THURSDAY, APRIL 14, 1904.

THE METALLOGRAPHY OF THE ALLOTROPIC SCHOOL.

Microscopic Analysis of Metals. By Floris Osmond, Paris. Edited by J. E. Stead, F.R.S. Pp. vii+178. (London: C. Griffin and Co., Ltd., 1904.) Price 7*s.* 6*d.* net.

THIS book is a translation of a French edition embodying several papers published by M. Osmond between 1895 and 1900. The editor, Mr. Stead, in a somewhat florid preface, states that he has confirmed most of Osmond's assays, and claims that the book must be regarded "as a standard work on metallography." This claim will be difficult to justify, since an *ex-parte* statement of the views of the leader of the allotropic school of metallurgy can hardly constitute a standard work, in which necessarily the facts and theories of both schools of thought should be impartially set forth and enunciated. Again, the work is to some extent unsystematic, as in its early pages gold, steel, silver and bronze are mixed together in a somewhat puzzling manner, and such important alloys as white metal and brass are not dealt with at all. Most of the photomicrographs are excellent, whilst a few are very indifferent.

In his preface Mr. Stead highly eulogises the method of "polish attack" for revealing structures. There is no doubt that it is useful for developing structures in an exaggerated form, but for the identification of constituents it is a method prolific in errors. With unconscious naïveté, M. Osmond on p. 73 admits this, remarking, "It is necessary to look at the sample periodically in order to stop when the desired effect is obtained." In an acute controversy between two schools of scientific thought, a method capable of giving a "desired effect" would seem a little out of place, and a method giving the actual result more desirable.

On p. 73 it is quite evident that M. Osmond has not realised that what he calls his "chemical attack" is really an electrochemical or galvanic attack, since efficient etching is achieved owing to the fact that the various constituents assume in the electrolyte or etching liquid either the electronegative or electropositive position. The latter, or anode, constituents are attacked, whilst the former, or kathode, constituents are relatively untouched. It is necessary to direct attention to a photomicrograph on p. 53, Fig. 34. This purports to be the structure of gold containing 0·2 per cent. of bismuth. The metal appears to be pure gold, as no sign of the well-known bismuth eutectic cement is visible between the crystals; Messrs. Osmond and Stead in publishing this structure must have forgotten that the late Sir W. C. Roberts-Austen admitted that he was not sure that the sample contained any bismuth.

Turning to steel, M. Osmond remarks on p. 107:—

"My trials have been specially carried out on five samples of the purest classes of steel made industrially, containing varying amounts of carbon, other foreign elements being in small and very slightly differing proportions."

Practical steel metallurgists will be little inclined to agree with the foregoing paragraph, since on referring to the table on the same page and the information on the following pages, it will appear that No. 1 sample is Swedish wrought iron (containing the unusually high percentage of 0·25 per cent. of manganese) which has been submitted to the malleable iron process of annealing in ore, and is hence a product unknown to commerce. No. 2 sample is an extra soft open-hearth steel, containing 0·14 per cent. of carbon and only 0·19 per cent. of manganese. This steel must have been very "wild" and oxygenated. No. 3 is a commercial steel rather low in manganese. No. 4 is a crucible turning-tool steel containing no less than 0·35 per cent. of silicon, being hence abnormal and unfit for water quenching experiments. No. 5 is stated to be extra hard cemented bar; as it contains 1·57 per cent. of carbon, it cannot be correctly classed as extra hard, but may appropriately be called abnormal, as it contains about six or seven times the amount of manganese usually present. Throughout his investigations M. Osmond has ignored the important influences of manganese and silicon.

Turning to the photomicrographs of the 0·14 per cent. carbon steel, there will be found on p. 116, Fig. 56, the structure of this steel magnified 100 diameters, the crystals shown being very coarse. On p. 117, Fig. 57, is shown the same steel magnified 100 diameters after re-heating to 750° C. A most remarkable fining down of the structure appears to have taken place, and this in spite of the dictum of Mr. Stead that such fining down only takes place at about 900°. Probably a simple explanation of these misleading photomicrographs is to be found in careless editing, likely hopelessly to puzzle students. The "v × 100 diameters" should, under Fig. 56, and repeated in the text, p. 114, probably read "v × 1000 diameters." In the interests of students it would be well if the publishers inserted an erratum slip in connection with this unfortunate error.

On p. 145 it is stated in the last paragraph:—

"C. Influence of Quenching.—A rondelle was heated and quenched at 735° in water at 15°. Hardening at this temperature produces fractures."[1]

That quenching at 735° produces fracture is opposed to the accumulated experience of a century and a half. The explanation of the isolated fact upon which M. Osmond bases so sweeping a generalisation is to be found in the circumstance that his tool steel was so impure with silicon as to be almost unfit for water hardening. With reference to the foot-note (the accurate translation of which has been verified from Osmond's original memoir published in May, 1895), it is no doubt true that the procedure there advocated would tend to prevent cracking, but unfortunately it would also prevent hardening, since steel quenched after the finish of the transformations during the cooling would be quite soft, because the carbon

[1] "The whole secret of hardening without cracking appears to be in quenching before the end of the transformations (during the heating) or after their finish (during the cooling). But that is easier said than done when the eye is the only guide. Hence the necessity for specialists. Again, these specialists are often found in error, when the point to which they have been accustomed is changed. Then they declare that the new steel is bad."

would be necessarily existing in the normal carbide condition.

Turning to the vexed question of nomenclature, the chapter on what M. Osmond calls the distinct constituent "sorbite" will hardly convince those who regard this substance as merely the first of three phases of pearlite. On p. 87 the author says, concerning sorbite:—

"Often very fine and deep lamellæ of cementite are found which are more or less continuous: this is what Fig. 45 (polish-attack v × 1500) ought to show, if the feebleness of the original photograph has been sufficiently reproduced, which is doubtful."

The reviewer does not pretend to grasp the meaning of this paragraph, unless owing to faulty translation the word feebleness has been substituted for delicacy. The following lines on p. 91 are also obscure; referring to sorbite M. Osmond says:—

"In the first edition of this work I did not give with sufficient clearness, ideas which were perhaps slightly confused."

With reference to "martensite," which M. Osmond calls "the fourth constituent," many metallurgists hold that it is a crystalline structure found in both hardened and unhardened steels, and hence cannot be a constituent.

It is stated by Mr. Stead in his preface that the special appendix on what M. Osmond calls the constituent "austenite" renders the work complete. On p. 39, Fig. 20, is figured in an excellent photomicrograph a pale substance stated to be austenite, and a dark substance which is called martensite. Carbonists, however, hold that the pale areas are hardenite containing dissolved cementite, the dark areas being a mixture of hardenite and free cementite (M. Osmond's methods are evidently not sufficiently delicate to detect in the dark so-called martensite the constituent last named). On etching, the hardenite with the free cementite assumes the anode position, but the areas of hardenite with the dissolved cementite assume the kathode position, and are hence unacted upon.

In the appendix on "austenite," a 1·55 per cent. carbon steel was evidently annealed in iron ore until the surface carbon was reduced to 0·35 per cent., the middle still remaining at 1·55 per cent. The composite mass was then quenched, polished and scratched with a needle. M. Osmond then found that the 0·37 per cent. region was harder than the 1·55 per cent. region, and hence that "austenite" is soft. No proof is given that in the high carbon region the separation of graphite had not been brought about by the annealing. However, no practical steel metallurgist can believe that a 0·37 per cent. carbon steel, rapidly quenched from 1050°, is harder than a 1·55 per cent. carbon steel quenched under the same conditions, because it has been frequently established that the latter will scratch quartz (7) and the former only apatite (5).

Concerning hardness, M. Osmond says on p. 83 that cementite has a hardness of 6 (felspar), and is harder than quenched steel. It is well known to mineralogists that the best classes of pen-knife blades (*which have been tempered*) have a hardness of 6 to 6·5, and that fully hardened steel has a hardness at least equal to that of quartz (7).

In connection with micrographic definitions it is interesting to note that within a year two books dealing with the microstructure of metals have been published by prominent members of the allotropic school, namely, the work under review and one by Prof. Howe.

It will be well here to quote the respective definitions given as to the nature of austenite.

Osmond (p. 98).—"To obtain it" (austenite) "the temperature of the steel must be above 1000° and the temperature of the quenching bath a little below, or just at, 0° C., and the proportion of carbon must exceed 1·1 per cent."

Howe, "Iron, Steel and other Alloys" (p. 179).—"Austenite, the characteristic and chief constituent of suddenly cooled, *i.e.* 'hardened' steel, is a hard, brittle mass, with a needle-like structure, and is a solid solution of carbon in iron, the proportion of carbon varying from nothing up to about two per cent."

Of allotropic definitions, students of metallography, somewhat modifying the words of Enobarbus, may well say:—

> "Truth cannot wither them, nor custom stale
> Their infinite variety."

Also Prof. Howe's reference to "a solid solution of carbon in iron" containing no carbon seems distinctly Hibernian.

All students should obtain M. Osmond's book. His brilliant and valuable thermal work and the charm of his ingenuous writings have made him many friends amongst those who strenuously oppose his theories and nomenclature. His book gives a fairly clear enunciation of his views, which are now accessible to all, whereas before they had been fully set forth only to those familiar with his original memoirs in French; nevertheless, a perusal of his book will reveal to many metallographists the fact that his patient work has been carried out in an environment perfectly detached from the stern actualities of the great world of practical steel metallurgy. J. O. ARNOLD.

ZOOLOGICAL ESSAYS.

Mostly Mammals. Zoological Essays. By R. Lydekker. Pp. ix+383; with sixteen full-page illustrations by the Duchess of Bedford, Lord Delamere, the Hon. Walter Rothschild, J. Wolf, and others. (London: Hutchinson and Co., 1903.) Price 12*s.* 6*d.*

THOSE who already know these zoological essays will welcome their re-publication in book form; those who have not previously discovered them in periodical literature may be envied their treat in store. For the essays are at the high-water mark of zoological exposition; they are vividly interesting, yet scrupulously accurate; they are rich in fresh facts, salted with big evolutionary ideas. The author is well known as one of the foremost experts on mammals, and he has exhibited for many years the great gift of discussing difficult problems "popularly," without blunting the edge of his scientific thoroughness.

Some of the essays discuss man's influence in ex-

termination and in domestication. We are reminded that the nineteenth century, so progressive for zoology, is responsible for many sad exterminations, in some of which man has played a careless part. The possibilities of adding to the list of domesticated animals are discussed, but the result of this interesting inquiry is not encouraging: it may be that the elephant and zebra will yield to domestication in Africa; the number of herbivores capable of acclimatisation in parks can be greatly increased, but the secret of domestication seems to have been lost as civilisation was gained, and no new additions of importance can be looked for with any confidence. It almost seems as if our ancient forbears had exhausted the possibilities. This naturally leads to a discussion of the origin of domesticated mammals, in the course of which it is confessed that we are unable to point to the ancestral stock of the sheep, and that there is great uncertainty in regard to the horse. The breeds of goats seem to be derived from the Persian pasang, the donkey seems referable to a Somaliland wild ass, and it is maintained, perhaps too dogmatically, that the numerous breeds of domesticated cattle in Europe all trace their ancestry to the great extinct wild ox, or aurochs. The difficult problem of extermination recurs in an essay on "A Land of Skeletons"—Argentina, once the headquarters of glyptodons, mylodons, megalotheres, and other splendid giants, which died off one after another through the long ages during which the mud of the Pampa was accumulating. Here man cannot have been the eliminating factor, but what the "death-bringing shackles" were we do not know.

For another group of essays the key-word is *distribution*. The marked individuality of the fauna of Celebes, the possibility of a previous land-connection between South America and Australasia, the characteristics of the African fauna, the inhabitants of deserts, are among the subjects discussed. Opportunity is found to correct the still lingering belief that deserts are uninterrupted plains of smooth sand, originally deposited at the bottom of the sea, from which they have been raised at a comparatively recent epoch.

"It may be laid down as a general rule that the greater the amount of sand to be found in a desert, and the greater the difference between the animals inhabiting that desert from those dwelling in the adjacent districts, the greater will be the antiquity of the desert itself. In the case of a desert forming a complete barrier across a continent, like the Sahara, if the animals on one side are quite different from those on the other, its antiquity will be conclusively demonstrated."

In another group of essays we have illustrations of the light which past history sheds upon the present. Thus Mr. Lydekker discusses some extinct Argentine mammals, such as the "ground-sloths," some of which "appear to have been kept in caves as domesticated animals by the ancient inhabitants of Patagonia" (!); the armour-clad whales, such as Zeuglodon, the characters of which point to an affinity between toothed whales and carnivores; the ancient hippopotamuses; and the prehistoric cats and dogs.

Coloration is the key-note of another group of essays. Protective coloration in large animals is illustrated by the Somali giraffe (well shown by one of Lord Delamere's photographs of a giraffesque thicket), by Grévy's zebra, and by many deer; but the point is emphasised that in many other cases, such as the males of the Indian blackbuck, of the white-eared kob, and of the banting, no quite satisfactory reason can be assigned for the development of the characteristic colouring. This discussion naturally leads on to the essay which deals with stripes and spots in mammals, in regard to which it is shown that, while there may be a substratum of truth in the late Prof. Eimer's "longitudinal-spotted-transverse-uniform" theory, it does not cover the facts. Thus transverse stripes appear in some of the most primitive of all mammals, and reappear in certain specialised groups where there is no evidence of a previous spotted stage having been passed through. From this theme we are led on to a discussion of "How Arctic Animals Turn White," in connection with which the importance of Metchnikoff's researches on the *rôle* of phagocytes in the blanching of hair is recognised. As to the protective value of the blanching there is no doubt. Under the striking title "An Invisible Monkey," Mr. Lydekker describes the remarkable black and white coloration of the guerezas (Colobus), which harmonises with the black-barked boughs thickly draped with pendent masses of grey lichen. "As the monkeys hang from the branches," writes Dr. Gregory, "they so closely resemble the lichen that I found it impossible to recognise them when but a short distance away." Another essay is devoted to the peculiar hair of the sloths, where resemblance to a lichen-clad knot is enhanced by a growth of green algæ on the hairs. A more difficult subject is the coloration of cowries, some lines in the manifold evolution of which the author tries to decipher. That banding was the original type seems to be indicated by the fact that it prevails in the young of the great majority of species.

Other essays discuss monkeys' noses and hand-prints, the aye-aye and the flying squirrels, the beaver, the quagga, cave-animals, giant land-tortoises, nursing habits of amphibians, scorpions and their antiquity. The only fault we wish to find with this delightful volume is that we can detect no arrangement in it, though, as our review shows, some grouping is readily possible.

