorological institute has been established at Bloemfontein. Substations are being started in Harrismith, Kroonstad, Heilbron, Bethlehem and Bethulie, and records from all points will be sent to Bloemfontein. Observations taken so far promise very interesting study, and show remarkable variations of conditions throughout the Orange River Colony, both as regards one part in relation to others, and in daily changes at some stations. Such systematic study of meteorological conditions as this will very soon be of practical benefit to agriculture in this colony.

A REUTER message from St. Petersburg states that the Imperial Academy of Science has decided to dispatch an expedition to search for Baron Toll, who left Siberia in June last with a few companions to explore Bennett Island, and has not been heard of since. The search expedition, which will be headed by Lieutenant Koltchak, who was with Baron Toll before he left the Siberian coast, will proceed shortly to New Siberia and, if necessary, to Bennett Island, as there is reason to believe that the baron, seeing his road back to New Siberia cut off by the breaking up of the ice towards the middle of July last, remained in the island to pass the winter.

THE New York correspondent of the *Daily Mail* reports that the first detailed announcement of the plans of the Rockefeller Institute, founded by Mr. John D. Rockefeller with an endowment of 40,000*l.* two years ago, has been made public. Mr. Rockefeller added 200,000*l.* to the endowment last summer. It is expected that his contributions will ultimately reach a total of two and a half million pounds. Mr. Simon Flexner, of the University of Pennsylvania, has been chosen to take charge of the work, which will be centred in New York. A research laboratory will be opened in October. Then will follow a hospital, where special groups of patients will be treated in order to develop new methods of practice. The programme also includes the publication of a journal of experimental medicine and the creation of a popular hygienic museum. Several physicians have already been sent to Europe to make special researches.

THE Savage Club entertained Mr. Marconi on Saturday evening, February 21. Mr. Henniker Heaton, M.P., occupied the chair, and among the visitors were the Marquis of Dufferin and Ava, the Earl of Malmesbury and Sir Charles Boxall. In responding to the toast of his health, Mr. Marconi said he demurred to the statement of the chairman that he had been neglected in England. Like the King of Italy, the King of England had been most kind to him, and for three weeks he, by desire of His Majesty, carried on experiments in His Majesty's yacht *Osborne* which greatly advanced the development of wireless telegraphy. He then traced his work and the opposition he had met with, step by step, from the cable companies. The Canadian Government had given him substantial assistance and a grant of money to carry on his work. The Italian Government had just passed a Bill to erect the largest Marconi wireless telegraph station in the world, to communicate with America. In conclusion, he made the announcement that he had just made an arrangement with a great daily newspaper in London to supply it with a wireless message every day from Canada.

THE Postmaster-General, in reply to a question on wireless telegraphy put by Mr. H. Samuel last Thursday, stated that the effect of recent progress on the commercial and strategic interests of the country was receiving careful attention, and that he was in communication with the Marconi Wireless Telegraph Co. on the subject of its relations with the Post Office. "I am not at present in a position," he added, "to make any final statement on the subject, but I have no doubt it will be possible to secure for the public of this country the use of this method of communication when it is sufficiently developed for commercial purposes." Contrast with this the attitude of the Italian Government, which has just passed a Bill for establishing a powerful wireless telegraphic station in Rome, which was introduced by the Minister of Posts and Telegraphs. The Senate passed a resolution expressing its great satisfaction with the statement of the Minister, and conveying congratulations to Mr. Marconi. It is proposed to make this new station the largest yet built, and it is hoped by its means to establish communication with Argentina and with all the existing long-distance stations.

A NEW form of electric heating apparatus has been invented by Mr. E. G. Rivers, of H.M. Office of Works. The radiator is constructed of a layer of finely powdered retort carbon held between enamelled iron plates and kept in position by asbestos cardboard. Three copper strips are led in, one at the centre and one at each end, and continuous current passed from the centre strip to the outer two. The current taken is about eight amperes at 200 volts, and with this a heating surface of 25 square feet can be maintained at an average temperature of 190° F. The manufacture of this radiator is, we understand, to be undertaken by the Electric and Ordnance Accessories Co., of Birmingham.

ACCORDING to last week's *Daily Mail*, the sharp frost in New York produced some startling effects on the elevated electric railway. There had been rain before the frost, as a result of which the centre rail had become coated with ice, and this led to sparking on a large scale. The effect appears to have been somewhat extraordinary if we may judge from the account given by the *Daily Mail's* correspondent, who writes as follows:—"Dazzling flashes of flame shot high into the air, the reflection in the sky strongly

resembling the Aurora Borealis. Every train resembled a blazing comet, being followed by a long stream of flame and sparks. The whole line glistened with beautiful electrical discharges. Thousands of persons walked the streets watching the strange spectacle." This seems to open out fresh possibilities for electric railways in catering for the public.

THE preliminary account of the international balloon ascents of December 4, published by Dr. Hergesell, show that France, Germany, Austria, Italy, Russia and the United States (Blue Hill) took part in the experiments. Both manned and unmanned balloons and kites were used; the highest altitudes attained were:—Itteville (near Paris), 14,823 metres, lowest temperature −52°·9 C., temperature on the ground −4°·8; Strassburg, 16,500 metres, minimum temperature −65°·2, on the ground −7°·8; Berlin, 14,465 metres, temperature −35°, on the ground −11°·5, the lowest temperature was −46°·7 at an altitude of 9670 metres; Pavlovsk, 17,700 metres, the lowest temperature was recorded at 11,220 metres, −63°·5, on the ground −20°·7; at Blue Hill the wind was not strong enough to raise the kite higher than 1100 metres; an inversion of temperature occurred at the height of 1000 metres. The European ascents were made in an area of high barometric pressure.

Symons's Meteorological Magazine for February contains the first of a proposed series of articles on the Canadian climate, by Mr. R. F. Stupart, director of the Meteorological Service of Canada. These articles bid fair to be of considerable interest, and will dispel the popular idea that Canada is an exceedingly cold country. Ordinary readers may not at first realise that a large portion of Ontario lies as far south as the south of France, that Toronto is further south than Florence, and that the southern point of Ontario is further south than Rome. Referring to Vancouver, the author points out that the rainfall along the exposed western coast exceeds 100 inches, but in the more eastern districts it is less than half that amount. "The mean monthly and annual temperatures correspond very closely with those found in parts of England; the summers are quite as long, and severe frost scarcely ever occurs." Crossing to the mainland, about 70 miles from Vancouver, the observations taken at an experimental farm give the mean temperature of January as 33°, and of July 64°; the lowest temperature on record is −13°, and the highest 97°. Further eastward the summers are warmer and the winters are colder, but bright, dry weather is the rule. In the prairie country the winters are at times very cold, but the air being dry, a temperature of −20° causes no inconvenience to ordinary daily avocations, and early in May the prairies are carpeted with flowers.

MR. L. H. MURDOCH describes (*Monthly Weather Review*, October, 1902, vol. xxx. No. 10) some interesting facts relative to the variation of precipitation at Salt Lake City, the water-level of the Great Salt Lake and some rainfall records from other localities in the States. The curves which he gives in the paper show a good agreement between the variation of the rainfall and the level of the lake, which led him to deduce that from 1827 to 1864 there was a dry cycle, from 1865 to 1886 a wet cycle, and from 1887 to the present time another dry cycle. To investigate the universality of these dry and wet periods he examined several American stations of about the same latitude. He found that the country west of the Rocky Mountains had its wettest cycle from 1866 to 1887, while the middle Mississippi and Ohio valleys had their heaviest precipitation from 1840 to 1859; thus, while the central portion of the country was receiving abundant rainfall, the west of the Rocky Mountains experienced "the longest dry cycle of which we have any record." At the present time, from San Francisco to Baltimore a dry cycle is in progress, and it is stated that "the past fifteen years have been the driest fifteen consecutive years on record for all the stations named, except Sacramento, and the drought is equally well marked there, but the fifteen years from 1851 to 1865 were a trifle drier." Mr. Murdoch examined the sun-spot curve to see if he could trace any connection between these periods of wetness and dryness, but he found none, years of minimum spots being sometimes excessively wet and sometimes excessively dry, and the same for the years of maximum sun-spots. How long will the present dry cycle continue? he asks, and he points out that a correct answer to this question would be worth millions of dollars to the people of the United States.

IN No. 13 (1902) of the *Annalen der Physik*, Herr Hans Lehmann publishes a list of the wave-lengths of the iron spectrum between λ 6811·30 and λ 8690·98, which should prove a useful standard of reference for wave-lengths in this region. Referring to Sir William Abney's conclusion that there is an upper limit to the spectra of certain metals, which the latter photographed during his experiments on the ultra-red region, Herr Lehmann states that his own experiments tend to confirm this conclusion.

PROF. J. TROWBRIDGE, who has been studying powerful electric discharges from condensers through hydrogen contained in silica-glass vacuum tubes, finds that by using this material for his tubes he can obtain and examine the most intense light yet studied in a laboratory (*Electrical Review*, November 22, 1902). His experiments show that to the eye the light of hydrogen appears to give a continuous spectrum, though photography reveals many bright and dark lines in the ultra-violet. Prof. Trowbridge considers that his results have an important bearing upon theories of the nature and constitution of stars and of the sun's spectrum, and that they open a new field in spectrum analysis.

AT Brescia in September, 1902, the Seismological Society of Italy held its first congress. An account of the proceedings, which extended over five days, and were largely devoted to seismometry, the Society publishes in its *Bulletin*, Nos. 4 and 5, vol. viii. One important discussion referred to the rate at which recording surfaces should be moved. Experience suggests that the speed to be adopted depends very largely upon the character of the earthquakes which are being studied. With earthquakes of local origin, waves with a period of 1/20 or 1/10 of a second may occur, whilst earthquakes of distant origin consist of waves which vary in period from 5 to 60 seconds. To obtain an open diagram of the former, the speed required for the recording surface should be so very much higher than for the latter that it would seem necessary to employ different types of apparatus for different types of earthquakes. Other discussions related to the form of unfelt seismic waves, modifications of the Rossi-Forel scale, the probable value of continuous determinations of the value of g in the vicinity of volcanoes, the establishment of a magnetic observatory in Sestola, to seismic periodicities and to other subjects. Many instruments and diagrams were exhibited, and under its able president, Prof. Pietro Tacchini, the Society is to be congratulated on the encouragement it has given to seismic research.

WE have received a paper by Father Algué, S.J., director of the Philippine Weather Bureau, on ground temperature observations at Manila. Underground temperatures have been regularly observed in Manila since the year 1895, with four thermometers placed 59·06 in., 29·53 in., 17·72 in. and 13·78 in. below the surface of the ground, and more recently three more have been added at depths of 9·84 in., 19·68 in.

and 39·38 in. Discussing the temperatures at 19·68 in. and 39·38 in. in detail, Father Algué finds that at the former depth the minimum of the year falls in December and the maximum in May; the minimum of the day occurs at 6 a.m., a secondary minimum at noon, and the maximum about 10 a.m. The daily range varies from about 6° C. in April to about 3° C. in the coldest months of the year; temperature is nearly constant from midnight to 6 a.m. At a depth of 39·38 in. the minimum temperature usually falls in December and the maximum in May; a large oscillation takes place from about 6 a.m. to 10 a.m., followed by a slight descent until 11 a.m.; from January to May temperature remains low to about 4 p.m., rises slightly until 5 p.m., and then remains steady all night until 6 a.m.

THE affective quality of auditory rhythm is the subject of a paper by Mr. Robert MacDougall in the *Psychological Review* for January, which deals more particularly with the external conditions of pleasurable or painful feeling in rhythm. Mr. MacDougall considers that the qualities of a rhythmical sequence which render it gay or restful are not attributable to secondary associations, but to the rhythm itself, and in particular to a relation of agreement between the rate of the rhythm and the prevailing mood of the observer. Variations in intensity of the rhythmical element are much less marked in their effect than variations of tempo. In regard to the proportion between the lengths of the various elements within the rhythm, it is found that those forms are the most pleasing in which the accentuated element is lengthened (as is commonly done in the recital of music or poetry), but a marked difference exists between trochaic and dactylic forms. In the former, equality of the two elements is the least pleasing form, while inverted types in which the unaccented element is lengthened have a peculiar character of their own which produces an agreeable sensation. In the dactylic form, the inversion of the intervals so as to give greater length to the unaccented element produces a more displeasing effect than absolute uniformity. The feeling of monotony when a rhythm is repeated is attributed to the tendency to differentiate between successive groups, and to combine them into larger rhythmical unities. The pleasure derived from pure rhythm is more marked in music than in poetry, where its continuity is continually interrupted by the stream of images aroused by the articulate sounds which support it.

MR. W. R. OGILVIE GRANT, of the Natural History Museum, has started on a collecting expedition to the Azores. Such an excellent all-round collector ought to obtain many novelties.

THE case of "recent additions" in the central hall of the British Natural History Museum contains an interesting series illustrative of burrowing animals. The exhibit at present includes a number of mammals, such as the common mole, star-nosed mole, golden moles, sand-moles, naked sand-rat, marsupial mole and duckbill, together with various burrowing snakes, beetles, molluscs, &c., as well as one species of bird.

IN *Naturwissenschaftliche Wochenschrift* of February 8 Dr. von Linden concludes his paper on the markings of animals, making special reference to the effects of change of temperature on those of the Lepidoptera, and pointing out that by means of such variations what are practically new species may be artificially produced.

IN the course of the second part of his article on the nests of bees, published in the *Biologisches Centralblatt* of February 1, Dr. von Buttel-Reepen publishes a phylogenetic table of the Apidæ, in which the honey-bees (Apinæ) and the stingless bees (Meliponinæ) are regarded as forming diverging branches from the ancestral humble-bees (Bombinæ).

IN response to a suggestion of Prof. Bardeleben, to the effect that a fresh study of the anatomy of generalised types of the different groups of vertebrates could scarcely fail to lead to good results, Dr. H. H. Wilder undertook the detailed examination of the skeleton of the American spotted salamander (*Necturus maculatus*). The result of his work, with numerous illustrations, forms vol. v., No. 9, of the *Memoirs* of the Boston Natural History Society.

IN a note in vol. xxvi. of the *Proceedings* of the U. S. National Museum, Mr. M. W. Lyon records the interesting fact that the females of the American bats formerly known as Atalapha, but now generally termed Lasiurus, are furnished with two pairs of mammæ, and generally produce from three to four young ones at a birth. A photograph of a female of the common North American *L. borealis*, with four young, is reproduced. Later on in the same volume Dr. L. Stejneger records the rediscovery of the *Salamandra quadrimaculata* of Holbrook, which inhabits Georgia and the Carolinas, and is entitled to rank as a distinct species of the genus Desmognathus.

THE *Irish Naturalist* for February records the breeding of that essentially Arctic bird, the red-necked phalarope, in the west of Ireland. In a series of notes on the birds of the Outer Hebrides, published in the *Annals of Scottish Natural History* for 1902 and January, 1903, Mr. J. A. Harvie-Brown adds the same species, together with the lesser tern, the pochard and the scaup-duck to the list of birds breeding in those islands. Mr. Brown mentions that although about 25,000 sea-birds of various kinds are annually killed by the islanders for food, yet this slaughter has no perceptible effect on the numbers of the feathered inhabitants of the islands. On the contrary, fulmar-petrels are steadily on the increase, and annually extending their breeding range.

THE *Emu* for January contains the presidential address of Colonel Legge read before the congress of the Australasian Ornithologists' Union. Reference is made to the good work done by the members of the Union, and especially to the success which has attended their official journal, the *Emu*. It is hoped that before long means may be found of illustrating that periodical, when necessary, with coloured plates. One of the most important papers to which the president referred is Mr. Le Souëf's note on the feathers of the emeu, in which it was pointed out that although the barring characteristic of the nestling plumage usually vanishes in the first year, yet that it occasionally reappears. Regret was expressed that the Tasmanian emeu, which probably belonged to a distinct race, was allowed to be exterminated before its characteristics were described. An excellent plate of a little penguin, with young, on its nest, forms a feature of the January number.

IN a paper on the Coleoptera of Colorado, published in vol. v., No. 3, of the *Bulletin* of the Iowa University, Mr. H. F. Wickham makes the following general remarks:—"The phenomena of distribution in Colorado are of much interest. Within a radius of a few miles we may find assemblages of species representing at least three distinct faunæ. The first, that of the great plains surrounding the mountains, is marked by a great development of wingless or imperfectly winged forms, probably largely invaders from the south, where we may suppose that the arid deserts first made their appearance, and where this characteristic feature is more in evidence among the beetles. . . . Occasionally these forms leave their natural haunts and extend for long

distances up the river valleys. . . . As we enter the timbered country on the higher foot-hills and lower mountain sides, we encounter a fauna which, while not unmixed with species that have come up from the plains, shows a strong affinity to the life about our Great Lakes. Higher still—from about 8000 to 9000 feet—we meet with species of genera still more boreal in their habits. . . . Above timber line the peaks sustain a few beetles which seem to be of Arctic origin, left probably by the retreating ice-sheets of the Glacial period."

IN the January issue of the *Journal of Anatomy and Physiology*, Dr. Tims discusses the evolution of the cheek-teeth of mammals. In the development of the premolar series it is considered that the increase or suppression of the cusps of the cingulum has played a part. The molars appear to have attained complexity by the fusion of two or more simple teeth in the same line. The molars of a rabbit represent a simple type, in which two cones, with their cingulum, have been fused. In most rodents two cones seem to be involved, although in the water-vole four may be united. The two outer cusps on the upper molar of a dog represent two elements united by fusion, and the evolution of the molars of ruminants is believed to run on parallel lines. The author adopts the concrescence theory of dental evolution, so far as it relates to fusion in the molars of cones situated in the same line; but is unable to find evidence of fusion out of this line, and cannot accept the view that cones of two dentitions are represented in the molars.

THE London Stereoscopic Company has sent us a list of cameras, lenses, optical lanterns and other apparatus connected with photography which are offered for sale at greatly reduced prices in order to make room for new articles. Opportunity is thus afforded for obtaining or supplementing a photographic outfit at much less than the usual cost.

THE February number of the *Parents' Review*, the monthly organ of the Parents' National Educational Union, contains two articles treating of two distinct branches of nature-study. The first, on "The Boughs of the Branstock," by Mr. W. G. Collingwood, deals with the pictorial representation of trees in an artistic manner; the second, "A Plain Account of a Kerry Potato-patch," by Miss E. A. Magill, describes certain experiments designed to test what could be done by one individual with the least possible capital in the cultivation of a kitchen garden.

IN pursuing his researches on the emanations from radio-active bodies, M. Henri Becquerel has recognised that the rays given off by polonium are identical with the *Kanalstrahlen* of Goldstein. In the current number of the *Comptes rendus*, M. Becquerel classifies the various rays as follows:—Uranium emits only one kind of radiation, charged with negative electricity and possessing high penetrating power. The emanation from polonium is charged with positive electricity, and is very easily absorbed, whilst the emanation from thorium and radium contains both kinds of rays.

THE additions to the Zoological Society's Gardens during the past week include an Agile Wallaby (*Macropus agilis*), a Brush Turkey (*Talegalla lathami*), a Frilled Lizard (*Chlamydosaurus kingi*) from Australia, presented by Mr. H. W. Fawdon; a Two-spotted Paradoxure (*Nandinia binotata*) from West Africa, presented by Mr. C. W. Wilson; two Red-sided Tits (*Parus varius*), European, presented by Mr. Howard Williams; a Chimpanzee (*Anthropopithecus troglodytes*) from West Africa, three Coquerel's Mouse Lemurs (*Chirogaleus coquereli*) from Madagascar, three Bearded Lizards (*Amphibolurus barbatus*), a Blue-tongued Lizard (*Tiliqua scincoides*) from Australia, two Black-headed Buntings (*Emberiza melanocephala*), European, deposited.