Zoologists will find much valuable material in this volume, and many suggestions which are evidently not *obiter dicta* but the outcome of an expert's reflection. But the author's power of carrying the reader with him from the familiar to the unfamiliar should make his book welcome to a wider circle—to all interested in the problems of natural history. Our conviction is that there is much more education to be got out of a book like this, if read as carefully as it has been written, than out of many a treatise on mammals. It introduces the student to actual problems and to the method which an expert pursues in studying these. In conclusion, we would direct attention to the beautiful illustrations, *e.g.* of the aye-aye, of giraffes in covert,

of the white-tailed guereza, of a Peking stag, of Père David's Mi-Lou deer, and of the giant tortoise of South Aldabra Island. We hope that this book, which is as stimulating as it is informative, and is far and away above most "popular" natural history essays in its thoroughness, accuracy, and suggestiveness, will have the wide circulation it deserves, and that the author will continue to enrich our scientific literature with many more "zoological essays."

J. A. T.

INFECTION AND IMMUNITY.

Infection and Immunity, with Special Reference to the Prevention of Infectious Diseases. By George M. Sternberg, M.D., LL.D., Surgeon-General U.S. Army (Retired). Progressive Science Series. Pp. ix+293. (London: John Murray, 1903.) Price 6s. net.

IN the preface to this volume we find the general statement that "all infectious diseases are preventable diseases," and with this proposition, at least in a general sense, we heartily concur. It follows that there can be no more important factor in the extermination of infectious diseases than the education of the public in their essential nature and modes of spread. For with such knowledge comes not only increased personal precaution against infection, but what is even more important, an enlightened tolerance of sanitary legislation. A volume on "infection and immunity" is thus most suitable for such an undertaking as the Progressive Science Series, and the editor has been fortunate in securing the services of Dr. George M. Sternberg as an expositor of the subject. Dr. Sternberg is well known as one of the pioneers of American bacteriology; he has taken a prominent part in the advancement of public health, and, in particular, of military hygiene in that country; disinfection is, moreover, one of the subjects with which his name is especially associated.

As befits the series to which it belongs, the book is written for the non-medical public, and the writer expresses the hope that it may serve as a text-book for those responsible for the sanitary welfare of public institutions, and even for high schools and colleges. It is divided into two parts, the first of which deals with the general principles of the subject, while the second is devoted to the chief infectious diseases in detail.

The general part contains thirteen short chapters. After a definition and explanation of what is meant by infectious disease, the nature of "disease germs" receives somewhat short treatment. The chapter on "channels of infection" is excellent, and gives a clear idea of the ways in which different diseases spread. Equally good is the chapter on susceptibility to infection, and this is followed by a series of chapters on disinfection and the different agents by which this can be brought about, such as heat, chemicals, and the like. The action of these agents is clearly explained. This part of the book is brought to a close by three short chapters on immunity and antitoxins. The author is probably wise in having omitted, in a popular work, all discussion of Ehrlich's fascinating theory of the origin of "anti-bodies."

It appears to us that Dr. Sternberg has done this part of his work well, and has furnished a very adequate and readable account of the subject, but it is permissible to doubt whether, in his effort to be concise, he has always made sufficient allowance for the extraordinary ignorance which undoubtedly exists in the mind of the average man as to the essential nature of bacteria and other disease germs. He deals with this matter, which it must be remembered lies at the very root of his whole subject, in five short pages, in which we fail to find any reference whatever to the size of the objects he is describing. Yet it is this very matter of size which is so great a stumbling-block to the average mind in forming a conception of the nature of infection. It would, in our opinion, have been well, in a book which is intended as a text-book for students in high schools and colleges, to have devoted a much larger space to elementary information as to the essential nature of disease germs. In spite of the great accuracy which marks the majority of the writer's statements, there are one or two to which it is possible to take exception. On p. 12 we read that "tetanus is the only disease of man in which spores have been demonstrated"; there are other anaërobic sporeformers which produce disease in man, *e.g. Bacillus oedematis maligni* and *B. aërogenes capsulatus*, while anthrax is unfortunately far from unknown as a human affection. Again, on p. 41, it is stated that alcohol has scarcely any germicidal power; it is true that alcohol cannot kill bacterial spores, but it is almost instantaneously fatal to non-sporing bacteria, at least when these are in the moist condition. These, however, are small blemishes upon what is, on the whole, a very excellent account of a difficult and complex subject.

When we turn from the general to the special part of the book, which occupies another twenty chapters, it is difficult to find anything which is not worthy of unstinted praise. The different infections are taken seriatim, and under each disease we find an admirable and lucid account of its epidemiology and history, of what is known as to the germ which causes it, of the channels by which it spreads, and of the precautions to be taken in combating it. The only important human infectious disease which is omitted is anthrax, if we except syphilis and gonorrhœa, which, from motives of, we think, mistaken delicacy, have been altogether excluded from the book. The author naturally draws much of his statistical information from American sources, and some of it will probably be novel to English readers; for instance, the striking connection between toy pistols and tetanus which has been observed in the United States. The typhoid statistics of American cities will also be viewed with a chastened satisfaction in view of our own more favourable figures, save only for Belfast. It may be regretted that, in treating of diphtheria, Dr. Sternberg has not laid more stress on the importance of

bacteriological examination of the throat and nose in convalescents and in mild sore throats associated with diphtheria epidemics, since there can be little doubt that this is one of the most important sources of danger in the spread of the disease. We note also the unaccountable omission of bleaching powder as a disinfectant for tuberculous sputum; this substance, on account of its solvent powers on mucus, is now well recognised as far superior to any other chemical disinfectant for the purpose.

Those who are acquainted with the Progressive Science Series will be prepared to find the book well printed and got up. The illustrations are few in number, but fairly good, if we except a poor figure of the diphtheria bacillus on p. 193. There is an excellent index.

PHYSIOLOGICAL CHEMISTRY.

Practical Physiological Chemistry. By Dr. J. A. Milroy and Prof. T. H. Milroy. Pp. viii + 201; interleaved. (Edinburgh and London: William Green and Sons, 1904.)

A Laboratory Manual of Physiological and Pathological Chemistry for Students of Medicine. By Prof. E. Salkowski. Translated from the second German edition by Prof. W. R. Orndorff. Pp. ix + 263; with ten figures and a coloured plate of absorption spectra. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 10*s.* 6*d.* net.

THE first work under notice is divided into two main portions, the first qualitative, the second quantitative, and the subjects of chemico-physiological interest are treated in a thoroughly practical and systematic manner. The book is written by those who have the necessary knowledge of both chemistry and physiology combined with experience in teaching. The result is a book which can be warmly recommended, and one which is perfectly trustworthy and free from error. It probably includes more than is usually done by students in a practical class with only a limited time at their disposal. It will be necessary for the judicious teacher to select the portions which he regards as essential; the large number of exercises will render this in one sense easy, though in some cases we see there may be a difficulty in choosing what shall be omitted where all is so excellent and so clearly explained. A few plates of important pieces of apparatus, of certain crystals and of absorption spectra are appended. We could have wished to see rather more illustrations of this kind, but this minor defect can be remedied in future editions.

Prof. Salkowski's name is a guarantee in itself that the student of physiological chemistry cannot fail to find much that is excellent and useful in any work he may write, and there is no doubt that this manual, either in the original German or in the present English translation, should find its place on the shelves of any well equipped physiological laboratory. There are certain methods of investigation which Prof. Salkowski has elaborated, and others at which he has particularly worked, some of a complicated nature not usually found in text-books of this kind; it is these which the advanced student or the investigator will find best treated in the present volume

We cannot say that we think the book well suited for students' class work. This is no doubt largely due to the difference between German and English methods of teaching. The systematic practical class which forms such an important feature in the medical schools of Great Britain and America is almost unknown in Germany. There each student works independently in the laboratory at times and for periods which best suit him; he is left to worry out the problems very largely by himself. For the first-rate man this is a first-rate method, but the main bulk of the students do not receive such a thorough grounding as under the English system. The book is far too elaborate for the average student, though not complete enough in all directions for those engaged in original research. The worst fault of the manual is its want of system, and no doubt this arises from the German method or want of method just alluded to. This was particularly striking as we had previously been reading the book by Prof. Milroy and his brother. In this book the rational method is adopted of describing first the detection of the elements in an organic substance, then follow chapters on the three main classes of physiological compounds, carbohydrates, fats and proteids; from this we pass by natural sequence to the foods, the digestive fluids, the excretions and so forth. Prof. Salkowski, on the other hand, starts with the examination of milk, and treats the properties of the proteids as a sort of appendix to the study of that fluid, although the principal proteid of milk is by no means a typical one. Next follows a chapter on muscular tissue, a complex subject for a student only just starting work. A study of gastric juice succeeds this, and a chapter on the blood is sandwiched between that and the study of saliva. The pancreas, the bile, the urine, the liver, bone, fat and egg follow in the order named. Exactly the same thing is seen in each individual chapter; thus in that on the quantitative analysis of urine, we find several methods given for estimating urea, but instead of all coming together, they are separated by sections dealing with the estimation of uric acid and creatinine. We notice also that the book is not thoroughly up to date; this has been remedied in some cases by additions made by the translator, but in other cases, notably in the chapter on muscle, this has not been done. The translation has been well carried out, and Prof. Orndorff has done wisely in omitting the very large portion of the original work which deals with inorganic chemistry.

It is quite right that a translation of Prof. Salkowski's book should have appeared; it is a book with a deservedly high reputation, and has much to recommend it; our criticisms are mainly directed to show that it is not suitable for the average student of medicine on account of the manner in which the subjects are presented to him.

OUR BOOK SHELF.

An Attempt towards a Chemical Conception of the Ether. By Prof. D. Mendeléeff. Translated by George Kamensky. Pp. 51. (London: Longmans and Co., 1904.) Price 2*s.* net.

THIS tract, by the famous chemical philosopher whose seventieth birthday has recently been welcomed by the congratulations of the whole scientific world, contains the views of the author of the periodic law with regard to the classification under that law of the recently discovered inert gases. Prof. Mendeléeff places hydrogen at the head of his group i., containing the metals of the alkalis, and makes a special group zero for the inert gases. He gives his reasons for thinking that in this group there are two elements lighter than helium. One of them, of density about 0·2 compared with hydrogen, he identifies with coronium, the source of the characteristic spectrum of the solar corona. Such a gas could not, in accordance with the views first promulgated by Stoney, be retained in the earth's atmosphere, but might be prominent in the higher regions of that of the sun. The other, which he feels justified in taking of extremely low density, he proposes to identify with the ether, which cannot be held by any heavenly body, but is spread through all space. No mention is made of Maxwell's classical objection that the ether cannot be molecular, for if it were, all the energy of the universe would have been transferred into it. He notes incidentally, in connection with the uniform scale and composition of the universe, that most stars the masses of which are known are of the same order of magnitude as the sun. He thinks the condensation of ether towards the massive stars is connected with their intense radiation. He also thinks that the activity of the molecules of radium must be connected with a special condensation of ether around them; for his opinion, stated with reserve and without the certainty which he felt with regard to his views on the periodic law, is entirely against any breaking up of molecules or degradation of elements into other forms, and he therefore rejects the idea of electrons.

The obvious criticism on this is that he thus puts aside all the modern ideas as to the nature of radiation and electric action, and as to physics in general. He thinks, in fact, that the transmission of light will prove a more complex affair than the simple ideas of undulatory propagation on which it is now founded. He thinks that there is only one type of substance, and that a "working hypothesis" type of ether, by which he means a scheme of relations defining a substance with properties different from those of ordinary matter, must be ruled out. He now gives to the world these ideas which he has entertained, because he thinks that there may be little time left to him, and in the hands of others they may come to development. Though much at variance with the modes of thought of students of modern physics, one admires in reading about them the same originality and allusive suggestion that make his "Principles of Chemistry" such an attractive book. J. L.

Monographieen aus der Geschichte der Chemie. Herausgegeben von Dr. Georg W. A. Kahlbaum. vii. Heft. (1) Jakob Berzelius. Von H. G. Söderbaum. Nach der wörtlichen Übersetzung von Emilie Wöhler bearbeitet von G. W. A. Kahlbaum. (2) Amedeo Avogadro und die molekular Theorie. Von Icilio Guareschi. Deutsch von Dr. Otto Merckens. (Leipzig: Johann Ambrosius Barth, 1903.)

DR. KAHLBAUM continues to put all chemists under an obligation to him by the successive issue of his valuable monographs on the history of chemistry. The volume before us is of special interest from the fact that the first part of it is a carefully edited translation of an autobiography of Berzelius. The statutes of the Royal Swedish Academy of Sciences require that each newly elected member shall deposit an account of his life and work at the time of his election, and that he shall add to it at stated periods so long as his membership continues. The autobiography before us is the result of that regulation.

It was translated into German, in the first instance, by Miss Emilie Wöhler, the daughter of the eminent chemist, himself a pupil and life-long friend of the great Swedish chemist, with the cooperation of Dr. Kahlbaum, and has been carefully edited and annotated by Prof. Söderbaum. No contribution to the personal history of chemistry that has appeared within recent years surpasses in interest this account by Berzelius of his own life. It is necessarily condensed from the very circumstances in which it was prepared, but all essential features of the career of its author down to 1840, a few years, therefore, before his death, are indicated.

The second monograph, on "Amedeo Avogadro und die Molekular Theorie," is by Prof. Icilio Guareschi, and has been translated into German by Dr. Otto Merckens.

It is a concise account of the rise of molecular theories in chemical and physical science, and of Avogadro's connection with the subject. Incidentally the author deals with the attempts made by Dr. Debus to transfer the credit hitherto associated with the name of the Italian physicist of being the first to indicate the generalisation that equal volumes of gases under comparable conditions of temperature and pressure contain the same number of molecules to John Dalton.

The discussion will be of interest, especially to English chemists. At the same time, it can hardly be said to be convincing or to advance the matter much beyond what is generally recognised as its true position.

De Vi Physicâ et Imbecillitate Darwinianâ disputavit Franciscus Gulielmus Bain, Artium Magister. Pp. 103. (Oxford and London: James Parker and Co., 1903.) Price 2*s.* 6*d.* net.

WE gather from this work that its author was present as a boy at Darwin's funeral in Westminster Abbey, and had his toe trodden on by the King himself, then Prince of Wales; that the impression produced on him was such that he determined to devote himself in future years to finding out who Darwin was; and that having now succeeded in this laudable endeavour, he cannot visit the British Museum of Natural History and look up at the statue on the staircase facing the entrance without being seized by inextinguishable laughter. "It is this curious incarnation of philosophical poverty and unscientific perversity," he exclaims, "who is elevated into a scientific deity. A theory-blinded and arbitrary denier of Nature's organic and creative power is worshipped as a god in her own temple, every object in which gives the lie to his creed." "The theory of Darwin," he says in another place, "is the *ne plus ultra* of human stupidity. It never could have occurred, except to one incapable of understanding the corollaries of organisation: but once having occurred, it never could have been retained and defended, except by one who was capable of systematically ignoring whole classes of animal organisation, and attending only to instances that prove nothing at all." But Darwin is not the only victim of the author's indignation. Of another name, scarcely less famous than Darwin's, we read that "the ravings of an old woman in a lunatic asylum would be wisdom in comparison with the latest views of this eminent philosopher." What, we may ask, is the cause of this lamentable

collapse on the part of modern men of science? The explanation offered is simple; it is merely that they have learned their method from "that unfortunate being J. S. Mill. I consider the authority of J. S. Mill, and the fact that his 'Logic' and 'Political Economy' were and still are text-books in the University of Oxford, to be a national disaster, and almost equivalent to destroying English intelligence in the germ." Most of the opinions here advanced are of equal weight with the foregoing.

We have let the author of this elegantly printed booklet speak for himself. He abounds in humour both of the conscious and unconscious variety, the latter predominating. F. A. D.

Bray and Environs. (Bray, Ireland: Published and Sold by Arthur L. Doran, 1903.) Price 1*s.* net.

MR. DORAN has produced a cheerful and original little guide to the gateway of the Wicklow highlands, and devotes five pages to the botany, geology, and ornithology of the district. In the botanical part he relies on the careful work of Mr. R. Lloyd Praeger ("Irish Topographical Botany"), published by the Royal Irish Academy, but he does not seem to have utilised the admirable new memoir to the Dublin area, prepared by Mr. Lamplugh and his colleagues, when drawing up his geological notes. This Geological Survey publication, including Killiney and many of the places mentioned, should be referred to in the next edition. Messrs. Ussher and Warren may then also appear as authorities in the section on the Irish birds.

But the present book is distinctly attractive, and full of quaintly expressed ideas. Anyone who reads the quotations from the Venerable Bede and Dr. Raverty, the medical superintendent officer of health, set in juxtaposition on p. 5, cannot fail to seek further, confident that he is in pleasant hands. Some of the references owe their sparkle to a touch of irony, such as the unkind mention on p. 11 of Mr. Evans and his votive offerings. Apropos of this, the holy well in Mr. Barrington's land in co. Dublin, with its twentieth century offerings of rags, is mentioned quite naturally on p. 35. Archæologists will note a profound significance in the very simplicity of Mr. Doran's words, and will, it is to be hoped, visit the old-world valley with no other feeling than respect. The present writer was once guided there in the gathering dusk, when Dublin, ten miles distant, seemed to lie, by another measure, thirty centuries away.

The mention of this obscure well, and of the little used but singularly picturesque route round Carrickgollogan (p. 89), will serve to show the perceptive spirit in which Mr. Doran has written for the tourist. G. A. J. C.

Senior Country Reader. III. By H. B. M. Buchanan, B.A. Pp. viii+293; with 143 illustrations. (London: Macmillan and Co., Ltd., 1904.) Price 2*s.*

AN enthusiastic reception may be predicted for this volume on the part of boys and girls in rural schools who have studied Mr. Buchanan's previous books in this series. There is a surprising amount of information provided, but it is generally presented in a sufficiently interesting manner to avoid weariness on the part of the young reader. The subjects treated—such as manuring, crops, cottage gardens, pigs and poultry—are just those which engage the practical attention of the children out of school, and about which they must know something after leaving school. It is clear from the beginning that Mr. Buchanan writes from personal experience in agricultural pursuits, and this fact will inspire the confidence of the student, while the numerous good illustrations will make quite clear what is being described.

LETTERS TO THE EDITOR.

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

A New Mineral from Ceylon.

SINCE writing last week, I have made further experiments on the cubical mineral, and have myself carefully examined the earth constituents. The statement made last week, that there is only an insignificant amount of thorium present, must be modified. On re-determining the equivalent of the crude oxalate, prepared after the yttrium metals had been separated by treatment with potassium sulphate, it has come out higher than I expected; indeed, assuming the metal present to be a tetrad, its atomic weight is even higher than that of thorium—about 240, as the mean of two closely concordant determinations. The lower equivalents mentioned in the previous letter were determined as fractions of the double potassium sulphate, prepared on a large scale. This high atomic weight points to the presence of unknown elements of higher atomic weight than thorium; indeed, the mineral appears to be of very complex composition. It may be incidentally remarked that the crude oxalate mentioned above must have contained all the cerium group, and if any considerable proportion of the elements of this group is present, the amount of the element with higher atomic weight than that of thorium would have to be proportionately increased. The high radio-activity would point to the presence of the elements obtained from thorium residues mentioned by Prof. Baskerville, which he states to be radio-active.

The equivalent was determined by comparing the weight of oxide from a known weight of oxalate with the percentage of oxalic acid, as determined by titration of another sample of the same preparation. WILLIAM RAMSAY.

THE letter dealing with the composition of a new mineral from Ceylon contributed by Sir W. Ramsay to NATURE of April 7 (p. 533) reveals certain discrepancies between the analytical results obtained with this material at University College and those of the Scientific and Technical Department of the Imperial Institute recorded in Prof. Dunstan's letter on this subject (March 31, p. 510). Sir W. Ramsay's results indicate that this mineral is practically free from thoria, whereas those recorded by Prof. Dunstan show that it is particularly rich in this oxide. As Prof. Dunstan is at present abroad, and therefore unable at the moment to comment on Sir W. Ramsay's letter, I may be permitted to direct attention to two observations mentioned by Sir W. Ramsay, which appear to be open to question.

He states that the oxalate obtained from a solution of the mineral is soluble in excess of a solution of ammonium oxalate, and that this reaction excludes the presence of thorium or metals of the cerium group, and points to the presence of zirconium. This inference is not in harmony with the observation recorded by Bahr (*Annalen*, 1864, 132, 231), that thorium oxalate *is soluble* in excess of ammonium oxalate, a fact since confirmed by Bunsen and by Brauner (*Journ.* Chem. Soc., 1898, 73, 951). Further, the solubility of the thorium salt in excess of ammonium oxalate has been used by Hintz and Weber (*Zeit. Anal. Chem.*, 1897, 36, 27) and by Glaser (*ibid.*, p. 213) as a method of separating thoria from monazite and similar minerals. It would appear, therefore, that the principal evidence brought forward by Sir W. Ramsay in support of his conclusion that the mineral contains no thoria in reality supports Prof. Dunstan's statement that it is rich in this oxide. It may be added that the solubility of the oxalate obtained from the mineral in ammonium oxalate had already been observed in this Department.

Sir W. Ramsay appears to be of opinion that the principal constituent of the mineral is the oxide of a new tetravalent element with an equivalent of about 44·7. If this were the case the specific gravity of the mineral would probably be less than 8·2, whereas the determinations of this constant

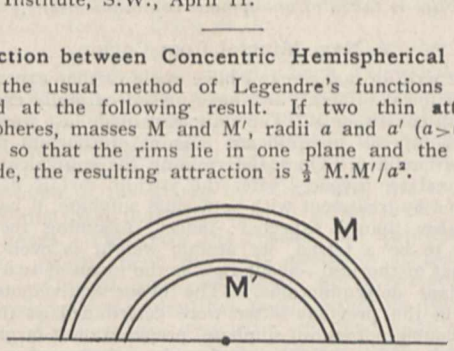
made here and at University College indicate that its specific gravity is about 9, and this figure agrees fairly well with that required for a mineral containing 75 per cent. of thoria.

T. A. HENRY.

Scientific and Technical Department, Imperial Institute, S.W., April 11.

Attraction between Concentric Hemispherical Shells.

BY the usual method of Legendre's functions I have arrived at the following result. If two thin attracting hemispheres, masses M and M′, radii a and a' ($a > a'$), are placed so that the rims lie in one plane and the centres coincide, the resulting attraction is $\frac{1}{2}$ M.M′/a^2.



From this result we conclude that we may replace M′ by any number of thin hemispherical shells (radii $< a$) subject to the conditions that the density of any shell is uniform, and that the total mass of all the shells is M′.

The result is so remarkable and simple that one looks for an elementary proof.

Perhaps some of your readers may be able to suggest one. GEORGE W. WALKER.

Physical Laboratory, The University, Glasgow, March 28.

MR. G. W. WALKER tells me that he has sent to NATURE his interesting problem of the mutual attraction between two uniform concentric hemispherical shells, bounded by a common diametral plane. The following elementary solution has occurred to me. Call the outer shell A and the inner B. Now let another hemisphere A′ be added to A so that instead of the hemisphere A we have a complete and uniform spherical shell surrounding B. The attraction between the complete sphere and B is zero, if, as is here understood to be the case, the attraction between the particles follows the Newtonian law. Hence the attraction F of A on B is equal and opposite to the attraction of A′ on B. But the force exerted by A′ on B is obviously equal and opposite to the attraction which would be exerted by A on a hemisphere added to B so as to convert it into a complete spherical shell. Hence the force exerted by A on the inner sphere thus completed would be 2F, and this attraction is the same as that which would be exerted on a particle of double the mass of B placed at the centre. The attraction F of A on B is therefore that which would be exerted by A on a particle of mass equal to B placed at the centre, and the same thing holds for the reaction of B on A. Mr. Walker's result is therefore established.

We may go a step beyond the problem as proposed. Let the diametral plane bounding B, the shells remaining concentric, make any angle with the diametral plane bounding A. Then, by the same process of completing the sphere by adding A′ to A, we see that the attraction exerted by A′ on B is equal, and opposite in direction, to that which would be exerted by A on a hemisphere added to B to complete it in its new position. But the attraction of A on the inner sphere thus completed is equal to that which would be exerted by A on a particle of mass equal to twice that of B situated at the centre, and therefore the whole pull exerted on B by A, in any direction, is equal to the force, in that direction, exerted by A, on a particle of mass equal to that of B situated at the centre. A. GRAY.

The University, Glasgow, April 6.

Curious Formation of Coal.

IN NATURE of January 14 (p. 250) Mr. Henry Hall describes a vertical deposit of a carbonaceous mineral in a wooden trough into which water from a coal mine had been delivered for three years. This interested me very much, as many years ago I described a similar carbonaceous mineral lining vertical cracks in a sandstone near Whangarei, in New Zealand (*Trans.* N.Z. Institute, vol. iii. p. 250, 1871).

I hope that Mr. Hall will make further observations and experiments on this singular phenomenon to see whether he is right in his explanation. F. W. HUTTON.

Museum, Christchurch, New Zealand, February 25.

Photographic Effect of Radium Rays.

IT is interesting to note how pictures of the portions in relief on coins, medals, &c., can be obtained by means of radium rays. The coin or other object is placed directly in contact with a photographic plate which is enclosed in an envelope opaque to light. A few milligrams of radium bromide, contained in the usual mica-covered box, are placed some distance above the plate, and the whole left for several days. After development it is found that a clearly defined picture is obtained of the portions in relief on the under sides of the coins. Pictures have thus been obtained of the portions in relief on silver coins (half-crown, sixpence, threepence), also of a name engraved on a mother-of-pearl seal. Ten days was the time of exposure when ten milligrams of radium bromide were placed six inches above the plate, and the coin was a threepenny bit. Ten days also in the case of a half-crown when five milligrams were placed 1½ inches above the plate.

This radium effect was first shown at my last lecture on radium at the College of Science, Newcastle, on January 16, and has been shown at my subsequent lectures.

HENRY STROUD.

Durham College of Science, Newcastle-on-Tyne, April 9.

ON THE MEASUREMENT OF CERTAIN VERY SHORT INTERVALS OF TIME.

ACCORDING to the discovery of Kerr, a layer of bisulphide of carbon, bounded by two parallel plates of metal and thus constituting the dielectric of a condenser or leyden, becomes doubly refracting when the leyden is charged. The plates, situated in vertical planes, may be of such dimensions as 18 cm. long, 3 cm. high, and the interval between them may be 0·3 cm., the line of vision being along the length and horizontal. If the polarising and analysing nicols be set to extinction, with their principal planes at 45° to the horizontal, there is revival of light when the leyden is charged. If the leyden remain charged for some time and be then suddenly discharged, and if the light under observation be sensibly instantaneous, it will be visible if the moment of its occurrence be previous to the discharge; if, however, this moment be subsequent to the discharge, the light will be invisible. The question now suggests itself, what will happen if the instantaneous light be that of the spark by which the leyden is discharged? It is evident that the conditions are of extraordinary delicacy, and involve the duration of the spark, however short this may be. The effect requires the simultaneity of light and double refraction, whereas here, until the double refraction begins to fail, there is no light to take advantage of.

The problem thus presented has been very skilfully treated by MM. Abraham and Lemoine (*Ann. de Chimie*, t. xx., p. 264, 1900). The sparks are those obtained by connecting the leyden with a deflagrator and with the terminals of a large Ruhmkorff coil fed with an alternating current. It is known that if the capacity be not too small, several charges and discharges occur during the course of one alternation in the primary, and that while the charges are gradual, the discharges are sudden in the highest degree. If, as in the present case, the capacity is small, it is necessary to submit the poles of the deflagrator to a blast of air, otherwise the leyden goes out of action and the discharge becomes continuous. Under the blast, the number of sparks may amount to several thousands per second of time. In this way the in-

tensity of the light is much increased and the impression upon the eye becomes continuous, but in other respects the phenomenon is the same as if there were but one spark.

In order to obtain a measure of the double refraction, which is rapidly variable in time, somewhat special arrangements are necessary. At the receiving end the light, after emergence from the trough containing the bisulphide of carbon, falls first upon a double image prism, of somewhat feeble separating power, so held that one of the images is extinguished when the leyden is out of action. The other image would be of full brightness, but this, in its turn, is quenched by an analysing nicol. When there is double refraction to be observed, the nicol is slightly rotated until the two images are of equal brightness. This equality occurs in two positions, and the angle between them may be taken as a measure of the effect. A full discussion is given in the paper referred to.

The finiteness of the angle, which in my experiments amounted to 12°, is a proof that the light on arrival at the CS_2 still finds it in some degree doubly refracting. To obtain the greatest effect the leads from the leyden to the deflagrator should be as short as the case admits, and the course of the light from the sparks to the CS_2 should not be unnecessarily prolonged. The measure of the double refraction, and in an even greater degree the brightness of the light as received, are favoured by connecting a very small leyden directly with the spark terminals, but the advantage is hardly sufficient to justify the complication.

The observations of Abraham and Lemoine bring out the striking fact that if the course of the light be prolonged with the aid of reflectors so as to delay by an infinitesimal time the arrival at the CS_2, the opportunity to pass afforded by the double refraction is in great degree lost, and the angular measure of the effect is largely reduced. There is here no change in the electrical conditions under which the spark occurs, but merely a delay in the arrival of the light.

The optical arrangements which I found most convenient in repeating the above experiment differ somewhat from those of the original authors. The sparks are taken at a short distance from the polarising nicol and somewhat on one side, and in both cases they are focused upon the analysing nicol. When the course is to be a minimum, the light is reflected obliquely by a narrow strip of mirror situated in the axial line, and focused by a lens of short focus placed near the first nicol. This lens and mirror are so mounted on stands that they can be quickly withdrawn, and by means of suitable guidance and stops as quickly restored to their positions. In this case the distance travelled by the light from its origin to the middle of the length of CS_2 is about 30 cm.