OUR ASTRONOMICAL COLUMN.

PHOTOGRAPHS OF THE NORTH POLAR REGION.—In the February number of the *Bulletin de la Société astronomique de France*, M. Flammarion gives an interesting description, embodying a catalogue of positions and several charts, of a series of photographs of the region surrounding the North Celestial Pole. The article describes the obtaining of the photographs and also shows how they indicate very clearly the movement of the pole among the surrounding stars during short intervals of time. In the catalogue, 356 stars, all within 2° of the dole, are arranged in the order of their North Polar distances on September 3, 1902, and their magnitudes, coordinates and numbers in the Redhill (Carrington's 1857) catalogue of circumpolar stars are also given. The charts show the movement of the pole among these stars during the period 1600 to 2200 A.D., and that Polaris, which is at present No. 129 in the catalogue, will attain its minimum N.P.D. in the year 2104.

A DEVICE FOR OBTAINING GOOD SEEING.—In a paper communicated to the *American Journal of Science* for February, Prof. S. P. Langley describes a novel device which he has found efficient in producing steady images of the sun and stars when observed with the reflector of the Smithsonian Astrophysical Observatory, and he believes that it will have the same effect when used with refractors.

Generally the point aimed at in previous attempts to obtain "good seeing" has been to abolish all air currents in and about the telescope tube, but Prof. Langley has found by experiment that the definition is very little improved when this course is followed. After various experiments at different altitudes he arrived at the conclusion that it is the air within a few hundred yards, or even feet, of the telescope that has the greatest disturbing effect, and he endeavoured to find some method of tranquillising this. The reflector he was using was fed by a coelostat, and he caused the reflected beam to pass through a long three-walled tube which was covered by a canvas tent, so that the contained air was thoroughly well insulated from the variations of temperature and the draughts in the surrounding atmosphere. Very little relief was found as a result of this arrangement, so Prof. Langley tried an experiment of a somewhat paradoxical character, which he found to answer very well. He drew a strong current of air through the inner tube and introduced cross currents by several inlets at various points in the length, thereby thoroughly agitating and mixing the enclosed air. Taking some artificial double stars for his objects, he found that doubles which were blurred and inseparable under the former condition were plainly visible and sharply separated when the air was thus agitated. When the sun was observed under the new conditions it was found that the "boiling" on the limb, which is normally so annoying to the observer, was very nearly abolished. No quantitative results are yet ready for publication, but Prof. Langley has no doubts as to the general advantages to be obtained from the application of his method.

PROPER MOTION OF THE SUN COMPARED WITH STELLAR VELOCITIES.—In a paper communicated to Section A of the American Association for the Advancement of Science, Profs. Frost and Adams, of Yerkes Observatory, give the results they have obtained, using the Bruce spectroscope, of the radial velocities of twenty stars having spectra of the Orion type. The table of radial velocities included in the paper shows that of all the stars considered, those between 3 hours and 7 hours R.A. have a positive motion, *i.e.* they are receding, whilst those in the opposite region of the heavens, 16 hours to 20 hours R.A., have a negative motion, *i.e.* they are approaching. This difference is chiefly due to the velocity of the proper motion of the sun, and if the amount of this motion be subtracted from the values obtained, the remaining proper motions of the stars are very small, scarcely any of them having such great velocities as that of the sun.

DISCOVERY OF ANCIENT ASTRONOMICAL RECORDS.—During Prof. Hilprecht's excavations at Nippur, a library, which it is estimated contains 150,000 tablets, has been discovered. Many of the tablets refer to ancient astronomical records, and it is expected that when these are finally translated, some remarkable facts concerning the state of astronomical knowledge during the period about 2300 B.C. will be disclosed.

ANIMAL THERMOSTAT.[1]

A THERMOSTAT is an apparatus, or instrument, for automatically maintaining a constant temperature in a space, or a piece of solid or fluid matter with varying temperatures in the surrounding matter.

Where and of what character is the thermostat by which the temperature of the human body is kept at about 98°·4 Fahrenheit? It has long been known that the source of heat drawn upon by this thermostat is the combination of food with oxygen, when the surrounding temperature is below that of the body. The discovery worked out by Lavoisier, Laplace and Magnus still holds good, that the place of the combination is chiefly in tissues surrounding minute tubes through which blood circulates through all parts of the body, and not mainly in the place where the furnace is stoked by the introduction of food, in the shape of chyle, into the circulation, nor in the lungs where oxygen is absorbed into the blood. It is possible, however, that the controlling mechanism by which the temperature is kept to 98°·4 may be in the central parts, about, or in, the pumping station (the heart); but it may seem more probable that it is directly effective in the tissues or small blood-vessels in which the combination of oxygen with food takes place.

But how does the thermostat act when the surrounding temperature is anything above 98°·4 and the atmosphere saturated with moisture so that perspiration could not evaporate from the surface? If the breath goes out at the temperature of the body and contains carbonic acid, what becomes of the heat of combustion of the carbon thus taken from the food? It seems as if a large surplus of heat must somehow be carried out by the breath: because heat is being conducted in from without across the skin all over the body; and the food and drink we may suppose to be at the surrounding temperature when taken into the body.

Much is wanted in the way of experiment and observation to test the average temperature of healthy persons living in a thoroughly moist atmosphere at temperatures considerably above 98°·4; and to find how much, if at all, it is above 98°·4. Experiments might also, safely, I believe, be tried on healthy persons by keeping them for considerable times in baths at 106° Fahr. with surrounding atmosphere at the same temperature and thoroughly saturated with vapour of water. The temperature of the mouth (as ordinarily taken in medical practice) should be tested every two minutes or so. The temperature and quantity and moisture and carbonic acid of the breath should also be measured as accurately as possible.

P.S., December 5, 1902.—Since the communication of this note, my attention has been called to a most interesting paper by Dr. Adair Crawford in the *Philosophical Transactions* for 1871 ("Hutton's Abridgments," vol. xv. p. 147), "Experiments on the Power that Animals, when placed in certain circumstances, possess of producing Cold." Dr. Crawford's title expresses perfectly the question to which I desired to call the attention of the British Association; and, as contributions towards answering it, he describes some very important discoveries by experiment in the following passage, which I quote from his paper:—

"The following experiments were made with a view to determine with greater certainty the causes of the refrigeration in the above instances. To discover whether the cold produced by a living animal placed in air hotter than its body be not greater than what would be produced by an equal mass of inanimate matter, Dr. Crawford took a living and a dead frog, equally moist, and of nearly the same bulk, the former of which was at 67°, the latter at 68°, and laid them on flannel in air which had been raised to 106°. In the course of twenty-five minutes, the order of heating was as annexed.[3]

Min.	Air	Dead Frog	Living Frog
	°	°	°
In 1	—	70½	67½
,, 2	102	72	68
,, 3	100	72½	69½
,, 4	100	73	70
,, 25	95	81¼	78¼

"The thermometer being introduced into the stomach, the internal heat of the animals was found to be the same with that at the surface. Hence it appears that the living frog acquired heat more slowly than the dead one. Its vital powers must therefore have been active in the generation of cold.

"To determine whether the cold produced in this instance depended solely on the evaporation from the surface, increased by the energy of the vital principle, a living and dead frog were taken at 75° and were immersed in water at 98°, the living frog being placed in such a situation as not to interrupt respiration.[1]

Min.	Dead Frog	Living Frog
	°	°
In 1	85	81
,, 2	88½	85
,, 3	90½	87
,, 5	91½	89
,, 6	91½	89
,, 8	91½	89

"These experiments prove that living frogs have the faculty of resisting heat, or producing cold, when immersed in warm water; and the experiments of Dr. Fordyce prove that the human body has the same power in a moist as well as in a dry air; it is therefore highly probable that this power does not depend solely on evaporation.

"It may not be improper here to observe that healthy frogs in an atmosphere above 70° keep themselves at a lower temperature than the external air, but are warmer internally than at the surface of their bodies; for when the air was 77°, a frog was found to be 68°, the thermometer being placed in contact with the skin; but when the thermometer was introduced into the stomach, it rose to 70½°. It may also be proper to mention that an animal of the same species placed in water at 61° was found to be nearly 61¼° at the surface, and internally it was 66½°. These observations are meant to extend only to frogs living in air or water at the common temperature of the atmosphere in summer. They do not hold with respect to those animals when plunged suddenly into a warm medium, as in the preceding experiments.

"To determine whether animals also have the power of producing cold when surrounded with water above the standard of their natural heat, a dog at 102° was immersed in water at 114°, the thermometer being closely applied to the skin under the axilla, and so much of his head being uncovered as to allow him a free respiration.

In 5 minutes	the dog was 108°,	water 112°	
,, 6 ,,	,, 109°,	,, 112	
,, 11 ,,	,, 108°,	,, 112,	the respiration having become very rapid.
,, 13 ,,	,, 108°,	,, 112,	the respiration being still more rapid.
,, 30 ,,	,, 109°,	,, 112,	the animal then in a very languid state.

"Small quantities of blood being drawn from the femoral artery, and from a contiguous vein, the temperature did not seem to be much increased above the natural standard, and the sensible heat of the former appeared to be nearly the same with that of the latter.

"In this experiment a remarkable change was produced in the appearance of the venous blood; for it is well known that in the natural state the colour of the venous blood is a dark red, that of the arterial being light and florid; but after the animal, in the experiment in question, had been immersed in warm water for half an hour, the venous blood assumed very nearly the hue of the arterial, and resembled it so much in appearance that it was difficult to distinguish between them. It is proper to observe that the animal which was the subject of this experiment had been previously weakened by losing a considerable quantity of blood a few days before. When the experiment was repeated with dogs which had not suffered a similar evacuation, the change in the colour of the venous blood was more gradual; but in every instance in which the trial was made, and it was repeated six times, the alteration was so remarkable that the blood which was taken in the warm bath could readily be distinguished from that which had been taken from the same vein

[1] By Lord Kelvin. Read before Section A of the British Association, Belfast, 1902.