The arrangements for a more prolonged course are similar, and they remain undisturbed during one set of comparisons. The mirror is larger, and reflects nearly perpendicularly; it is placed upon the axial line at a sufficient distance behind the sparks. The light is rendered nearly parallel by a photographic portrait lens of about 18 cm. focus, the aperture of which suffices to fill up the field of view unless the distance is very long. In all cases the eye of the observer is focused upon the double image of the interval between the plates of the CS_2 leyden.

The earlier experiments were made at home somewhat under difficulties. For the blast nothing better was available than a glass-blowing foot bellows; but nevertheless the results were fairly satisfactory. Afterwards at the Royal Institution the use of a larger coil in connection with the public supply of electricity, and of an automatic blowing machine, gave steadier sparks and facilitated the readings. An increase of about one metre in the total distance travelled by the light reduced the measured angle from 12° to 6°, so that the time occupied by light in traversing one metre was very conspicuous.

It is principally with the view of directing attention to the remarkable results of Abraham and Lemoine that I describe the above repetition of their experiment, but I have made one variation upon it which is not without interest. In this case the spark is placed directly in the axial line and at some distance behind, which involves the use of longer leads, and therefore probably of a lower degree of instantaneity. The additional retardation is now obtained by the insertion of a 60 cm. long tube containing CS_2 between the sparks and the first nicol, and the comparison relates to the readings obtained with and without this column, all else remaining untouched. The difference is very distinct, and it represents the time taken in traversing the CS_2 over and above that taken in traversing the same length of air. It should be remarked that what we are here concerned with is not the wave-velocity in the CS_2, but the *group*-velocity, which differs from the former on account of the dispersion.

In the above experiments the leyden, where the Kerr effect is produced, is charged comparatively slowly and only suddenly discharged. For some purposes the scope of the method would be extended if the whole duration of the double refraction were made comparable with the above time of discharge. This could be effected somewhat as in Lodge's experiments, where a spark, called the B-spark, occurs between the outer coatings of two jars at the same moment as the A-spark between their inner coatings. The outer coatings remain all the while connected by a feeble conductor, which does not prevent the formation of the B-spark under the violent conditions which attend the passage of the A-spark. The plates of the Kerr leyden would be connected with the outer coatings of the jars, or themselves constitute the "outer" plates of two leydens replacing the jars. RAYLEIGH.

ENTROPY.[1]

IN NATURE, April 30, 1903, there is an article entitled "Entropy," describing at some length the great practical use which the engineer now makes of the $t\phi$ diagram. Engineers very ignorant of mathematics are able with clearness and certainty to make quantitative computations such as used to task the powers of mathematicians. The problems so easily worked out are very numerous and of a useful, interesting character, and mistakes are not easily made. On the other side of this question, in a notice of Mr. Donkin's translation of Prof. Boulvin's "The Entropy Diagram and its Applications" (NATURE, May 4, 1899), it was pointed out that such books were doing much harm because they made an illegitimate use of the $t\phi$ diagram. Thus I say:—"Of course we may, if we please, say that when steam is released to the condenser, we may imagine the whole change as occurring in the cylinder itself; only we ought to remember that we are substituting a very simple hypothetical process for a very complicated reality, which has almost nothing in common with it. We ought to remember that the very pretty, beautifully complete, cyclic $t\phi$ diagrams, which we obtain from childish assumptions, may get to be looked upon by students, and even by ourselves, as having a real meaning."

It is evident that this misuse of the $t\phi$ diagram is too prominent in Mr. Swinburne's mind, and that he fails to see the real usefulness of ϕ to engineers.

[1] "Entropy or Thermodynamics from an Engineer's Standpoint and the Reversibility of Thermodynamics." By James Swinburne. Pp. x+137. (Westminster: Archibald Constable and Co.). Price 4s. 6d. net.

He seems to think it easy to study some of those irreversible changes which even the greatest of mathematical physicists have been afraid of, and it is my ungrateful duty to say that he is so ill equipped for the study that he does not comprehend the elementary principles of thermodynamics. Even in the last page of this book he states that thermodynamics "is perhaps the most slippery branch of science there is." He does not seem to know that in the books condemned by him there is an exact study of some irreversible processes, such as the wiredrawing of steam, and that the $t\phi$ diagram lends itself to the study of another irreversible process, the efflux of steam from an orifice.

I take it that this mental phenomenon is not, after all, curious; it is often exhibited when men of great individuality refuse to take the usual point of view, refuse to use words in the exact sense in which other people use them, and create a scientific language of their own which prevents mutual understanding with other people. Mr. Swinburne shows that he has not been able to study the subject from the usual scientific point of view; he has a view of his own much like that of David Deans in religious matters. He says:—"So far as I am aware there is not any work on the steam- or gas-engine in this country that gives a correct definition of entropy." Throughout the book he is everywhere severe upon other writers. "Most treatises on physics, English and foreign, contain incorrect definitions of entropy." We wonder whether any English writer would be particularly pleased in being told that his treatise was held by Mr. Swinburne to be one of the exceptions to this sweeping indictment. But at p. 119 he goes further. "I know of no writer who has tried to give any sort of explanation of what is meant by entropy, except that it is the quantity factor of heat, which is obviously nonsense." "As a young man, I tried to read thermodynamics, but I always came up against entropy as a brick wall that stopped my further progress." Of course it was not the simple idea of entropy with which we try to make all students familiar which stopped his progress. It was Mr. Swinburne's own idea, and any persevering person who manages to get through this book will say that this idea of entropy (or these ideas, for there are many and inconsistent) has not only stopped Mr. Swinburne's progress, but may send any ordinary man into a lunatic asylum.

He has not only a view of his own about thermodynamics, but a painful examination shows that he has several points of view of his own. When he occupies one of these his statements sound quite orthodox, but presently the reader finds that he has completely changed his point of view, and it is exceedingly difficult for even a painstaking reviewer to find out what particular kind of mistake he is making. He is dealing with a mathematical subject, and yet he will not keep to one definition of any of the quantities he is dealing with. Because of certain old terms such as "latent heat" being in use, he seems to think that in thermodynamics we do not use the word *heat* in a definite sense, and from all that the ordinary writers of treatises say he is not sure that to them external work is not heat or chemical energy or electron-flights or the energy of pedesis (pp. 116–117). He himself takes great liberties with the word, and it is quite evident that he believes heat to be something not yet defined and not yet measurable. He sometimes uses the word correctly as meaning heat received by the working substance; but mostly he thinks of heat as something *in* the working substance, and in the majority of such cases what he calls *heat* is what we should call "intrinsic or internal energy" (see pp. 15, 16 and 32, where he uses "heat" and "internal energy" indifferently).

Thus, at p. 124, after some vague phrases which he seems to regard as a definition, he says, "this definition of heat includes the heat that makes things hot, and locomotive heat in general, and it also includes 'latent heat' at constant volume, but only part of any misnamed 'latent heat' that includes any form of external work. It includes latent heat of fusion, of vaporisation apart from external work, and of allotropic modification. What is most heterodox is that it includes chemical energy." It is hardly believable that in a dynamical illustration (p. 108) he should imagine the momentum of a system of two colliding bodies to be increased by the collision, in opposition to the most fundamental, most elementary principle of mechanics. Possibly, as in the case of entropy, he attaches a novel meaning to such a term as momentum. Men who use the *poundal* will be interested in a statement on p. 57:—"But as we have the foot-pound and I think, the poundal, as units of energy. . ." I mention only a few of these curious things without comment, because any adequate comment would almost seem to be a personal insult.

He possesses the power of persuasively stating or implying as a major premiss some general notion of his own and then drawing the conclusions which he wants to draw. For example (p. 136), "The fact that certain units in thermodynamics have no names goes to show that the science is not fully developed. Measurement is an essential in science." In the first part of this he implies the great major:—a science is not fully developed (as no science is fully developed, he means "is badly developed") unless the units of the quantities dealt with have names. Is dynamics badly developed? And is there a name for the fundamental unit of all, the unit of momentum? In the second part he implies that there is no measurement if there are no names for the units. Is there no measurement? Is there not the most accurate measurement of momentum? Is mathematics, is Euclidean geometry a science? What are Euclid's names for the units of length or area or volume? Is astronomy a science? What is the name for the units of force or momentum used by Newton? He immediately proceeds to give as an example that there is no name for differences of temperature according to the absolute Kelvin scale. I think that he does not mean the absolute scale of 1848, because that scale is only of historical importance; he probably means the perfect gas scale invented by Clausius in 1850, which Kelvin showed in 1854 to be independent of the nature of the working substance—well, why can he not be satisfied with the name "degree"? Surely he might have tried to suggest a better name.

The name *Rank* is used by many English speaking people for the British unit of entropy, and it even appears sometimes in examination papers; it is most appropriate. But of course, it would be out of the question to expect Mr. Swinburne to use an existing name, so he wishes to have the word *Claus* used for the British unit of entropy. Rankine used this unit always; it is impossible to imagine that Clausius ever did, or that any person not an Anglo-Saxon ever will. This may merely indicate love for the foreigner. Rankine, Cotterill, Ewing and others have given great pains to perfecting tables of the properties of steam. I know that my students and I spent some months on tables that I myself have published. But the only tables of which Mr. Swinburne makes mention are certain American tables which are obviously incorrect in very important particulars. Reeve's tables are certainly elaborate enough, but every one of the 789

values of the volume of a pound of steam happens to be wrong.

He says (p. 68), "The whole nomenclature of thermodynamics demands re-modelling." Of course we all know that there is much in scientific nomenclature which we should like to re-arrange, but his sweeping denunciations are mostly applied to things that are quite correct. For example, "To measure the heat received at constant pressure or temperature by a 'specific heat at constant pressure' or 'a specific heat at constant temperature' is absurd." The book is full of this sort of statement, delivered with the air of Cato the Censor, accompanied by very clever un-Cato-like gibing such as might be expected in a cheap monthly magazine when the writers are poking fun at scientific persons.

It is often quite impossible to find out the author's line of thought. For example, on p. 50, where he says, "$d\phi$ on the other hand is a complete differential in terms of the ordinates of the state diagram in which $pv = R\theta$, but it is not a complete differential with reference to the external work or piston co-ordinates of the Watt diagram." No reader of this book can fail to notice that Mr. Swinburne has some novel idea as to the meaning of "a complete differential," and I have given much thought to the above cryptic statement hoping that it would throw light upon this interesting matter, but, alas! it still rests in the deepest kind of obscurity. Want of clearness does seem, somehow, to be inherent in his study of this "slippery" subject, for in a footnote (p. 35) he states that "Rankine is not clear about his 'thermodynamic function'" (now called entropy by orthodox persons). "He certainly did not develop the idea of entropy and its relation to waste which forms the basis of this book. No doubt a man of his ability, if he had written on steam engines somewhat later" (Rankine's book on steam engines, published in 1859, is not altogether unknown), "would have been not only perfectly correct, but also clear and unambiguous in his statements and definitions." It is evident that Rankine and Bahram, the great hunter of Omar Khayyam, have something in common, and that in this note Mr. Swinburne departs more than usual from the attitude promised by him on p. 4, that he was not writing "in any spirit of superiority." One is inclined to use the language of Tennyson addressing Bulwer Lytton, "What, you a Timon, . . .!" but it is better not to quote the words; they are omitted from the later editions of Tennyson.

Probably the obscurity is deepest in connection with the meaning of a pv diagram. He says (p. 49), "There is considerable confusion as to the meaning of a pv diagram; that is to say, as to what p means in an irreversible change. As a pv or Watt diagram is . . ." I beg to tell Mr. Swinburne that a Watt diagram is not what anybody means (unless when speaking casually and hurriedly) by a pv diagram; that in thermodynamics we are dealing with a quantity of stuff the v, p and t of which are supposed to be known at each instant, and that if we are not so dealing, if we have irreversible changes, to speak of the pressure of the stuff is to talk nonsense; to speak of a pv diagram is to talk nonsense. He says (p. 71), "If the common statement that the area of a $\theta\phi$ is the same as or proportional to that of the pv diagram were correct" (it certainly is correct) "there would be . . ., and all steam and gas engines would have an efficiency of $(\theta_1 - \theta_2)/\theta_1$." I can explain the meaning of this very incorrect statement only on the assumption that Mr. Swinburne does not know the cycle of a steam or gas engine. The context shows that he means by θ_1 and θ_2 (at all events in the case of a steam engine) the highest and lowest temperatures. Now even on the Rankine cycle of the perfect steam engine the above efficiency is not reached, and any other steam engine cycle, even if reversible, known to us, has a smaller efficiency that the Rankine cycle.

I think that most of Mr. Swinburne's mistakes arise somehow from a belief that it is easy, or ought to be easy, to explain exactly what occurs in irreversible processes, and if without attacking other people he set himself to such a study, even so ill equipped as he seems to be for the task, he would have the sympathy of all students of thermodynamics. Most certainly it would be dangerous for me to criticise him, for I myself have given hostages to fortune in that some six years ago I published an attempt to study what occurs when steam is released from a cylinder, and the other irreversible operations in a steam cylinder. The late Prof. Fitzgerald commended my attempt, but I must confess that although I gave much thought to the matter I published it with some expressions of dissatisfaction. I must, however, say something about Mr. Swinburne's discovery, which resembles the famous pill to prevent earthquakes, namely, his $\theta\chi$ diagram. If θ is absolute temperature, $\theta.d\chi$ is the increase of energy "in the form of heat in the body itself." Close study shows that he here means the heat energy received by the body during a small change minus the work done in the body's expansion. Well, this is what we orthodox people call intrinsic energy dE. We may put it, then, in this way: if dH is the heat received by a body the p and θ of which are the same throughout,

$$\theta d\chi = d\mathrm{E} = d\mathrm{H} - p.dv,$$

or

$$d\chi = d\mathrm{E}/\theta = d\mathrm{H}/\theta - p.dv/\theta.$$

Now Mr. Swinburne uses a $\theta\chi$ diagram to show the changing state of the water-steam stuff, and so means what we mean when we say that $d\chi$ is a complete differential. As, to Mr. Swinburne, the subject is, as he himself says, "slippery," I would ask him to take no difficult case, no irreversible case, but to take any pv diagram of any steam engine, and he will find that he cannot close his cycle in a $\theta\chi$ diagram. In fact, when p and v and θ and E and ϕ all return to their old values at the end of a cycle χ does not do so. This happens to be a matter of mathematical proof, for if $d\mathrm{H} = k.d\theta + l.dv$, Mr. Swinburne's $d\chi$ cannot be a complete differential unless l is equal to p. That is, the substance must be one the intrinsic energy of which is a function of its temperature only. A perfect gas has this property. Changing water-steam certainly does not possess it. If his discovery is found to be worthless in all cases where we have a pv diagram where we can test its value, why should we think it of worth for irreversible cases of which we know so little?