[2] Observations by Governor Ellis in 1758; teachings of Dr. Cullen prior to 1765; very daring and important experiments by Dr. Fordyce on himself in heated rooms, communicated to the Royal Society of London in 1774.

[3] In the two following experiments, the thermometers were placed in contact with the skin of the animals under the axillæ.—ORIG.

[1] In the above experiment, the water, by the cold frogs and by the agitation which it suffered during their immersion, was reduced nearly to 91½°.—ORIG.

before immersion by those who were unacquainted with the motives or circumstances of the experiment.

"To discover whether a similar change would be produced in the colour of the venous blood in hot air, a dog at 102° was placed in air at 134°. In ten minutes the temperature of the dog was 104½°, that of the air being 130°. In fifteen minutes the dog was 106°, the air 130°. A small quantity of blood was then taken from the jugular vein, the colour of which was sensibly altered, being much lighter than in the natural state. The effect produced by external heat on the colour of the venous blood seems to confirm the following opinion, which was first suggested by my worthy and ingenious friend, Mr. Wilson, of Glasgow. Admitting that the sensible heat of animals depends on the separation of absolute heat from the blood by means of its union with the phlogistic principle in the minute vessels, may there not be a certain temperature at which that fluid is no longer capable of combining with phlogiston, and at which it must of course cease to give off heat? It was partly with a view to investigate the truth of this opinion that Dr. Crawford was led to make the experiments recited above."

These views of Dr. Crawford and "his worthy and ingenious friend, Mr. Wilson,[1] of Glasgow," express, about as well as it was possible to express before the chemical discoveries of carbonic acid and oxygen, the now well-known truth that oxygen carried along with, but not chemically combined with, food in the arteries, combines with the carried food in the capillaries or surrounding tissues in the outlying regions and yields carbonic acid to the returning venous blood, this carbonic acid giving the venous blood its darker colour, and being ultimately rejected from the blood and from the body through the lungs, and carried away in the breath. Crawford's very important discovery that the venous blood of a dog which had been kept for some time in a hot-water bath at 112° Fahr. was almost undistinguishable from its arterial blood proves that it contained much less than the normal amount of carbonic acid, and that it may even have contained no carbonic acid at all. Chemical analysis of the breath in the circumstances would be most interesting; and it is to be hoped that this chemical experiment will be tried, not only on dogs, but on men. It seems, indeed, with our present want of experimental knowledge of animal thermodynamics, and with such knowledge as we have of physical thermodynamics, that the breath of an animal kept for a considerable time in a hot-water bath above the natural temperature of its body may be found to contain no carbonic acid at all. But even this would not explain the *generation of cold* which Dr. Crawford so clearly and pertinaciously pointed out. Very careful experimenting ought to be performed to ascertain whether or not there is a surplus of oxygen in the breath; more oxygen breathed out than taken in. If this is found to be the case, the *animal cold* would be explained by deoxidation (unburning) of matter within the body. If this matter is wholly or partly water, free hydrogen might be found in the breath; or the hydrogen of water left by oxygen might be disposed of in the body, in less highly oxygenated compounds than those existing when animal heat is wanted for keeping up the temperature of the body, or when the body is dynamically doing work.

BACTERIAL TREATMENT OF CRUDE SEWAGE.

THE fourth report on the experimental treatment of crude sewage in settling tanks and coke-beds has just been made public by the London County Council.[2] The work under notice was commenced in April, 1898, at the Barking and Crossness outfall works, where the sewage of the County of London and of certain neighbouring districts is discharged into the lower Thames.

The plan of experiment was suggested by the chemical adviser to the Council, and has been carried out under his direction and supervision, with the cooperation of the chemists and superintendents at the outfalls. A very small fraction of the sewage only has been thus treated, but in quality it has fairly represented the immense volume which arrives continuously from the sewer system of the metropolitan area. The results which are summarised in the report may therefore be looked upon as representative, and the conclusions and recommendations which have been founded upon them may be considered to be reasonably applicable to the entire metropolitan sewage discharge. The report gives a general *résumé* of the four years' experimental work, which has now led to results of so satisfactory a nature that the tentative treatment has been discontinued with the view of making a commencement of work on the large scale.

The early experiments were carried out with crude sewage, which had only been screened from its grosser suspended matters. This was allowed to flow into tanks filled with fragments of hard coke of uniform size. As soon as this bed was filled to the surface of the coke, the sewage was allowed to remain at rest for two or three hours and was then drained off from below. After the coke had remained for about five hours with air in the interstices, a second quantity of sewage was allowed to flow in as before. This cycle of processes was repeated for many months, and in some later experiments for more than a year.

The sewage was clarified by this treatment, but no purification from dissolved organic matter occurred in the early stages with a new bed. After the bed had been at work for about a week, however, it gradually began to effect a marked purification of the sewage from its dissolved putrescible matter. After two or three weeks, the contact of the sewage with the coke effected a removal of from 50 to 60 per cent. of the dissolved putrescible matter. This degree of purification was steadily maintained when the bed had been once "matured," and the effluent sewage was found to be non-putrescible even when it was maintained at summer-heat (80° F.) in an incubator. Hence the oxidisable organic matter which remained in the effluent was not such as would lead to offence when the effluent was discharged into an ordinary watercourse.

The treatment of the crude sewage, as judged by chemical criteria, was therefore successful. Dr. Houston, however, stated that, bacteriologically considered, this effluent was not appreciably better than the clear untreated sewage. But this he considered to be unimportant in the case of an effluent which was discharged into the muddy and brackish lower river, the water from which could never be used for drinking purposes.

A more serious difficulty, however, was soon encountered. It became necessary to ascertain what was the working sewage capacity of the coke-bed, in order to be able to state what area of land would be required to be laid down in coke-beds for the treatment of the whole of the London sewage. On gauging at frequent intervals the sewage capacity of a bed, it was found that the capacity decreased at a uniform and rapid rate, and that after use for about two years the bed would become practically choked and unable to receive its supply of sewage.

An examination of the coke surfaces showed that a gelatinous growth had formed upon them; this proved to be bacterial in nature, and necessary for producing the purifying effect. It was found, however, that this growth was impregnated with a certain amount of grit, evidently road detritus, and that woody fibre from the wood pavements and chaff and straw fragments from the horse droppings in the streets were also present in some quantity. It appeared that the gelatinous bacterial growth was a normal and necessary result and was definite in amount, but that the other matters derived from the street traffic accumulated on the coke and reduced the sewage capacity of the bed at an almost uniform rate.

Experiments on the preliminary sedimentation of the sewage were made by allowing it to flow through troughs and tanks on its way to the bed, and they proved that the gritty and cellulose matters could be almost completely separated from the sewage before it reached the coke-bed, and that this could be effected without allowing the comminuted fæcal matter to settle in any large degree. The matter thus separated by subsidence could be dried and in large part consumed in a destructor, the mineral portion being left as a useful clinker. The sedimented sewage was found to undergo satisfactory purification in the coke-bed without diminishing its sewage capacity.

It was evident that coke-beds must not be allowed to receive mineral detritus from the wear and tear of the roads, and that the cellulose matters derived from the roads were equally objectionable since they were not removed by bacterial action in the coke-bed as

[1] Who, no doubt, was Dr. Alex. Wilson, first professor of astronomy in the University of Glasgow (1760-1784); best known now for his ingenious views regarding sun-spots.

[2] "Bacterial Treatment of Sewage." Fourth Report by Dr. Clowes. Published for the County Council by P. S. King and Son, 2, Great Smith Street, Westminster.)

rapidly as they were introduced by the sewage. But both the grit and the cellulose matters could be separated by sedimentation; and the cellulose matters might, according to modern research, be slowly resolved by the action of suitable bacteria, if such could be established. Accordingly, it was arranged that the crude sewage should undergo a preliminary settlement in a deep tank, where the sediment should remain undisturbed in the hope that bacterial resolution of the organic matters in the deposit might occur.

This settling or so-called "septic" tank was found after a time to effect the resolution of the cellulose matters most satisfactorily, the necessary bacteria being evidently contained in the sewage. The amount of sediment which should have been found at the bottom of the tank was estimated by carefully gauging the volume of sewage which passed through the tank in the course of six months and determining the amount of suspended matter which the sewage contained. When the actual amount of sediment present in the tank at the end of this period was measured, it was found to correspond to about 50 per cent. of the total quantity introduced, and the sediment which remained consisted largely of the grit which had not been previously separated. It was therefore possible to dispose of the troublesome cellulose matter by long-maintained bacterial action in the settling tank, and to prevent it from clogging the coke-beds.

The final experimental stage consisted in passing the screened crude sewage through a settling tank, which was of such capacity that the sewage required five hours to pass through it and was so arranged that the sediment was undisturbed by the flow. The effluent from this tank was received successively in a series of coke-beds, in which it was treated in the way already described. After two hours' contact with the coke, it issued as an inoffensive and non-putrescible effluent which readily maintained the life of fish. The sediment in the settling tank was left entirely undisturbed. As soon as it had become permeated with its suitable bacteria, more than 50 per cent. of it was resolved into gaseous and soluble substances, and it was certain that a preliminary sedimentation of the grit must have further increased this percentage.

The sewage capacity of the coke-bed, on the other hand, was carefully gauged at intervals. It was found that the capacity diminished during the formation of the bacterial growth upon the coke surfaces, and that when this was complete the capacity of the bed was about 30 per cent. of the whole space which had been filled with coke and with sewage. No permanent alteration in capacity occurred during many months, although the capacity temporarily rose or fell by a few units per cent. from the average.