Probably the most curious of his conflicting notions about entropy is what he develops in chapter iv. When heat is being conducted along a bar or through a plate from furnace to water, he speaks of the great growth of entropy. It is useless to point out to him the importance of keeping to one definition. But surely even he must see that there is something quite inconsistent in two of his ideas. First, that if the state of a quantity of stuff is known, its entropy is known. This is, of course, a mere statement of the second law of thermodynamics, and he occasionally admits its truth. Second, a thin slice of bar which is conducting heat keeps in the same state all the time, and yet it is losing entropy continually, that is, it is giving out more entropy than it receives. He introduces a new idea quite inconsistent with his other ideas, that entropy is something which may travel from one body to another. He grudgingly allows us to talk of heat being transferred, or any kind of

energy being transferred, but cheerfully introduces this new idea of a peripatetic entropy.

The fact is, so soon as a man departs from the mathematical definition of a quantity like entropy, he is in danger of all sorts of inconsistency. Conduction of heat implies that temperature is *not* constant in the thinnest slice of a bar or portion of fluid, and we have no right to speak of the entropy of a portion of stuff or of its pressure or of its temperature unless it is in the same state throughout. It is obvious that underlying Mr. Swinburne's statements throughout this book it is not always the entropy of a quantity of stuff that he thinks of; it is often the entropy of a quantity of heat, just as if we said:—Heat H in the furnace at a high temperature θ_1 has entropy H/θ_1; in the water of the boiler θ_2 is the much lower temperature, and the entropy H/θ_2 is much greater than in the furnace, and so on. Wherever there is conduction or any kind of irreversible operation there is a growth of entropy. This sort of representation is familiar to all users of the $\theta\phi$ diagram, but they know how to put the matter quite clearly (see NATURE, April 30, 1903) without using terms in a wrong sense, without confusion of ideas, without condemning wholesale what other men have written, without contradicting the fundamental laws of thermodynamics.

This notice may seem to be unduly long; I may seem to waste valuable space in NATURE and give undue importance to an unscientific book. But unhappily it is necessary. Mr. Swinburne's vague denunciations of writers on thermodynamics in letters and articles to the engineering papers have done a great deal of harm to young engineers, and I am peculiarly bound to the very ungrateful task of pointing out his mistakes. A writer who proves that the earth is flat deserves no notice, for he can do no harm, but although Mr. Swinburne's heresies are just as unscientific, just as absurd, they must be noticed and condemned. He uses a jargon which sounds quite scientific to a young engineer; he involves a reader in his mistakes so persuasively that if this reader is an earnest young engineer I feel sure that he must get utterly discouraged with the idea that the study of thermodynamics can be of any use to him. Probably the best of antidotes to this poison are the two articles in NATURE referred to at the beginning of this notice.

JOHN PERRY.

AGRICULTURAL EDUCATION AND RESEARCH IN INDIA.

THE last mail brings an issue of the Allahabad *Pioneer*, containing the resolution of the Government of India regarding the establishment of an agricultural college and research station at Pusa, in Bengal. It will be remembered that Mr. Henry Phipps gave a sum of 20,000*l.* to be devoted to whatever object of public utility (if possible in the direction of scientific research) the Viceroy might prefer, and on the decision to create with this sum an imperial centre for agricultural investigation Mr. Phipps increased his donation by another 10,000*l.* It was at first proposed to make the existing laboratory at Dehra Dun the nucleus of the new work, but the superior advantages offered by the estate at Pusa have resulted in the decision "to make Pusa the headquarters of the Imperial Agricultural Department, and to establish there the laboratories required by the experts, combining with them farms which will offer every convenience for practical work, and an agricultural college." For this purpose the estate has been transferred from the Government of Bengal to the Government of India, and the existing staff at Dehra Dun will move to Pusa when the laboratories are ready, which is expected to be in September, 1905.

The agricultural college is intended to serve not only Bengal, but the whole of India, and to provide a supply of trained men, who "will be required to fill posts in the Department of Agriculture itself, such as those of assistant directors, research experts, superintendents of farms, professors, teachers, and managers of court of wards and encumbered estates."

At the research institute it appears that the staff is to consist of two chemists, one being specially concerned with bacteriology, two botanists, one cryptogamic, the other "biological," and an entomologist.

This scheme ought to grow into an institution of the utmost value to India, a country which is full of agricultural industries, involving great interests, yet proceeding wholly by rule of thumb tempered by occasional analyses performed in London. Systematic investigations of the conditions of the industry on the spot have been wanting except latterly among the tea-planters of Ceylon and Assam. Indigo growing affords a case in point; for years it was obvious that the natural product was going to meet with severe if not ruinous competition, yet nothing was done until the artificial indigo had reached the position of being able to undersell the Indian article, then at last a chemist and a bacteriologist were hurried out to try to save the failing industry. But how can the most eminent scientific man be expected to descend from Europe like the god from the car and revolutionise an old and complicated business at sight?

The new institute at Pusa will be well situated among some of the best agricultural developments in India, so that the scientific staff will have an opportunity of learning where their skill can be of service to the cultivator, and of trying to keep this or that industry in a healthy condition instead of being called upon to resuscitate it when *in extremis*. There may be even now a chance for the grower of indigo if only he is given some of the systematic scientific effort which has hitherto been the monopoly of his competitor.

NOTES.

PRESS messages from New York contain an account of the discovery, by Prof. Baskerville, of the University of North Carolina, of two new elements possessing somewhat remarkable properties. By distilling thorium oxide in a quartz tube with carbon and chlorine there are produced a greenish condensable vapour to which the name berzilium is given, and a crystalline, pinkish substance which adheres to the quartz tube and is named carolinium, whilst a certain quantity of thoria remains unchanged in the tube. Prof. Baskerville has at his disposal 5 grams of carolinium and 2·5 grams of berzilium, presumably in the form of volatile chlorides. In a lecture before the Chemists' Club Prof. Baskerville exhibited the two elements in a darkened room, and showed that each of them is capable of shedding an illumination through tubes of copper, brass, iron and glass, all covered with cloth. Further investigations are in progress, in which Prof. Zerban, of Berlin, will cooperate.

PROF. R. W. BOYCE, F.R.S., has been appointed a special advisory member of the committee of the African trade section of the Liverpool Chamber of Commerce on matters relating to health and sanitation.

REUTER'S Agency is informed that the British Antarctic vessel *Discovery*, with Captain Scott and his staff, is not

likely to return to England before the autumn. It is expected that the relief ships *Morning* and *Terra Nova* will sail direct for home.

A REUTER message from Montreal, dated April 7, states that "The Board of Trade has decided to take steps to second the proposal of the London Chamber of Commerce to organise tours throughout Canada for English university graduates, as moved at the Congress of Chambers of Commerce held last summer."

THE opening meeting of the Sociological Society will be held at the School of Economics and Political Science, Clare Market, W.C., on Monday next, April 18, when Dr. E. Westermarck will read a paper on woman in early civilisation. The following papers have also been arranged:—May 16, Mr. Francis Galton, F.R.S., on eugenics: its definition, scope and aims; June 20, Prof. E. Durkheim and Mr. V. Branford, on sociology and the social sciences; July 18, Mr. Patrick Geddes, on civics as applied sociology.

M. DE FONVIELLE writes that at a recent meeting of French meteorologists in Paris M. Bouquet de la Grye delivered an address in which he referred to the extent of the work of the French meteorological service. The number of stations in connection with the service sending observations twice daily to Paris is 126, of which 72 are in foreign parts and 7 are mountain observatories. During 1903 it appears that sixty storms visited the coasts of France, of which fifty were announced by telegrams. Ninety per cent. of the storm warnings published in the Press were verified. During the same year the meteorological kites reached the great height of 5960 metres. The conclusion of the speech of M. Bouquet de la Grye was devoted to the work of Sir Norman Lockyer on the connection between solar and terrestrial phenomena.

SOME of the effects produced by the high altitudes traversed by the Tibet expedition were referred to last week (p. 540). Imperfectly cooked food caused indigestion among the troops, and congealed oil led to difficulties with the magazines of the rifles. Commenting upon these points a correspondent of the *Times* remarks:—"Any tiro in physical science could have told the military authorities that at 15,000 feet above the sea oil ceases to be a lubricant and becomes a clog. Also that the temperature of water boiling in an open vessel falls roughly two degrees Fahrenheit for every 1000 feet you ascend. He could also have given the remedy in both cases. Our men ought to have had pure glycerine to lubricate the locks of their rifles and Maxims. They ought to have had cooking-pots with air-tight lids furnished with simple safety valves blowing off at a pressure of 15 lb. on the square inch. Then they would have had no trouble either with rifles or cooking. The tiro could also have pointed out that the elasticity of springs, and especially of certain kinds of spring, is greatly affected by temperature, and that it would have been well to test the Maxims at such temperatures as they would certainly have to encounter."

THE Deutsche Seewarte has made a very useful addition to its international ten-day weather report by the issue of charts showing, for 8h. a.m. each day, the distribution of atmospheric pressure over the North Atlantic between the continents of North America and Europe by means of isobaric lines, with arrows denoting wind direction and force. The positions of the areas of high and low barometric pressure are plainly shown, and are the more interesting and valuable from the fact of the publication of the charts so soon after date. The supplement to the weather report of April 1 last, for instance, contains the daily isobaric charts for March 1–10, together with tabular statements as hitherto of the ten-day results of pressure, temperature, and rainfall at stations in North America, Europe, and intermediate islands.

IN several papers descriptions have recently appeared of a "novel method of electric traction," in which the current is employed to generate steam in an ordinary locomotive boiler by means of an electric furnace. The system is obviously very wasteful of power from a thermodynamic point of view, and those who wish to learn what the waste would amount to under actual conditions will find a letter on the subject, by Mr. Arnold G. Hansard, in *Knowledge and Scientific News* for April.

AN interesting account of the Imperial University of Tokyo is contributed to a recent number of the *Popular Science Monthly* by Mr. Naohidé Yatsu. It will probably interest European readers to learn that "in so remote a time as the eighth century a university had already been established in Japan that included such modern divisions as schools of medicine, ethics, mathematics, history, and that some of the text-books employed at that remote period dealt with such subjects as the diseases of women, *materia medica* and veterinary surgery, types of text-books which appear to have been unknown in European countries until about 1000 years later."

A RECENT number of the *Revue générale des Sciences* contains a short note on the Arnold electropneumatic system of traction, the object of which is to overcome the difficulties connected with electric traction by alternating currents consequent on the variable velocity of the train. The motor in this case consists of a stator and a rotor, of which the latter is directly fixed to the axle of the wheel. The stator is, however, free to rotate, but by doing so it operates on a condensing pump connected with an air engine, which in its turn works on the wheels. When the train is running at a speed corresponding to synchronism, the stator remains at rest, and the apparatus then works like an ordinary alternate current motor. In starting the train, on the other hand, the pneumatic action is brought into play, the necessary synchronism being maintained by the rotation of the stator.

A PAPER has been communicated to the Vienna Academy by Dr. N. Herz on a generalisation of the so-called "problem of eight points." The problem may be stated as follows:—If from any four points the twelve angles subtended by four objects are measured, or if from any three points the twelve angles subtended by five points are measured, then the relative positions of the eight points are completely determined. The importance of the problem is obvious in connection with the photographic survey of unexplored districts, as by comparing the relative positions of the same five objects on three different plates, a plan of the region can be constructed with greater precision than is possible with sketches.

THE catalogue of additions to the library of the Botanic Gardens, Kew, received during 1903, forms appendix ii. to the *Bulletin* and is printed as usual on one side of the paper only, so that the titles may be cut out if desired.

A PAMPHLET dealing with diseases of the sugar cane has been received from the Imperial Department of Agriculture for the West Indies. This contains the substance of three lectures delivered by Mr. Lewton-Brain, the official mycologist in Barbados, in which special consideration was given to the rind and root diseases. As Sir Daniel Morris

mentions in the preface, the rind fungus caused the damage to the canes in 1895, but this was overcome by the introduction of a resistant variety. The root disease caused even greater disaster last year, and as so far no variety has been obtained which is resistant to its attack, the planter has to adopt more laborious and continuous measures of dealing with it.

JUDGING from the fact of its having reached a third edition, Dr. Hoyle's "Handy Guide" to the Manchester Museum appears to be highly appreciated by the class of visitors for which it is intended.

DR. R. W. SHUFELDT, in the January number of the *American Naturalist*, discusses the osteology and systematic position of the grebes and divers (Pygopodes). The author maintains his former opinion as to the probability of these birds being the descendants of toothed divers more or less closely allied to the American Cretaceous Hesperornis, the grebes exhibiting the most marked traces of this relationship. As the flightless Hesperornithidæ themselves are doubtless the descendants of flying types, so, in the author's opinion, our modern grebes and loons may, if they survive long enough, become in the course of ages modified into forms incapable of flight.

THE biological articles in the January number of the *Journal* of the Straits Branch of the Royal Asiatic Society include an account of new Malayan plants by Mr. H. N. Ridley, a list of Bornean butterflies by Mr. R. Shelford, the description of certain Hymenoptera in the Raffles Museum at Singapore by Mr. P. Cameron, and notes by Mr. G. B. Cerruti on the Sakais of Batang Padang, Perak. Although it may be doubtful whether the forest aborigines whom the Malays designate Sakai are really true Negritos, Mr. Cerruti's essay demonstrates that they are certainly of a very low grade, being destitute of either written records or of signs to represent language.

IN the *American Naturalist* Mr. R. S. Lull continues the "symposium" on the adaptive modifications of mammals, taking for his text those induced by the exigencies of a cursorial mode of existence. Naturally the greatest modifications occur in the limbs, but correlated with this is also an elongation of the head and neck in long-legged types. Adaptation for speed is further exhibited in the moulding of the shape of the body so as to present the minimum amount of resistance to the air, as well as in increase in heart and lung capacity to meet the extra expenditure of energy. Finally, in the jumping forms we meet with an increase in the length and weight of the tail, which has to act as a counterpoise. As regards the feet, a reduction in the number of digits is a frequent feature, more especially among the hoofed forms, where the culmination in this respect is attained by the existing members of the horse tribe and certain representatives of the extinct South American Proterotheriidæ, both of which are monodactyle.

ACCORDING to the report of the Marine Biological Association of the West of Scotland for the past year, which is illustrated with a portrait of Sir John Murray, the station at Milford has undergone considerable enlargement and extension through the liberality of Mr. J. Coats, jun. Notwithstanding the building operations, which commenced in May last, the work of nearly all the departments shows an excellent record for the year. It is satisfactory to learn that Sir John Murray, who has filled the office of president for the last three years, has offered three prizes of 50*l.* each for papers on that number of subjects connected with the work of the association. The prizes are given in memory of the late Mr. F. P. Pullar, who was long associated with Sir John in the bathymetrical survey of the Scottish lochs, and who lost his life in an ice accident in February, 1901. "These prizes are open for competition to investigators from any part of the world who conduct observations in the several subjects at the Millport Marine Station, and who produce at any time before January 1, 1905, papers which, in the opinion of a committee of three scientific men, to be nominated by the Association and by Sir John Murray, shall be deemed to be of sufficient value to merit publication."

PROF. LOEB, whose work on artificial parthenogenesis is well known, has recently succeeded in causing the fertilisation of the egg of the sea-urchin by the sperm of the starfish. This interesting result has been brought about by altering the constitution of the sea-water, preparing an artificial sea-water (NaCl 100, KCl 2·2, $MgCl_2$ 7·8, $MgSO_4$ 3·8, $CaCl_2$ 2 in half gram-molecular solution), and rendering it slightly alkaline with caustic soda (0·3–0·4 c.c. of deci-normal NaOH per 100 c.c. of the solution). In this some 50–80 per cent. of the sea-urchin (*S. purpuratus* and *S. franciscanus*) eggs may be fertilised in a short time by the addition of living sperm of a starfish (*A. ochracea*). The eggs form a membrane of fertilisation, and at the proper time segment and develop into swimming larvæ. The ultimate development of these hybrid larvæ has yet to be observed (University of California *Publications*, Physiology, vol. i., No. 6, 1903).

THE problem of the further development of Halteridium, a blood parasite of birds, and its definitive host has until now remained unsolved. Schaudinn has recently published an exhaustive paper on the cycle of development of a Halteridium of the little owl (*Athene noctua*). He traces the further development of the parasite in the middle intestine of the common gnat, *Culex pipiens*, and finds that in this insect it becomes a well defined flagellated organism or trypanosoma. The male and female gametes conjugate in the mosquito, and certain of these cells develop into asexual trypanosomes, others into thick trypanosomes having female characters, and others into small slender trypanosomes having male characters. The parasites congregate in the poison-gland of the insect, whence they are injected into a fresh host when it bites. The trypanosome forms then attack the red blood cells, enter these, and lose their flagella, becoming the intra-corpuscular Halteridium forms once more. Schaudinn re-names the parasite *Trypanosoma noctuae* (*Arbeit. aus d. kaiserl. Gesundheitsamte*, xx., Heft 3).

IT is quite clear from the report of the council and proceedings of the Hampstead Scientific Society for the year 1903—a copy of which has been received—that the association is doing good and useful work, particularly at meetings of sections, of which there are three—astronomical, natural history, and photographic. The number of members now stands at 315, a total increase of 29 members since the last report.

THE first part of "A Technological and Scientific Dictionary," edited by Messrs. G. F. Goodchild and C. F. Tweney, and published by Messrs. George Newnes, Ltd., has been received. It consists of 64 pages, and contains articles, definitions, and terms of science and technology in subjects the names of which begin with letters from A–B(ow). The dictionary is to be completed in fifteen parts, and each part costs a shilling net.

MESSRS. HARRY W. COX, LTD., have sent us a copy of a new illustrated catalogue of their induction coils, inter-

ruptors, X-ray tubes, apparatus for fluoroscopy and radiography, primary and secondary batteries, high frequency apparatus, dynamos, and other instruments. Many useful details as to the various instruments are described; and the catalogue also contains about thirty pages of practical hints to beginners, which will prove of assistance to those who propose to work with Röntgen ray, high frequency and electromedical apparatus.

A SECOND edition of Prof. Stanislas Meunier's volume on "La Géologie expérimentale" has been published by M. Félix Alcan, Paris. The work contains many ingenious and instructive experiments illustrating the phenomena of geology and physical geography, and most of them can be performed successfully with very simple appliances. The original edition was reviewed in NATURE in August, 1899 (vol. lx. p. 388), and the new volume, though dealing essentially with the same subjects, is differently arranged, and includes much new matter.

PROF. W. OSTWALD'S "Grundlinien der anorganischen Chemie" (Leipzig: Engelmann; London: Williams and Norgate), which originally appeared in 1900, and was reviewed in NATURE of April 11, 1901 (vol. lxiii. p. 557), has reached a second edition. The work provides students with a text-book in which chemistry is developed from the outset in accordance with modern theoretical knowledge. The book attracted immediate attention, not only on account of the author's eminence as a teacher and investigator, but also because of its plan of treatment. The new and revised edition will certainly meet with the same success as the original work, of which the edition of four thousand copies was exhausted in about three years.

A SECOND edition of "Towers and Tanks for Waterworks," by Mr. J. N. Hazlehurst, has been published by Messrs. Wiley and Sons (London: Chapman and Hall, Ltd.). The book deals with the design and construction of metal stand pipes and tanks for storing up water at a sufficient elevation to provide adequate pressure for its proper distribution. A review of the original volume appeared in NATURE of September 26, 1901 (vol. lxiv. p. 525). Another work just published by Messrs. Wiley is the eighth edition of "The Theory and Practice of Modern Framed Structures," by Messrs. J. B. Johnson, C. W. Bryan, and F. E. Turneaure. This comprehensive volume is designed for use in technical schools and by engineers in professional practice. A large part of the original work has been re-written, and many changes have been made in other parts to bring them into close touch with modern practice. The new designs and improvements in methods of description, the practical character of the text and illustrations, and the use made of graphical representation, combine to make the volume one to which all students of engineering should have access.

A DETERMINATION of the molecular weight of solid phosphoretted hydrogen, described by Messrs. Schenck and Buck in a recent number of the *Berichte*, has shown that this compound has a more complex formula than that which has usually been assigned to it. The method employed consisted in determining the depression of the freezing point of a solution in yellow phosphorus, and the results obtained indicate that the molecular weight corresponds with the formula $P_{12}H_6$, and not with the simple formula P_4H_2.

M. GUILLAUME sends a correction of the note on nickel-steel which appeared in our issue of March 24 (p. 496); the coefficient of expansion of γ-iron is greater than that of α-iron, and all non-magnetic steels in which the iron is retained in the γ form, such as Hadfield's manganese steels, retain the large coefficient of expansion characteristic of this modification of iron. M. Guillaume adds that "the function of nickel in the alloys is essentially to unite into a single change the two transformations of pure iron, and thus, as M. Osmond has shown, to eliminate altogether the β variety; then, on account of the state of mutual dissolution in which the two chief constituents of the alloy are found, to create an equilibrium varying with the temperature, such that the transformation of α into γ iron and conversely takes place over a considerable interval instead of being concentrated at a single point as in pure iron."

A SOMEWHAT striking observation is recorded by Dorn in the *Physikalische Zeitschrift*. A tube of alkali-free Jena glass, containing 30 mg. of radium bromide, had been sealed up on December 3, 1902, in order that some experiments might be carried out on the supposed loss in weight of radium salts. Six months later, on May 27, 1903, it was desired to open the tube. This was done by means of a triangular file, but as soon as the metal touched the surface of the glass the tube was pierced by an electrical spark so bright as to be clearly visible in broad sunlight close to the window, whilst the sound was mistaken by an assistant in the room for the discharge of an induction coil. It is suggested that the retention in the tube of the positively charged α particles and the escape of the negatively charged β particles must have set up a potential difference between the inside and the outside of the tube so great that it was ultimately able to pierce through 0·3 mm. of glass.

THE electrochemical behaviour of radium is discussed by Mr. Alfred Coehn in a recent number of the *Berichte*. From the thermochemical data it would appear that the separation of the metal would be increasingly difficult in the series Ca, Sr, Ba, but when a mercury kathode is used the voltage required is greatly reduced owing to the energy liberated in the formation of an amalgam, and the order in which the metals separate is reversed. Thus it requires 0·2 volt more to separate strontium than barium, and 0·25 volt more to separate calcium than strontium; if the series were continued radium should require 0·3 or 0·4 volt less than barium, and metallic radium can actually be precipitated by barium amalgam. Owing to the very small proportion of radium in the crude bromide it is impossible to effect a sharp separation of the metals except with an impracticably small current density, but a considerable concentration may be effected by this method. It is of interest to note that freshly prepared (unoxidised) radium amalgam, like the salts of the metal, only slowly attains its maximum activity, whilst the silver anode, which at first exhibits a very powerful induced activity, soon becomes altogether inactive.

THE additions to the Zoological Society's Gardens during the past week include a Maccarthy's Ichneumon (*Herpestes fulvescens*) from Ceylon, presented by Mr. Arthur M. Dowson, R.N.; a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Mr. W. A. Ridley; a Cocteau's Skink (*Macroscincus cocteaui*) from the Cape Verde Islands, presented by Mr. — Hastings; two Painted Frogs (*Discoglossus pictus*), European, presented by Dr. F. G. D. Drewitt; three Jays (*Garrulus glandarius*), British, purchased; an Eland (*Orias canna*), a Mouflon (*Ovis musimon*), eight American Timber Wolves (*Canis occidentalis*), a Muscat Gazelle (*Gazella muscatensis*), born in the Gardens; a Black Swan (*Cygnus atratus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE GREENWICH SECTION OF THE ASTROGRAPHIC CATALOGUE.—At the meeting of the Royal Astronomical Society held on March 11, the Astronomer Royal gave the chief particulars concerning the first part of the Greenwich section of the International Astrographic Catalogue, which is now quite ready for publication. The whole section comprises the region between declination +64° and +90°, whilst the part soon to be published deals with the region +64° to +72° inclusive, and covers 1077 square degrees, containing 80,000 stars. From the results already obtained it is computed that the complete Greenwich contribution to the catalogue will include about 179,000 stars.

In his communication Mr. Christie stated that the number of stars per square degree increases with the declination until a maximum is reached at +76°; this effect is probably due to the Milky Way. A discussion of the relative magnitudes of the stars obtained on the catalogue plates has shown that stars down to at least the eleventh magnitude appear on negatives which received six minutes' exposure (the *Observatory*, April).

THE COMPUTATION OF ELEMENTS FOR AN ANNULAR ECLIPSE.—A paper by Herr Zwack, secretary of the Philippine Weather Bureau, issued as a supplement to the *Bulletin* for August, 1903, explains the method used in computing the elements for an annular eclipse of the sun. The method of successive approximations is illustrated by a detailed explanation of the procedure employed in computing the elements for the annular eclipse of March 17, 1904, as seen at San Domingo (Batanes Islands) and Manila (Luzon).

RAPID CHANGES IN A SUN-SPOT.—In a communication to No. 343 of the *Observatory*, Mr. Denning gives particulars of some rapid changes which he saw take place in a sun-spot on January 22. The spot was one of four in the north-west quadrant, and it had a triple umbra. Whilst Mr. Denning was observing, one of these umbræ became greatly modified, and two new small spots appeared. Mr. Denning suggests that much valuable information regarding the behaviour, the formation, and the cyclonic conditions of spots might yet be obtained by more persistent observations. Solar observations generally terminate when the positions and forms of the spots have been recorded, and from these records valuable knowledge as to the period and loci of sun-spots has been deduced, but for about the last forty years very little consistent work has been done in *persistently* noting the minute yet constant changes which take place in the disturbed regions about spots.

Mr. Denning further suggests that daily observations extending over several hours would probably produce results which would completely justify the outlay of the time necessary for making them.

PHOTOGRAPHIC OBSERVATIONS OF BORRELLY'S COMET (1903 *c*).—A paper by Mr. Sebastian Albrecht in No. 2, vol. xix., of the *Astrophysical Journal* describes thirty-one negatives of the comet 1903 *c*, taken at the Lick Observatory, between June 22 and August 18 inclusive, with the Crocker telescope and the Pierson camera respectively.

The negatives show two tails, one about 10° in length and generally straight, the other about 1°·5 in length and much curved. In addition to these, occasional streamers developed and were generally fairly persistent, narrow and straight, sometimes emanating from the main tail, sometimes from the coma. The modifications in the main tail which have been previously noted by the observers at the Nanterre and Yerkes Observatories are very prominently shown on the negatives secured at Lick on July 23, 24 and 26, three beautiful reproductions of which accompany Mr. Albrecht's communication. The negative of July 23 shows an entirely new tail, having a length of about 4° and an angular width of about 4°·6, issuing from the head and preceding the radius vector by about 6°. This feature is not shown on the negative secured on July 24.

The paper also contains a discussion of the various changes, together with several tables giving the dimensions and positions of the tails and streamers which are shown on the negatives.

THE EVOLUTION OF EMPIRE.

NO matter what may be the subject of investigation, the process of evolution always appears as a progressive movement from the simple to the complex, from homogeneity to heterogeneity. It is so in zoology when the simple self-contained cell by segmentation sets out on the upward path of organisation; it is so in sociology when the primitive homogeneous community through division of labour takes the first step in civilisation; it is so in art; it is so in letters; it is so in all the multifarious domains of human experience, and the evolution of empire forms no exception to the rule. In every case the method is the same. The course pursued is a zig-zag or spiral, which tends now towards difference and again towards agreement; there is a constant ringing of the changes between variation and integration, and the goal is ultimately reached under the simultaneous or alternate influence of the forces of separation and union.

In the cooperation of these apparently antagonistic factors towards a common end lies the paradox of all ages. It is the riddle of the sphinx which each succeeding generation must solve or succumb. Ancient philosophy made many good guesses at the truth. Herakleitos, 500 B.C., wrote, "Opposition unites; from what draws apart results the most beautiful harmony; all things take place by strife." Empedokles a few years later spoke of creation as the product of love and strife, "From these come all things that are or have been or shall be." Still later Plato, referring to the teaching of Empedokles, wrote, "Being is many and one and is controlled by hate and love; borne apart it is always borne together." The Persians personified the antithesis under the dualism of Ormuzd and Ahriman, the powers of light and darkness. So universal is this concerted antagonism that it seems to be inherent in the very essence of things, and is doubtless a manifestation of the polarity which pervades creation. Even in music, the most fugitive and intangible of arts, the process of evolution through difference and agreement is clearly marked. The simplest music is in unison—to this succeeds a differentiation into various parts, and these are ultimately blended in harmony. So that the sequence, here as elsewhere, is from unity, through difference, up to union, the reintegration being more complex and in a far higher plane of performance than the uniformity from which it was evolved.

It was left for Darwin to focus the vague surmises of his predecessors and to demonstrate the systematic operation of variation and integration in the production of new forms. Science since his day has been occupied in applying his theory to fresh fields of inquiry, and in no department has a richer harvest of results rewarded the investigator than in tracing the application of the laws of evolution in the development of communities.

Comte was of opinion that the most fruitful results would follow the process of sociological suggestion followed by zoological verification, and striking confirmation of the efficacy of this method is found in the fact that Darwin got the first hint of his discoveries from contemplating the dilemma of Malthus with regard to population. This sequence is most rational, for selection has arrived at a far greater degree of finality and excellence in living forms than in social organisms. In each case nature proceeds by continual invention and experiment and ruthless discarding of failures, but in zoology the problems are simpler, because the factors are more determinate than in sociology. The rigorous dynamics of blood pressure and the limitation of speed of nerve currents are fixed conditions which prescribe the economic size of the individual. These conditions have existed since the beginning of the world—the necessity of rapid reaction to stimulus and of vascular efficiency has caused the elimination of the unwieldy antediluvian monsters in favour of the marvellously agile and tensely arterialised modern carnivora.