It appeared, therefore, that the above method of treatment was applicable to London sewage and that it might now be applied on the large scale. The experimental work was accordingly suspended, and the conclusions arrived at were stated and recommendations were framed in the following words:—

"*Conclusions arrived at by the Experimental Treatment.*

"(1) That by suitable continuous undisturbed sedimentation the raw sewage is deprived of matter which would choke the coke-beds, and the sludge which settles ou is reduced in amount by bacterial action to a very considerable extent. This reduction might undoubtedly be increased by the preliminary removal of road detritus.

"(2) That the coke-beds, after they have developed their full purifying power by use, have an average sewage capacity of about 30 per cent. of the whole space which has been filled with coke.

"(3) That the sewage capacity of the coke-bed, when the bed is fed with settled sewage, fluctuates slightly, but undergoes no permanent reduction. The bed does not choke, and its purifying power undergoes steady improvement for some time.

"(4) That coke of suitable quality does not disintegrate during use.

"(5) That the 'bacterial effluent' of settled sewage from the coke-beds does not undergo offensive putrefaction at all even in summer heat, and can never become offensive. That this effluent satisfactorily supports the respiration of fish.

"(6) That the use of chemicals is quite unnecessary under any circumstances when the above method of treatment is adopted.

"*Recommendations founded on the above Conclusions.*

"It would appear desirable, therefore, without delay, to commence the treatment of the London sewage by the above bacterial method. The construction of the necessary works will take time and will involve expenditure, but unless it is taken in hand, all considerations tend to show that owing to the increased abstraction of water by the water companies, both at their existing intakes and at the newly constructed reservoirs for storm water at Staines, a large portion of the lower river will continuously deteriorate. This deterioration would arise from the increase in the amount of the discharge of sewage effluent and the decrease in the upper river flush. Possible trouble arising from these causes will be absolutely prevented by adopting, under proper conditions and on a large scale, the treatment which has been strikingly successful on the experimental scale. It must be remembered that the condition of the river cannot be improved by any suddenly adopted action.

"If the treatment is introduced without delay and is gradually extended it may reasonably be expected that the increasing deterioration in the lower river water will first be checked and will ultimately be prevented; while the gradual development of the treatment will cause the expenditure to be spread over a period of years, and will prevent it from being unduly burdensome.

"It must be remembered that the present settling channels would serve, as at present, for settling purposes, but by the altered method of working them they would also act as sludge destroyers. They should, however, undoubtedly be preceded by grit chambers.

"It must be further borne in mind that the expense involved in the purchase and application of chemicals would be dispensed with."

Other conclusions, which were incidentally arrived at during the above experimental work, may be mentioned. The material used for filling the bacteria bed seems to exert no considerable influence on the purification obtained; coke proved to be the most efficient, ragstone containing calcium carbonate was less efficient, but the difference in efficiency was not of serious amount.

The depth of the coke-bed did not materially affect its efficiency between the limits tried, which ranged from four feet to twelve feet. In the interspaces of the coke, even in the deepest bed, a satisfactory proportion of oxygen was present in the air; the bed was able to aërate itself without mechanical aid.

The amount of sewage dealt with satisfactorily by the system of intermittent filling of the coke-bed described above was greater than that which could be similarly purified by a continuous supply furnished by sprinkling or by other methods of distribution.

The report concludes with detailed information concerning the bacterial treatment of their sewage by the authorities in forty-eight of the principal centres of population in this country. This information has been supplied by the responsible officers from the centres concerned and has been brought up to date of April 30, 1902.

A consideration of this information in conjunction with that supplied concerning the London experimental work will probably be felt to justify the opinion "that the process (of bacterial treatment of sewage) has been uniformly successful when the construction and use of the necessary plant has been reasonably and properly carried out," and that the metropolis may now safely adopt this "natural" method of sewage disposal.

FRANK CLOWES.

SILICA GLASS.

A FEW weeks ago we described some of the excellent results obtained by Messrs. Heraeus, of Hanau, in their attempts to produce apparatus of "silica glass," and Prof. Dewar has added point to our remarks by exhibiting at the Royal Institution a "liquid air holder" made of silica, which had been made to order and sent by return of post, almost, from Hanau to London a few days before. Similar apparatus could have been made in England, it is true, but it could not have been produced by any means so quickly as at Hanau. Now we receive from America an account of an animated discussion on the subject of "silica glass" which lately took place at a meeting of the American Electrochemical Society at Niagara Falls on the occasion of the reading of a paper, by Mr. R. S. Hutton, of Manchester, on his method of casting silica tubes in the electric furnace, which shows that our American cousins

are as fully aware of the importance of this subject as our German competitors.

Truly, as Prof. Dewar said the other evening, there will soon be another "lost industry" if our practical men do not wake up. Silica glass making as an industry no doubt is still in earliest infancy, but though so young, it already shows signs of growth. But, alas! whilst two years ago England was first in this matter and the rest of the world, almost, nowhere, already England is only second, and is standing still, whilst Germany is first, and is going forward.

Everyone who has worked with silica, and knows its properties and how comparatively easy it is to work with, foresees that soon silica glass will replace ordinary glass in many of its most important applications, and yet though the foundations of the coming new industry were laid in this country, none of our manufacturers has been willing to take the small risks and trouble involved in an attempt to carry out in the workshop, and with electric furnaces, the new processes, or modifications of them, which have been worked out in the laboratories and placed at their disposal by the experimenters. It is true that owing to the initiative of one firm—Messrs. Baird and Tatlock—silica glass made by Mr. Shenstone's oxyhydrogen flame—or laboratory—process has for some time been available in this country. But can it be supposed that this essentially laboratory process is the last word of science, or of workshop practice, on this subject, or is likely to hold the field permanently, except for work on the small scale.

It is still fresh in our memories how the makers of optical glass waited until German manufacturers, aided by German men of science, had revolutionised and captured their industry. Unless something is done at once by the combined action of our men of science and manufacturers, history will repeat itself in the case of this new material.

SIR WILLIAM HOOKER'S SCIENTIFIC WORK.

SIR JOSEPH HOOKER contributes to the January number of the *Annals of Botany* a sketch of the life and labours of his father, Sir William Jackson Hooker, accompanied by a portrait. Sir William Hooker was born at Norwich on July 6, 1785, and in due course attended the Norwich Grammar School, but little is known of the progress he made there, though his son tells us that at home he devoted himself to entomology, drawing, and reading books of travel and natural history. Early in life he became interested in ornithology. That his entomological pursuits were, when still in his teens, appreciated by the veteran Kirby is evidenced by the latter having, in 1805, dedicated to him and his brother a species of Apion. The first evidence of his having taken up botany is the fact that he was the discoverer in Britain, in 1805, of *Buxbaumia aphylla*. His first published paper, entitled "Musci Nepalenses," was read before the Linnean Society in June, 1807. In 1809, following the suggestion of Sir Joseph Banks, Hooker visited Iceland, and in 1813 his "Journal of a Tour in Iceland" was published, though it had been privately circulated in 1811. In 1816 he produced the first part of a work entitled "Plantæ Cryptogamicae, quae in plaga orbis novi Aequinoctialis colligerunt Alex. von Humboldt et Aimat Bonpland." The first volume of "Musci Exotici" appeared in 1818 and the second in 1820. Hooker was in 1820 appointed professor of botany at Glasgow University, and remained there until 1841, when he was appointed director of the Botanic Gardens at Kew. At Glasgow he met with the greatest success, and his herbarium and library before he had been there ten years were reckoned as amongst the richest private ones in Europe, and botanists of every nationality repeatedly visited them. The scientific works published during the Glasgow period were very numerous, and Sir J. D. Hooker gives a list of them in an appendix. The directorship at Kew Gardens was held by Sir William for twenty-four years, until his death on August 12, 1865. From 1855 he was assisted by his son, Sir Joseph Hooker, who was in that year appointed assistant director. Such are a few of the many incidents in an exceedingly busy life. Sir Joseph Hooker has conferred a favour upon men of science by bringing together, in convenient compass, the leading facts of an illustrious career.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. E. J. Routh, F.R.S., has been appointed a governor of Dulwich College, and Dr. E. W. Hobson, F.R.S., a governor of Derby School.

The special board for moral science propose that, in view of the progress of the department of experimental psychology under Dr. Rivers, an annual grant of 50*l.* shall be made towards the expenses of the department, and a special grant of 50*l.* for apparatus.

Mr. W. L. Mollison, Clare, has been appointed an elector to the Plumian professorship of astronomy; Dr. J. Larmor, F.R.S., has been appointed an elector to the same professorship, and to the Isaac Newton studentship; Prof. H. B. Dixon, F.R.S., of Manchester, an elector to the Jacksonian professorship of natural philosophy; Prof. H. A. Miers, F.R.S., of Oxford, an elector to the chair of mineralogy; and Dr. R. T. Glazebrook, F.R.S., an elector to the Cavendish professorship of experimental physics.

IT is announced in the *Globe* of February 21 that a commission has been appointed in Pretoria to inquire what steps can be taken for the creation of an institution to form part of a teaching university to provide the highest training in the arts and sciences connected with mining and other industries.

TWO Pfeiffer scholarships in science, each of the annual value of 48*l.*, and tenable for three years at Bedford College for Women, will be offered for competition in June, 1903. Two Deccan scholarships, offered by Mrs. Thomson, of Poona, Bombay, of the value of 50*l.* each per annum for three years, will also be awarded.

THE principal of the Northampton Institute, London, Dr. R. Mullineux Walmsley, is being sent on a three months' tour to the United States and Canada for the purpose of investigating the present position of technical education in those countries and its bearings upon industrial production in the subjects covered by the technological work of the Institute, but more especially in the engineering industries.

A STATUTE enacting that persons who have passed the Abiturienten examination at a gymnasium in Germany, Austro-Hungary or Switzerland shall be exempt from Responsions and from the examination in an additional subject at Responsions at the University of Oxford was presented to a congregation of the University on February 17. The preamble of the statute was approved by congregation on February 3, and as no amendment had been proposed, the statute was submitted and approved.