In sociological problems the hand of nature is still that of the apprentice. New conditions as to communication and transport have rendered previous conclusions nugatory. The difference in speed of communication to-day as compared with 300 years ago is illustrated by the fact that the news of Queen Elizabeth's death did not reach some parts

of Devonshire until the Court was out of mourning, whereas the message announcing the death of Queen Victoria outstripped the sun. It has been well said that the extent of the unit of government is determined by the facility of communication, so that in the age of electricity all former notions in this respect have to be recast.

Nature may therefore be said to be still in the first chapter of Genesis in regard to social evolution. Probably with abundant provision for autonomy the social organism may eventually be found to be capable of world-wide extension, and the poet's dream of the parliament of man and the federation of the world may at some remote epoch be realised. But this far off event will not be hastened, but rather retarded, by any premature attempt to snatch attainment. A pebble dropped into a pond stirs in ever widening waves the whole surface of the water, but the extension depends on the orderly progression of each succeeding circle. There are no sudden leaps in evolution. "From lower to the higher next, not to the top is Nature's text." It is by timely limitation that the due furtherance of the process is ensured.

The evolution of empire is of intense interest to all, and is of vital importance to the British race, because it has stretched further afield and covers a greater and more diverse area than has ever been previously attempted. The idea which possessed many well disposed people at the advent of the International Exhibition epoch that the future rivalry of nations would take place in a fair field of industrial emulation, that fiscal barriers would be abolished, and that war would soon become an anachronism, must now, to say the least, be pronounced as premature. It is true that the nation, which was formerly regarded as the finished social product, has become the raw material out of which empires are constructed. The areas of government have consequently been extended, but it is only what may be regarded as division fences that have been removed. The ring fences are higher than ever. The international nexus is still of the feeblest texture, and organisation must for a long period continue to be intra- and not inter-imperial. Those are the best cosmopolitans, and best advance the destined solidarity, who pay due regard to the definite problems of the present. It is quite certain that the future will be attained by a continuance of the recognised methods of natural selection, namely, cooperation within the circle and competition without. It is well constantly to bear in mind the invariable biological rule that organisation must increase with size. Mere bulk without adequate organisation only serves to increase vulnerability. The view that the British Empire, the most extensive of all, can afford to remain less organised than any is a dangerous heresy. Not further aggregation but integration is the pressing need of the age, and the success which has in recent years attended the bringing of large areas under the federal form of government indicates that in federation will be found the best means of uniting the widely extended territories of Greater Britain. This indication is also supported by theoretical considerations, for federation affords the fullest scope for the variation and the adaptation to local conditions so indispensable to progress; while at the same time it provides sufficient integrating power to coordinate the diversified elements for defence and mutual advancement. It combines firmness with flexibility, and reconciles empire and liberty.

In the middle of last century the government of the colonies from Downing Street was found to be impracticable, and such centralisation would be doubly impossible now that both area and diversity have so greatly increased. To the preceding generation of statesmen the only alternative to the old colonial system appeared to be separation, and most assiduously they set to work to loosen the bonds and to facilitate the severance of the colonies from the Mother Country, and it was in order to pave the way to this desired dissolution that autonomy was granted. In adopting this course they were, however, all unconsciously ministering to the evolutionary requirements of a combined and not of a disintegrated empire. For at that stage the prime necessity for higher organisation was to provide free play for the variation which the diverse circumstances of the widely scattered colonies demanded. The result has been the unfettered development of nations such as Canada and Australia, which have attained an individuality of their own without any diminution, but rather with an increase, of attachment to the Mother Country. They are still daughters in their mother's house, though mistress of their own.

The requirement to-day is for sufficient integrating force to bring the diversified elements into organic union, so as to present a united front to the world and compete on equal terms with highly organised rivals. The harmonious evolution of the empire will then appear as an orderly sequence from the unity of the old colonial system, through the diversity engendered by the "beneficent neglect" and apathy of fifty years ago up to the coordination of individual but component nations in imperial federation. From the scientific standpoint the subject is fascinating, but the question that presents itself to the practical British mind is whether it is possible from a study of the mode of operation of the laws of evolution not only to comprehend the past, but to derive guidance for the future.

The withdrawal of British troops from the colonies, although at the time the step was greatly regretted, enabled the local defences, by a partial elimination of red tape, to be organised on lines better adapted to actual requirements; and we have seen with what advantage the different contingents cooperated on the veldt. Imperial countenance instead of discouragement to the development of similar individuality in naval affairs might be expected to yield equally good results. Many statesmen, both at home and in the colonies, have expressed the opinion that a mistake was made in granting fiscal autonomy to the colonies. This is probably an erroneous view; uniformity would have hindered the requisite variation. But that is no reason why, under an integrating influence, some form of coordination of tariffs might not now with advantage be effected.

In a federation many matters which are ordinarily under central control devolve upon the component States and municipalities, and thereby congestion of the central Government is avoided and autonomy is fostered. Thus the integrating influence in no way checks the working out of their own problems by the people on the spot who have the most intimate knowledge of local requirements. The time is far distant yet when a federal legislature can be established, but the sooner a permanent council of advice is erected the better for the avoidance of blunders in colonial administration. The integrating process must in no way be permitted to stunt colonial individuality and initiative; these should be treasured as the qualities which have led to the pre-eminence of the race. The refusal to crystallise into system is the characteristic of the Anglo-Saxon as compared with the Latin races, and from this capacity for variation springs the genius of the British race for successful colonisation and world-wide empire building.

JOHN A. COCKBURN.

A BOTANICAL LABORATORY IN THE DESERT.[1]

THE great impetus given to physiological and œcological botany by the foundation of research laboratories within the tropics gives some indication of the latent possibilities of the new laboratory established in the desert, where the botanical problems awaiting solution are many and varied. While numerous observations have been made upon the morphology of desert-plants, only a few detached physiological experiments have been conducted on them; yet the desert, with its sharply marked and exaggerated characters, offers a favourable field for research into manifold phases of physiological activity, and such research cannot fail to bring to light truths having a general application to plants of all climes.

Again, inquiries into the details of the geographical distribution should yield much valuable information. Of the flora of a desert tract it is known that many constituent species are descendants of outcasts from the adjoining more fertile lands, but that others belong to a few widespread orders or genera which reappear in deserts far apart, and thus show their antiquity of possession, and finally that

[1] "Desert Botanical Laboratory of the Carnegie Institution." By F. V. Coville and D. T. MacDougal. (Washington, U.S.A.: Published by the Carnegie Institution, 1903.)

still other constituents—few though they be—like *Acanthosicyos horrida* and *Welwitschia mirabilis*, are enigmatic and isolated species the presence of which defies explanation. On the geographical distribution of species in deserts questions present themselves in numbers. For instance, why are certain species limited to specific areas of a large continuous desert? Competition among the component plants is practically eliminated, save, perhaps, in the seedling stage. Is the restriction of area a consequence of temperature, and therefore indirectly one of lineage, or of the chemical or physical nature of the soil, or of a number of factors? The vast North American desert district affords admirable opportunity for answering these and other questions, as it stretches, with small interruptions, from Mexico northward to the heart of the United States, and its different areas display differences in their floras. The Mexican deserts, for instance, give blurred impressions of an enfeebled tropical flora, inasmuch as they include Hæmatoxylon and Guaiacum, which are absent farther north. The Sonora desert in Mexico shows a somewhat exceptional feature in the marked presence of climbers, including malpighiaceous lianes and two other remarkable plants, a tuber-rooted straggling Cereus and the tendrilled cucurbitaceous *Ibervillea sonorae*, which in form recalls Testudinaria. Yet in this same desert there is not wanting evidence in favour of the view that climbers driven into the desert give rise to self-supporting descendants, for *Ipomoea arborescens* is a tree thirty feet in height. Another remarkable assemblage of plants is to be seen in the same desert at the harbour of Guaymas, in the salt waters of which tropical mangrove plants (Avicennia and Rhizophora) are growing side by side with typical desert plants, including two species of Cereus.

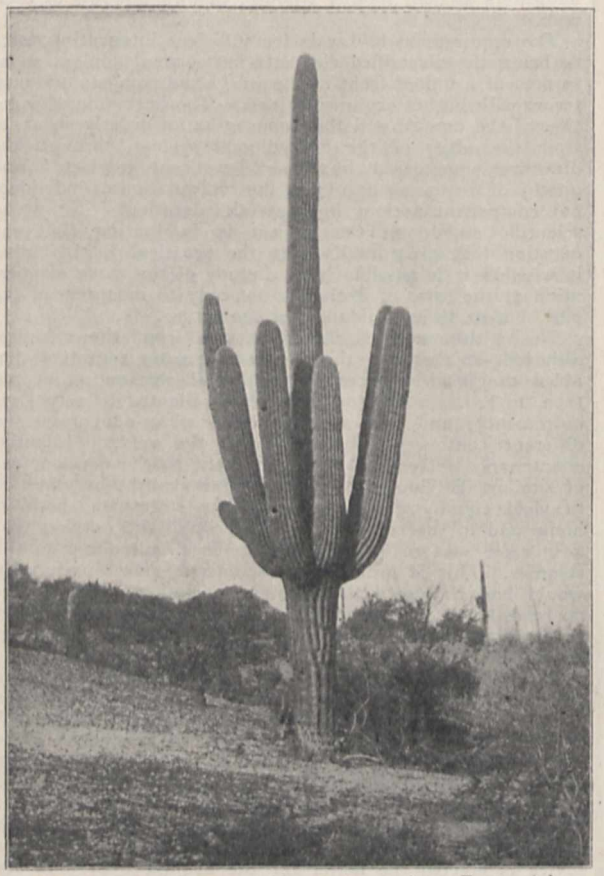


FIG. 1.—Saguaro or giant cactus (*Cereus giganteus*) near Tucson, Arizona. About 40 feet high.

Quite apart from a desert climate, waste tracts can be induced by physiologically dry substrata, such as rocks, shifting sand, gravel, saline or alkaline soils, and these soils, or high winds, may accentuate the sterility of climatic deserts. All these conditions are to be met with within relatively easy reach of Tucson, Arizona, the site of the laboratory, as is shown by the present report, written by Messrs. F. V. Coville and D. T. MacDougal. Desert tracts occur varying from the most forbidding and bare areas with meagre floras to richer ones like that near Tucson, the desert flora of which in an eastward direction gradually gives way to the luxuriant subtropical flora of eastern Texas.

The following particulars culled from the report serve to illustrate the great variety in the deserts within reasonable distance of Tucson laboratory.

South of Tucson lies the desert of Chihuahua, "with a long stretch of sand dunes." Here the sand is siliceous, and *Yucca radiosa*, with its immensely long horizontal roots, plays a great *rôle* as a sand-binder.

The Tularosa desert, on the other hand, exhibits a remarkable area of white shifting sand, mainly composed of calcium sulphate. On these soluble "white sands" *Rhus triloba*, forming hemispherical bushes, fixes the sand, and *Populus fremontii* lives.

Lying farther north than Tucson, the Colorado desert includes gravel-hills, sand-dunes, alkali-flats, as well as wet saline and alkaline spots. Here occur unique groves of a fan-leaved palm, *Neowashingtonia filifera*, growing on alkali-encrusted soil above a moist clay subsoil. Over portions of this desert "the vegetation is subject to a veritable sand-blast," which threatens to sever the telegraph poles at a height of two feet, and has carved the creosote bushes (Covillea) into "most fantastic shapes."

The report includes a record of a few preliminary observations made by Dr. MacDougal, and a bibliography compiled by Dr. W. A. Cannon, the resident investigator. Its value and interest are enhanced by twenty-nine excellent photographs of vegetation in the deserts.

For the establishment of this laboratory botany owes a debt not only to the munificent founder, Mr. Carnegie, but also to the suggester of the scheme, Mr. F. V. Coville.

PERCY GROOM.

FIG. 2.—Group of Palms (*Neowashingtonia filifera*) in the Colorado desert, California.

FIREBALLS VISIBLE IN THE SPRING MONTHS.

THOUGH ordinary shooting stars are rare in the second quarter of the year, fireballs appear to be moderately numerous and to afford definite evidence of some interesting systems which, like the comets of short period, move in *direct* orbits with small inclinations. Many of these systems remain uncertain, and necessarily so from the circumstances, for fireballs are usually seen accidentally, and often only by persons who are unable to record them accurately. But every year fortunately adds something to our knowledge of these interesting and brilliant visitors. They are occasionally witnessed and described by practised observers, their real paths computed, and the accumulated data now enables us to discover the special periods when fireballs are usually abundant and to determine the positions of some of their principal radiant points.

I have just completed a comparison of the dates of more than 100 fireballs (the majority of which appeared over England) seen during the last ten years in the spring quarter, and find the more prolific epochs to have been as under :—

April 1–5, 8–12, and 19–22; May 2–6, 11–16, 24–28; and June 8–10.

A discussion of many hundreds of fireballs observed before 1890, which I undertook some years ago, indicated also the dates May 31, June 6–7 and 28–30. The June 6–7 epoch nearly corresponds with the more recent one of June 8–10, the absence of leap year in 1900 and other causes having probably made the date of occurrence a little later.

Observations this year at the following epochs will be likely to add to our knowledge of these striking objects, and it is hoped they will be specially looked for during the earlier part of the night, for fireballs are more numerous during the two or three hours after sunset than at later times :—

Fireball Epoch	Notes
April 19–22.	Lyrid epoch. There will be slight moonlight.
May 2–6.	Aquarid epoch. Partial moonlight.
May 11–16.	Moon invisible.
May 24–28.	Bright moonlight.
May 31.	,, ,,
June 6–7.	No moonlight in evenings.
June 8–10.	,, ,,
June 28–30.	Bright moonlight.

The fact of there being bright moonlight at several of these epochs need not interfere with observation. Fireballs are sometimes so vividly luminous as apparently "to put the moon into the shade." I have occasionally seen them flash out with astonishing brilliancy and cause shadows, though the nearly full moon was shining at the time!

In April many fine meteors diverge from Virgo and Libra, while in May there are Serpentids, Scorpiids and Ophiuchids. In June the chief radiant is in Scorpio. As a rule, fireballs move very slowly in long flights directed from radiants not far above the horizon. Whenever such objects are seen their paths amongst the stars should be carefully recorded and their durations of flight estimated.

W. F. DENNING.

SEISMOLOGICAL NOTES.