SIR WILLIAM ABNEY, K.C.B., F.R.S., has accepted the post of adviser to the Board of Education in matters connected with science, upon his retirement from the post of principal assistant secretary to the South Kensington branch of the Board on April 1 next. It has been decided from that date to organise a division of the staff of the Board for matters connected with technology and higher education in science and art. The President has appointed Mr. Grant Ogilvie (at present the director of the Edinburgh Museum of Science and Art under the Scottish Education Department) to be a principal assistant secretary of the Board in charge of this division as from April 1 next. The Hon. W. N. Bruce, assistant secretary of the Board, is to be promoted on that date to be principal assistant secretary in charge of another division of the Board, which will be organised to deal with secondary schools.

THE council of the Association of Technical Institutions, after consultation with the London Members of Parliament, has adopted resolutions urging that it is of importance that an Education Bill for London should be passed into law during the present session; that there should be but one education authority for London for all grades of education, and such authority should be the London County Council, acting through an education committee constituted by statute; that a majority of this committee should be appointed by and out of the Council, and be so chosen that there shall be at least one County Council member from the City of London and from each metropolitan borough; and the committee should also include one person nominated by

the City Corporation, persons having experience in education and knowledge of local educational requirements, and persons to be appointed by the County Council on the nomination of certain suggested educational bodies to be specified in the Bill, among which are the University of London; the City and Guilds of London Institute; the trustees of the City Parochial Foundation; the Association of Technical Institutions; the Society of Arts; the London Chamber of Commerce; and five educational associations; that it is undesirable that there should be any delegation by the authority to such borough committees of powers with regard to education other than elementary.

AT the third yearly meeting of the Court of Governors of the University of Birmingham, held on February 18, the principal, Sir Oliver Lodge, referring to the work of the past session, said the University was now recognised by the Board of Education as an inspecting agency for secondary schools in the midland district, and they wanted to inaugurate a new system of examination and inspection, as thereby they could do much good and could help the new education authority not only in the city, but in the neighbouring counties. No doubt some of those present were, or would be, connected with the education authorities in the surrounding districts, and he would say to them, "do not start new training colleges of your own detached from places of learning." At conferences which he had attended at Cambridge and Oxford, at which headmasters and educational workers from all parts of England were present, the opinion was unanimously expressed that teachers should be trained along with men preparing for other professions; that they should rub shoulders with professors and teachers not only in their own subjects, but in all subjects. He should like all teachers to train themselves to some extent both in science and in art. At the British Association, which would meet in September in Lancashire, Sir Norman Lockyer intended to devote a great part of his address to the duty of the State, and of England generally, in undertaking on a totally new and enlarged scale this vital subject to the future of this country. The University ought to take its share in the reorganisation of secondary education. Some secondary authorities were jealous of having university representatives upon them, but they did not want to be there to look after the interests of the university which they represented, but to act as experts, as advisers, not as controllers. If only they could get as professor of education a man of the right type, they might hope to train teachers and influence the youth of England by their means—to train them, he hoped, not in arts alone, nor in science alone, but in originality of thought and fertility of ideas generally.

THE trustees of the Carnegie Trust for the Universities of Scotland met on Monday to receive the annual report and the scheme of endowment of post-graduate study and research drawn up by the executive committee. The *Times* summary of the report is here abridged. The report stated that there was a natural desire on the part of the universities that under the head of teaching the committee should assign a portion of the annual grants to be used as income. In certain cases of extreme urgency such grants had been given, but they had been limited, both in regard to amount and to the time for which they were payable. It was considered inadvisable to commit the committee to permanent obligations in this direction. Further, the committee considered that in the long run its plan would prove the best for the universities. The scheme adopted, besides making a contribution of 100,000*l.* to the buildings and permanent equipment, and of 20,000*l.* to libraries, would at the close of the period of five years have increased the resources for teaching in the four universities by permanent endowments amounting to 70,500*l.*, while it would at the same time have made during those five years an addition of 1900*l.* a year to the income of two of them. With regard to the endowment of post-graduate study and research, the committee decided that scholarships, fellowships, and grants might with advantage be instituted, but that for many reasons it was not desirable to allot definite sums, or offer separate endowments, to individual universities and institutions. A common scheme had, therefore, been established, the administration of which would be retained in the committee's own hands. It was held that in no other way could the full advantage of this most important branch of the work of the Trust be adequately secured; and the committee regarded it as essential that those who were to profit by the opportunities offered for higher study and research should be the best the universities of Scotland could produce, and their work of the high character which alone was consistent with the intention of the founder. The nominations and applications under this scheme would be referred to an advisory board, consisting of the chairman, the four representatives of the universities and three other members of the Trust. There had been paid by the Trust for the summer session, 1902, the sum of 11,976*l.* 13*s.* on behalf of 1595 students, representing the fees of 4522 classes; and for the winter session, 1902-3, the sum of 28,275*l.* 5*s.* on behalf of 2867 students, representing the fees of 8806 classes—in all, for the year to December 31, 1902, 40,251*l.* 18*s.*

SCIENTIFIC SERIAL.

Journal of Botany, February.—A third contribution of occasional notes on freshwater algæ, which begins in this month's number, is presented by Mr. W. West and Mr. G. S. West. It represents mainly new British forms which have come under observation during the past two years. Several Chantransia and Lemanea forms, originally described by the late Prof. Sirodot, have been obtained in rapid streams in Yorkshire, Cornwall and Westmorland. To the Phæophyceæ are added *Phaeococcus paludosus*, and a new monotypic genus Phæosphæra. The more important additions to the Chlorophyceæ are *Uronema confervicolum*, *Pseudochaete gracilis* (a new genus), *Roya cambrica* and *Debarya desmidioides*. The last-mentioned is regarded by the authors as constituting a connecting link between the Desmidiaceæ and the Zygnemaceæ, since the filaments break up into individual cells, and conjugation occurs only between a pair of such isolated cells.—Continuing his remarks on *Calyptopogon mnioides*, Mr. E. S. Salmon separates this plant from Streptopogon on account of the papillose areolation and the form of the perichætial leaves, and from Barbula on account of the mitriform calyptra. A complete diagnosis, with an illustrative plate, is appended.—Two short lists of local plants are furnished, one referring to the Bournemouth district, by Mr. E. F. Linton, and the other giving new Bristol records, by Mr. J. W. White, in conjunction with Mr. C. Bucknall and Mr. D. Fry.—A series of "Wayfaring Notes from the Transvaal" is instituted by Dr. R. F. Rand, the first of which discusses botanical features to be observed in the neighbourhood of Johannesburg.—Mr. Garry continues his notes on the drawings for "English Botany."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 12.—"On the Negative Variation in the Nerves of Warm-blooded Animals." By Dr. N. H. **Alcock**. Communicated by Dr. A. D. Waller, F.R.S.

The conclusions arrived at are:—

(1) It is possible to examine isolated mammalian and avian nerves under the same conditions as frog's nerves.

(2) There is no essential difference between the nerves of frogs, mammals and birds as regards their negative variation, excitability and reaction to anæsthetics.

(3) There is a marked difference in the extinction point for heat. The negative variation in frog's nerve is abolished at 40°--42° C., in rabbit's nerve at 48°--49°, in pigeon's nerve at 53°.

(4) This extinction point corresponds closely with the first coagulation point of the body proteids, where these are known, and thus coagulation is probably the cause of the permanent loss of irritability of the nerve.

(5) The point at which the nerves are paralysed by cold is $-3°{\cdot}5$ in the frog, $-1°{\cdot}4$ in the hedgehog, $+3°{\cdot}8$ in the rabbit and $+6°{\cdot}9$ in the pigeon.

"Studies in the Morphology of Spore-producing Members. No. V. General Comparison and Conclusion." By Prof. F. O. **Bower**, F.R.S., Regius Professor of Botany in the University of Glasgow.

Geological Society, February 4.—Prof. Charles Lapworth, F.R.S., president, in the chair.—The granite and greisen of Cligga Head (West Cornwall), by Mr. J. B. **Scrivenor.** The small granite-mass between St. Agnes and Perranporth is a remnant of a larger mass which has been partly denuded and partly hidden by a fault; "bedding" is well developed. The granite bordering the bedding-planes has been altered into greisen. Each greisen-band contains a quartz-vein, marking the original fissure along which metasomatism took place; the veins contain tourmaline, cassiterite, wolfram, mispickel and chalcopyrite. Two main reactions appear to have taken place in the formation of the greisen: the felspars affording topaz, muscovite and secondary quartz; the biotite brown tourmaline, magnetite and secondary quartz. The greisen is an example of Prof. Vogt's "pneumatolytic" action in thoroughly acid rocks.—Notes on the geology of Patagonia, by Mr. J. B. **Scrivenor.** The sedimentary strata consist of Tertiary, Cretaceous and Jurassic formations, which, with the exception of the Jurassic, yield varied faunas, both vertebrate and invertebrate. Except in the north, where intrusions of an acid type have disturbed the sediments, the southerly dip is so gentle as only to be appreciable where sections can be followed for some distance. Mr. Hatcher considers that an unconformity separates the Magellanian and Guaranitic Series, also the Cretaceous and Jurassic. Very little is known of the igneous rocks. Apart from those of the Cordillera, there are vast plateaux of basalt and intrusions of quartz-porphyry. The specimens of igneous rocks collected from the moraines of the Cordillera comprise biotite-granite, hornblende-granite, quartz-mica-diorite, gabbro, hornblende-picrite, quartz-porphyry, rhyolite, obsidian, ophitic olivine-dolerites, olivine-basalts and acid tuffs. The basalt-flows cover an enormous area. They slope gently towards the Atlantic, and are cut off from the Cordillera by a longitudinal depression. All that can be said of their age is that they are older than the transverse depressions of the Cordillera, and older than the glaciation of the eastern slopes of that chain. The Téhuelche Pebble-Bed, which covers nearly the whole of Patagonia, has been ascribed to marine action by some authors, by others to glacial action. A third suggestion is the agency of big rivers. The drainage-system includes several eastward-flowing rivers and numerous lakes, some of which occupy transverse valleys cutting through the Cordillera.—On a fossiliferous band at the top of the Lower Greensand, near Leighton Buzzard (Bedfordshire), by Mr. G. W. **Lamplugh** and Mr. J. F. **Walker.** This paper describes a newly-discovered fossiliferous band at the top of the Lower Greensand, overlain by the Gault, in the sand-pits at Shenley Hill, near Leighton Buzzard, in Bedfordshire. The fossils of this band present a different facies from that of any other previously-known fossiliferous horizon of the Lower Greensand, and show closer affinities with the fauna of the Upper Greensand than have hitherto been recognised in any deposit below the Gault. The fossiliferous bed is marked off from the underlying unfossiliferous "silver-sands," but more from the overlying Gault. Stratigraphically it forms part of the Lower Greensand, and cannot be considered to belong to the Gault. The fossils constitute the newest Lower Cretaceous fauna as yet recognised in England.

Royal Meteorological Society, February 18.—Captain D. Wilson-Barker, president, in the chair.—Mr. E. **Mawley** presented his report on the phenological observations for 1902. In all parts of the British Isles, the phenological year ending November 30, 1902, was for the most part cold and sunless. Rain fell at unusually frequent intervals, so that, although the total quantity proved deficient, there at no time occurred any period of drought. Wild plants were everywhere behind their mean dates in coming into flower, but the departures from the average were, as a rule, slight, until about the middle of May. After that time, until the end of the flowering season, the dates of blossoming were later than in any other year since the present series of records was instituted in 1891. The swallow, cuckoo and nightingale were a few days earlier than usual in making their appearance. The most remarkable feature as regards the weather and its effect on vegetation was the way in which it favoured the growth of all the farm crops, except potatoes and hops. For it is seldom in the same year that the yields of wheat, barley, oats, beans, peas, turnips, mangolds and grass are alike abundant, even in a single district, much less in all parts of the kingdom, as was the case in 1902. On the other hand all the fruit crops were more or less deficient, with the exception of strawberries, which yielded well, but were like most other fruits, lacking in flavour.

CAMBRIDGE.

Philosophical Society, January 19.—Mr. Seward, vice-president, in the chair.—On the invariant factors of a determinant, by the president (Dr. **Baker**).—On the variation with wave-length of the double refraction in strained glass (second paper), by Mr. L. N. G. **Filon.**—On the alimentary canal of the mosquito, by Mr. A. E. **Shipley.** The paper dealt with the alimentary canal of *Anopheles maculipennis*, Meig., special attention being paid to the mechanism by which "biting" is effected and by which the food is pumped up into the pharynx. Three food reservoirs were described. The alimentary canal, the salivary glands and the Malpighian tubules were described in detail.—A second memoir on integral functions, by Mr. E. W. **Barnes.** In this paper the author continues certain researches on the asymptotic expansions of integral functions which were published in the *Philosophical Transactions* of the Royal Society, Series A, vol. cxcix. pp. 411–500 (1902). Asymptotic expansions are obtained for the standard functions of double sequence, and an attempt is made to classify Taylor's series by means of the asymptotic expansion of the inverse of the mth root of the mth coefficient.—On the theory of shadows, by Mr. H. M. **Macdonald.**

DUBLIN.

Royal Dublin Society, January 20.—Prof. W. F. Barrett, F.R.S., in the chair.—Prof. J. **Joly,** F.R.S., gave a further account of his preliminary experiments on the conservation of mass which he had presented at the meeting of December 16, 1902.—A paper was read by Dr. W. E. **Adeney** on the ultra-violet spark spectrum of ruthenium. The first instalment of wave-length determinations in spark spectra from the large Rowland spectrometer in the Royal University, Dublin, is given in this communication, reproductions of photographs from which have already been published in the *Scientific Transactions* of the Royal Dublin Society, vol. vii., 1901. 1461 lines have been measured between the two extreme limits of wave-lengths 2263 and 4560. Kayser has given 1613 lines as occurring in the arc spectrum between the same limits of wave-length. About 800 lines are common to both forms of the spectrum. Very few in either list are due to impurities. Exner and Haschek have measured 2250 lines between the same limits of wave-length; some 1330 of these occur in the author's photographs.

MANCHESTER.

Literary and Philosophical Society, January 20.—Mr. Charles Bailey, president, in the chair.—Mr. Thomas **Thorp** gave an account of some researches he had made on the production of metallic surfaces having the properties of Japanese "magic" mirrors. A passage was read from "Light, Visible and Invisible," by Prof. Silvanus Thompson, pp. 51–52, relative to the manufacture of these mirrors in Japan, from which it appears that scraping is resorted to previous to polishing, great pressure being used. These researches were undertaken by Mr. Thorp with a view to determine whether the same "magic" effect can be produced by the ordinary methods of grinding and polishing. Replicas of a Japanese mirror capable of showing the "magic" effect in a very slight degree were made in hard bronze (bell metal). One of these was ground and polished by the method used for glass, &c., considerable pressure being used in the polishing. The result was a decided improvement on the original. The second replica was now ground and polished in a similar manner, but under conditions which prevented flexure during the processes. The result was a plane mirror, without the "magic" properties. As straining the first mirror had been noticed to give enhanced effects, the plane mirror was now subjected to uniform pressure from the back, when the design was seen to start out in a very decided manner, being much brighter than the rest of the surface. On the mirror

being subjected to a partial vacuum, again from the back, portions of the design were seen to be darker than the surrounding surface, but bordered with a light fringe. It appears now to be thoroughly established that the cause of the "magic" effect in Japanese mirrors is due to the unequal resistance to flexure during the polishing process.

PARIS.

Academy of Sciences, February 16.—M. Albert Gaudry in the chair.—The **President** announced to the Academy the death of Sir George Gabriel Stokes, foreign associate.—A law relating to the electromotive forces of batteries based on the reciprocal action of saline solutions and soluble electrolytes, by M. **Berthelot.**—A direct and simple calculation of the velocity of propagation of a wave front in a medium having complicated equations of motion, by M. J. **Boussinesq.**—On the radiation of polonium and radium, by M. Henri **Becquerel.** In a previous paper the author has shown that the α-rays of Rutherford, which are probably identical with the *Kanalstrahlen* of Goldstein, are capable of a slight deviation in a strong magnetic field. The present paper is devoted to a proof of the existence of a corresponding property in the radiation from polonium. Owing to the very slight photographic action of the specimen of polonium under examination, the action had to be prolonged for twenty hours. The same apparatus was used for comparative experiments with radium. The two photographic proofs, the one with radium and the other with polonium, appeared to be superposable, thus proving the absolute identity under the conditions of the experiment of the α-radium rays and the polonium rays. In neither case was there any trace of dispersion analogous to that observed with the kathode rays.—On some new syntheses effected by means of molecules containing the methylene group associated with one or two negative radicles. The action of epichlorhydrin on the sodium derivatives of acetone-dicarboxylic esters, by MM. A. **Haller** and F. **March.** The sodium derivative of acetone-dicarboxylic acid condenses readily with epichlorhydrin, giving a keto-lactone, the properties of which, with those of its semicarbazone, are described.—Approximate algebraic expressions for transcendental, logarithmic and exponential functions, by M. J. A. **Normand.** A series of formulæ is developed permitting of the rapid calculation of the numerical value of logarithms. Numerous examples showing the degree of approximation are appended.—Remarks by M. **Considère** on a memoir on the resistance of armed mortars.—M. René Benoit was elected a correspondant in the section of physics in succession to the late Prof. Rowland.—The eruption of Mont Pelée in January, 1903, by M. A. **Lacroix.**—Perturbations independent of the eccentricity, by M. Jean **Mascart.**—Researches on electrolytic valves, by M. Albert **Nodon.** The term electrolytic valve is applied to an electrolytic cell for the conversion of an alternating current into a unidirectional current. Metals having a low atomic weight, such as magnesium or aluminium, are the best for this purpose, and a solution of ammonium phosphate forms the best electrolyte. The electrostatic capacity of these cells is considerable, about 1 farad per square centimetre of surface of aluminium, the thickness of the dielectric which forms the condenser being of the order 10^{-8}, or of molecular order. Such a cell may be successfully applied to the rectification of telephone currents, and can be used for their measurement.—On the induced radio-activity produced by salts of actinium, by M. A. **Debierne.** It is known that the compounds of radium possess the property of rendering bodies placed in their vicinity temporarily radio-active. Actinium salts possess the same property, the effects produced presenting the same general characters as with radium. There are, however, differences distinguishing the action of the two elements.—The conditions of estimation of manganese in acid solution by persulphates, by M. H. **Baubigny.** A series of determinations is given, showing the effect of the nature of the acid, its quantity and the amount of persulphate used.—The heats of formation of some sulphur and nitrogen compounds, by M. Marcel **Delépine.**—The action of hydrogen upon silver sulphide in the presence of the sulphides of antimony and arsenic, by M. H. **Pélabon.**—The action of phosphoric acid upon erythritol, by M. P. **Carré.** Phosphoric acid acts upon erythritol firstly as a dehydrating agent, and then forms a mono-ester of erythrane. A portion of the latter is converted into a di-ester.—The preparation of some combinations of α-methyl-α-isopropyl-adipic acid, by M. C. **Martine.**—On the temperature of calefaction, and on its use in alcohol determinations, by M. **Bordier.** The term point of calefaction is applied to the temperature at which contact ensues between a hot plate and a drop of liquid in the spheroidal state. In the case of mixtures of alcohol and water this temperature is a function of the composition, and the use of this method is suggested as a means of determining the amount of alcohol in solution. It has the advantage of requiring only a very small quantity of liquid.—On the pathogenic action of the rays emitted by radium on different tissues and organisms, by M. J. **Danysz.** The action is most intense on the skin, the action being relatively slight upon the underlying tissue and attached muscle. The nervous system is especially sensitive to the action of the rays. The larvæ of insects exposed to the rays were paralysed in twenty-four hours and died two days later.—The mechanism of the action of secretin on the pancreatic secretion, by M. C. **Fleig.** The experiments given tend to show that secretin acts directly upon the pancreas, either acting directly upon the pancreatic cell or on the excito-secretory elements. Secretin, contrary to the views of Popielski, offers a good example of special chemical substances which, by their diffusion in the blood current, establish relations between certain determined organs.—The action of the fundamental vibrations of the vowels on the ear in a pathological state, by M. **Marage.**—On the implantation of dead bone in contact with living bone, by MM. V. **Cornil** and P. **Coudray.** Dead bone remains very nearly in the condition in which it was implanted, embedded in a fibrous capsule. It behaves almost like a foreign body, its resorption, even at the end of six months, being insignificant.—On Châtaignier's disease, caused by *Mycelophagus Castaneae*, by M. L. **Mangin.**—A new genus of Chytridiaceæ, by M. P. A. **Dangeard.**—Phenomena of transportation in the eastern Mediterranean, by M. L. **Cayeux.**—The absorption of ammonia by sea-water, by M. J. **Thoulet.**

NEW SOUTH WALES.

Royal Society, December 2, 1902.—Prof. Warren, president, in the chair.—On the occurrence of an important geological fault at Kurrajong Heights, Blue Mountains, by Prof. T. W. Edgeworth **David,** F.R.S. Traced in a southerly direction across the Grose Valley to Glenbrook Railway Station, the fault dies out, passing into a gentle westerly fold, which does not appear to have been accompanied by shearing. To the east is the well-known steep *easterly* monocline. Traced northerly, the monocline crosses Grose Valley and forms the eastern slope of Kurrajong Heights. The monocline at the Kurrajong is bounded westwards by an abrupt fault, whereas at Glenbrook the line of disturbance takes the form of a gentle fold facing the west. The fault plane, though somewhat eroded, still forms a steep and very conspicuous escarpment. The effect of this fault in displacing the Coal-measures on either side of it will obviously claim the serious attention of those who, in the future, have charge of coal mines in that portion of our coalfields.—Investigations in regard to the comparative strength and elasticity of Portland cement, mortar and concrete, when reinforced with steel rods and when not reinforced, by Prof. W. H. **Warren.** The paper describes experiments on various mortars and concrete in tension and compression, also when subjected to bending stresses. The extensions of the specimens subjected to direct tension when reinforced with steel rods were considerably less than occurred in similar specimens not reinforced; the stress-strain diagrams plotted from the observations taken were all convex to the stress axis, but the curve was much flatter for the reinforced specimens. The transverse tests consisted of experiments with beams reinforced on the tension side with steel rods, compared with similar beams not reinforced. In all cases the reinforced beams were from 5½ to 10 times stronger than the plain beam, and the deflections of the beams before fracture were enormously greater in the reinforced beams.—The fallacy of assuming that a wet year in England will be followed by a wet year in Australia, by H. C. **Russell,**

F.R.S. It is a widespread idea that if abundant rain falls in England there will be an abundant rainfall in Australia in the following year. By means of a diagram showing the rainfall in England and in Sydney for a number of years in succession, it is shown that, as a matter of fact, this seldom occurs.—On the presence of platinum and iridium metals in meteorites, by Prof. **Liversidge**, F.R.S. The author described the occurrence of gold in meteorites; in certain cases, the gold is accompanied by one or more of the platinum and iridium metals. The Boogaldi meteorite contains both gold and one or more of the platinum metals; these metals do not appear to be uniformly diffused through the meteorite, for some parts apparently contain a much larger proportion than others. The amount of the platinum metals in the Boogaldi meteorite is comparatively large, being at the rate of several ounces per ton.—Is Eucalyptus variable? by Mr. J. H. **Maiden**. The author takes the following characters seriatim, and shows that they all vary:—Habit, bark, timber, exudations, petiole, leaf—(*a*) suckers, (*b*) cotyledon leaves, (*c*) venation, (*d*) young stems, (*e*) essential oil, (*f*) stomata—galls, inflorescence, anthers, pollen-grains, calyx, fruit.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 26.

ROYAL SOCIETY, at 4.30.—Bakerian Lecture: Solid Solution and Chemical Transformation in the Bronzes: C. T. Heycock, F.R.S., and F. H. Neville, F.R.S.

ROYAL INSTITUTION, at 5.—Insect Contrivances: Prof. L. C. Miall, F.R.S.

SOCIETY OF ARTS, at 4.30.—Gleanings from the Indian Census: J. A. Baines.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Nernst Lamp: J. Stöttner.—And, *if time permit*, Distribution Losses in Electric Supply Systems: A. D. Constable and E. Fawssett.—A Study of the Phenomenon of Resonance in Electric Circuit by the Aid of Oscillograms: M. B. Field.

FRIDAY, FEBRUARY 27.

ROYAL INSTITUTION, at 9.—Perfumes: Natural and Artificial: Dr. A. Liebmann.

PHYSICAL SOCIETY, at 5.—On the Measurement of Small Capacities and Inductances: Prof. Fleming and Mr. Clinton.—On the Interpretation of Milne Seismograms: Dr. Farr.—On the thickness of the Liquid Film formed by Condensation at the Surface of a Solid: Dr. Parks.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Relative Advantages of Single Screws, Twin Screws, and Triple Screws, for Marine Propulsion: E. Falk.

SATURDAY, FEBRUARY 28.

ROYAL INSTITUTION, at 3.—Light: Its Origin and Nature: Lord Rayleigh.

ESSEX FIELD CLUB (Essex Museum of Natural History, Stratford), at 6.30.—The British Vespidæ and their Vespiaries: Edward Connold.

MONDAY, MARCH 2.

SOCIETY OF ARTS, at 8.—Hertzian Wave Telegraphy in Theory and Practice: Prof. J. A. Fleming, F.R.S.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Need of Duty-Free Alcohol for Industrial Purposes: Thomas Tyrer.

TUESDAY, MARCH 3.

ROYAL INSTITUTION, at 5.—Recent Advances in Photographic Science: Sir William Abney, K.C.B.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed.*—Mechanical Handling of Material: G. F. Zimmer.—*Succeeding Papers.*—Recent Irrigation in the Punjab: S. Preston.—The Irrigation Weir across the Bhadar River, Kathiawar: J. J. B. Benson.

ZOOLOGICAL SOCIETY, at 8.30.—Observations and Experiments on Japanese Long-Tailed Fowls: J. T. Cunningham.—On the Land Operculate Mollusca collected during the "Skeat Expedition" to the Malay Peninsula: E. R. Sykes.—The Significance of the Callosities on the Limbs of the Equidæ: R. Lydekker.

SOCIETY OF ARTS, at 4.30.—The Uganda of To-day: Herbert Samuel.

WEDNESDAY, MARCH 4.

SOCIETY OF ARTS, at 8.—Education in Holland: J. C. Medd.

ENTOMOLOGICAL SOCIETY, at 8.—The Aculeate Hymenoptera of Barrackpore, Bengal: G. A. James Rothney.—Notes on the Nests of Bees of the Genus Trigona: Charles Owen Waterhouse.—On the Aganiidæ in the British Museum, with Descriptions of some New Species: Colonel C. Swinhoe.

THURSDAY, MARCH 5.

ROYAL SOCIETY, at 4.30.—*Probable Papers*:—The Resistance of the Ions and the Mechanical Friction of the Solvent: Prof F. Kohlrausch, For. Mem. R.S.—The Electrical Conductivity of Solutions at the Freezing Point of Water: W. C. D. Whetham, F.R.S.—A Note on a Form of Magnetic Detector for Hertzian Waves adapted for Quantitative Work: Prof. J. A. Fleming, F.R.S.—On the Laws governing Electric Discharges in Gases at Low Pressures: W. R. Carr.—The Differential Invariants of a Surface, and their Geometric Significance: Prof. A. R. Forsyth, F.R.S.

ROYAL INSTITUTION, at 5.—Insect Contrivances: Prof. L. C. Miall, F.R.S.

SOCIETY OF PUBLIC ANALYSTS, at 8.

CHEMICAL SOCIETY, at 8.—The Mechanism of the Reduction of Potassium Bichromate by Sulphurous Acid: H. Bassett.—The Constitution of Pilocarpine. Part IV.: H. A. D. Jowett.—Preparation and Properties of 1:4 (or 1:5)-Dimethyl Glyoxaline and 1:3-Dimethyl Pyrazole: H. A. D. Jowett and C. E. Potter.—Some Analyses of "Reh," or the Alkaline Salts in Indian Usar Land: E. G. Hill.—Experiments on the Synthesis of Camphoric Acid. Part III. Synthesis of Isolauronolic Acid: W. H. Perkin, Jun., and J. F. Thorpe.—Camphor-β-thiol: T. M. Lowry and G. C. Donington.—Isomeric Change of Dibenzanilide into Benzoylortho-amino- and Benzoylpara-amino- Benzophenone: F. D. Chattaway.—The Rate of Decomposition of Diazo-Compounds. Part III. The Temperature Coefficient: J. C. Cain and F. Nicoll.

LINNEAN SOCIETY, at 8.—On some Points in the Visceral Anatomy of the Characinidæ: W. S. Rowntree.—On the Anatomy of the Pig-footed Bandicoot *Chaeropus castanotis*: F. G. Parsons.—Further Notes on Lemurs: Dr. Elliot Smith.

RÖNTGEN SOCIETY, at 8.30.—Spark Phenomena: F. H. Glew.

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ROYAL INSTITUTION, at 9.—Studies in Experimental Phonetics; Prof. J. G. McKendrick, F.R.S.

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