THE periodicity of the aftershocks of the great Indian earthquake of June 12, 1897, is treated by Mr. R. D. Oldham in vol. xxxv. of the *Memoirs* of the Geological Survey of India. The principal conclusions, drawn from the records of the Shillong seismograph, have already been published in the *Journal* of the Asiatic Society of Bengal, vol. xxxi., and the present paper contains particulars of the discussion of other records, of varying completeness, and shows that they confirm the conclusion already arrived at, that there is a tendency to a slight increase of frequency about the time when the horizontal tide-producing forces are varying most rapidly in amount and direction. The paper is illustrated by a number of curves of frequency, among which we may specially refer to one showing the semidiurnal frequency of shocks during the half days in which the variation of tidal stress is greatest and least; the curves are striking as they stand, but would have been even more instructive had the relative frequency been calculated to the mean of the whole year instead of to that of each period. The very marked diurnal variation in frequency is shown to have no relation to the variations of barometric pressure.

In *Die Erdbeben Warte*, Nos. 3, 4, 5, iii. Jahrg., 1903–4, Dr. A. Cancani contributes an interesting paper on the frequency of large earthquakes and small changes in latitude. What the author does is to examine critically, to extend, and to confirm results published in the seismological reports of the British Association (see report for 1900, p. 107), which show that when world-shaking earthquakes have been frequent pole displacements have been comparatively great and *vice versâ*. For example, between 1895 and 1902 inclusive, if we write the number of world-disturbing earthquakes in the position of numerators, and the corresponding pole displacements expressed in seconds of arc in the position of denominators, we get the following series :—

9	18	44 or 47	30	27	17	22	29
0·53	0·91	1·07	0·79	0·72	0·32	0·53	0·97

For the first two years the earthquake records, owing to the small number of observing stations, are somewhat uncertain. The results of investigations published in the British Association report in 1903, which show that large earthquakes have also been frequent when the change in the direction of pole displacements was comparatively rapid, Dr. Cancani has apparently not had an opportunity to discuss. Two other papers in the same journal relate to the magnetic storm of October 31, 1903. In the latter of these, by Dr. A. Belar, references are made to a possible relationship between such disturbances, earthquakes, sunspots, and other phenomena.

An article on the work accomplished by Alexander von Humbolt in the domain of seismology and vulcanology, a description of the terrible shock which on January 25, 1348, destroyed Villach and shook central Europe, a register from the Laibach Observatory, and a reproduction of registers for May, 1903, which are largely those of stations cooperating with the British Association, together with reviews and notices relating to seismology, complete Dr. A. Belar's useful journal.

In No. 19 of the *Publications* of the Earthquake Commission of Vienna, Dr. E. v. Mojsisovics gives a general account of the earthquakes recorded in 1902 in the Austrian Empire, to which he adds an interesting note relating to records obtained from a pair of Wiechert's seismographs established at Pribram, one of which is on the surface and the other at a depth of 1115 m. Both pendulums from time to time show pulsatory movements, but the movements below are less than those on the surface.

In the records of earthquakes with distant origins the details of the seismograms from both instruments exactly agree, with the exception that the amplitude recorded underground is somewhat less than that recorded on the surface, which may mean that one instrument has a smaller sensibility than the other.

No. 20 contains the earthquake register from Reubeur-Ehlert pendulums at Trieste, whilst No. 21 gives similar records from Kremsmünster, both catalogues referring to 1902.

In No. 6, vol. iv., of the *Bollettino della Società sismologica Italiana*, earthquake registers are brought up to the end of June, 1902. In the latest register issued by Strassburg, which refers to June, 1903, we find the duration of the earthquakes recorded at Strassburg and the time of their commencement. In addition we find the "commencements" for teleseisms as recorded at various stations round the world, which for the most part are reproduced from the registers issued by the British Association. In the Laibach registers there are similar but more complete reproductions. The most complete reproductions, containing not only the times of commencement, but also times of certain phases of motion, duration, and amplitude, are those in the *Bollettino*. A sheet that only gives the times at which earthquakes have commenced has a value, but this would be enormously enhanced by adding other details.

CHLOROFORM ANÆSTHESIA.[1]

THE administration of chloroform is a subject that is of personal and direct interest to everyone in this present age of civilisation. Sooner or later either we ourselves or those dear to us gladly accept the relief from suffering that is offered, and that chloroform shall be given so that no unavoidable risk is run is a necessity that forces itself on our attention.

That much remains to be done in the direction of safety is only too evident. We confess to perusing the diagram of the yearly increasing death-rate from chloroform on p. 14 of Dr. Waller's lecture with a feeling of horror, and that is deepened when we read the instances given of such deaths, and supplemented by others which have come to our knowledge independently, where chloroform has been given for a trifling operation to an otherwise healthy patient, and where the phrase "Death from cardiac syncope" has acted as an anæsthetic to the conscience of the ignorant and careless anæsthetist. It is plain that some vital factor in the problem of safe chloroform administration has been overlooked, and what this consists in is readily seen when it is pointed out to us. The student of anæsthetics is taught to regard most carefully the minor details of the process; the observation of the state of the pulse and the condition of the conjunctival reflex is reduced to a fine art, but the most important detail of all, the amount of chloroform administered, is dismissed with the remark, made in our hearing by a professional anæsthetist, "I judge of the dose of chloroform by the effect[2] on the patient"!!! Yet if strychnine or arsenic were given without a measured dose, the folly of the proceeding would be manifest, and the possibility of such a remark, made by one who had spent some time in the study of the subject, shows at least that this study had been misapplied.

To replace ignorance of knowledge it is, however, necessary to do more than talk, and the lecture now under review gives an outline of the research that has been carried on in the physiological laboratory of the University of London on chloroform anæsthesia. It was apparent that there was a great lack of quantitative measurement in the process, and the first step consisted in obtaining a ready and accurate method for the estimation of the percentage of chloroform in air, and this was accomplished by the "densimetric" method. It then became possible readily to ascertain :—

(1) What percentage of chloroform in the inspired air was sufficient to cause anæsthesia.
(2) What percentage of chloroform caused death.
(3) How this death was brought about.
(4) By taking the percentage of chloroform in the *expired* air as well as in the *inspired*, together with the amount of air breathed, to measure the total quantity of chloroform used in any experiment.

Proceeding in this quantitative way, it was found that though death from too much chloroform can occur in either of two ways, yet, so far as the experiments lead us, neither way can occur when chloroform is given regularly in a percentage not greater than 2, and so before we can claim that a healthy patient has died from "idiosyncrasy" or "cardiac syncope" it is incumbent on us to show that we have not given him too much chloroform, and to ascertain that the cause of death (in at least the great majority of cases) arises from this easily remediable source, and not from some mysterious accident, is a very great advance towards safety.

We shall await the results of further observations on the human subject with interest, as well as the records of the use of the Dubois apparatus, which appears to be well adapted for clinical use. But meanwhile the facts here recorded merit the most careful consideration, and clearly point out the lines on which further research must be carried out.

[1] A Lecture on the Administration of Chloroform to Man and the Higher Animals. Delivered in the University of London on October 3, 1903, by A. D. Waller, M.D., F.R.S.

[2] By a curious mental process this anæsthetist, when the patient dies, does not consider that too much chloroform has been given, but that death has occurred from "idiosyncrasy"!

THE FIRST INTERNATIONAL CONGRESS FOR SCHOOL HYGIENE.

THAT it should be possible to hold an international congress on a subject which a few years ago had but little attention paid to it shows the enormous strides which have been made in the knowledge of the hygiene of children attending schools.

The first International Congress of School Hygiene was held at Nuremberg from April 4 to 9, and the credit for starting the congress must be given to Prof. Griesbach, the president of the "Allegemein deutschen Vereins für Schulgesundheitspflege." The energy and determination with which Prof. Griesbach overcame all obstacles are proved by the fact that every European country, except Italy and Turkey, was represented at the congress, and in addition to these European countries America and Japan were also represented.

The congress was opened formally by Prince Ludwig Ferdinand of Bavaria, and the work of the congress was carried on in sections. How extensive the work of the congress was may be gathered from the fact that there were seven sections. The first dealt with school buildings and the furnishing of the school-room, the second with the hygiene of residential schools, with the methods of hygienic investigation and research in schools, and with the physiology and psychology of educational methods and work.

The third section dealt with instruction in hygiene for teachers and scholars, the fourth with physical education and training in personal hygiene, the fifth with contagious diseases, ill-health, and conditions affecting attendance at school. The sixth section dealt with special schools, including those for the feeble-minded, the blind, deaf, dumb, cripple, invalid and exceptional children, and the seventh with out of school hygiene, holiday camps and schools, the relation of the home and the school, and the hygiene of the teaching profession.

The sectional meetings were held in the Royal Industrial School, a building well adapted for such a purpose. An exhibition of apparatus necessary for school purposes was held in the same building. Excellent arrangements had been made for the accommodation of those attending the congress, and also for obtaining information. Nor had the social side of the congress been neglected, and every facility was given to visitors to see those things in which they took the greatest interest.

Great Britain was represented by a committee with representatives from various societies interested in education and hygiene, with Sir Lauder Brunton as president.

The next International Congress of School Hygiene will be held in London in 1907, and Sir Lauder Brunton has been elected president of that congress.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

AT the graduation ceremony at the University of Edinburgh on April 9 the honorary degree of LL.D. was conferred on Prof. Alexander Macalister, F.R.S.

DR. ROSE, H.M. Consul at Stuttgart, continues his account of German technical education in No. 603 of the miscellaneous series of the diplomatic and consular reports issued by the Foreign Office. The recent report is on technical schools for special branches of the metal industries. Dr. Rose finds that in Germany for certain special branches of the metal and other industries the practical instruction given to apprentices in the workshops of factories is often incomplete and not progressively arranged, and the theoretical instruction given in evening and Sunday continuation schools is generally insufficient and not even obligatory in all cases. At the special technical schools for these industries the instruction is complete and progressively arranged, practice and theory being carefully and judiciously combined. As the schools, moreover, are situated in the midst of the industries they are intended to promote, they are kept in the closest possible touch with the actual and progressive requirements of factory methods and processes. The report gives full accounts of the courses of instruction, the hours, the preliminary knowledge expected of students,

and the examinations at each of the twelve technical schools for special branches of the metal industries which have been established in Germany.

THE thirty-ninth annual catalogue of the Massachusetts Institute of Technology at Boston gives full particulars of the multitudinous courses of instruction provided and of the complete laboratory accommodation and equipment available for every branch of scientific technology. In addition to the opportunities for advanced study and investigation connected with the Graduate School of Engineering Research, the institute now offers excellent facilities for purely scientific research in all its laboratories. For research work in physical chemistry and sanitary science two new laboratories devoted exclusively to these subjects have been established during the past year. Researches in the research laboratory of physical chemistry are carried on in part by a staff of research assistants and associates and in part by graduate students working under the direction of the professors connected with the subjects of theoretical or physical chemistry. A number of advanced lecture courses are offered by the members of the laboratory staff. By the generosity of an anonymous donor the institute has recently established upon land specially secured for the purpose a sanitary research laboratory and sewage experiment station, provided with facilities for demonstration of the more important methods employed on a large and a small scale for the purification of sewage and water, and in connection therewith well equipped sanitary, chemical, and bacteriological laboratories.

THE Department of Agriculture and Technical Instruction for Ireland has issued, in the miscellaneous series of its *Bulletins*, a report on some features of American education, by Mr. Robert Blair, the assistant secretary in respect of technical instruction to the department. Mr. Blair was a member of the Mosely Education Commission, and part of this report appears in the recent conjoint report of the commission. Some interesting statistics collected by Mr. Blair as to the openings for students trained in American technical institutions are summarised in the report. It appears that in the Westinghouse shops and offices 160 college-bred men are engaged, out of a total of 10,000 employees. At the Carnegie Steel Works, where there are 7000 hands, there were about 100 technically trained men, 7 of the 23 leading officers being college graduates. Of 118 engineers on the staff of the Rapid Transit Railroad Commissioners of New York City, who are constructing a city underground railway, 84 per cent. had been college students; of 75 petty officers, 58 per cent. were college trained. In the Baldwin Locomotive Works, 43; on the Pennsylvania railway lines west of Pittsburg, 52, "nearly all being graduates"; at the Schenectady works of the General Electric Co., 264; the Illinois Central Railroad Co. employ 200 men who are "either graduates of a technical institution or have had some training in that line"; and a similar proportion is true in the case of the employees of the Baltimore and Ohio Railway. Facts such as these are the best proof of the belief of the American people in higher education, and it is to be hoped that British employers of labour will soon follow a similar course. Given suitable openings for qualified technical students in this country, and the increase in the number of students in our colleges would soon be apparent.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 18.—"Atmospherical Radio-activity in High Latitudes." By George C. **Simpson**, B.Sc., 1851 Exhibition Scholar, Owens College, Manchester. Communicated by Arthur Schuster, F.R.S.

In 1901 Elster and Geitel discovered a radio-active gas in the earth's atmosphere, and developed a method of detecting it, also an arbitrary standard by which it can be measured. In this paper the author gives the results of a series of measurements carried out on Elster and Geitel's plan at the village of Karasjok, Lapland. The measurements were made three times a day, and continued uninterrupted for four weeks, from November 23 to December 19, 1903, during which time the sun did not rise above the horizon.

The chief result obtained is the very high value which the radio-activity attains, the mean value for the month (A=102) being nearly six times, and the maximum value (A=432) nearly seven times greater than the corresponding values found for mid-Germany by Elster and Geitel.

An analysis of the results shows that the means of the morning and afternoon observations are very near one another (87 and 88 respectively), while the mean of those for the evening is very much higher (131), thus showing a daily period.

The effect of the different meteorological elements is fully investigated, but no connection can be detected between the radio-activity and the height of the barometer or the temperature, although the latter extends over the wide range from $-35°$ to $+2·5°$ C. On the contrary, the amount of cloud does appear to have an influence, the radio-activity for no clouds being A=130, for detached clouds A=107, for completely overcast sky A=76. Measurements of the potential gradient, which were made by a self-registering electrometer concurrently with those of the radio-activity, show no direct relation between the two. The aurora also appears to exert no influence on the radio-activity.

These results are of peculiar interest owing to the northerly position of the place of observation (69° 20′ N. and 25° 30′ E.), and will throw some light on the geographical distribution of atmospheric radio-activity. The hard frozen state of the ground, with its covering of snow for more than 100 miles round, are uniform conditions which should help to a proper understanding of the source of the radio-active emanation in the air.

March 10.—"On Electric Resistance Thermometry at the Temperature of Boiling Hydrogen."[1] By Prof. James **Dewar**, M.A., LL.D., F.R.S.

In his Bakerian lecture the author adverted shortly to some results obtained in low temperature resistance thermometry, and gave a table (Roy. Soc. *Proc.*, vol. lxviii. p. 363) of numerical values deduced from experimental observations for some of the more prominent metal resistance thermometers. In the present communication the experimental records of eight additional electric resistance thermometers are given, and the results of the observations on all the resistance thermometers used during the investigations are collected and compared.

Two facts seem to result from this inquiry, viz. (1) that the resistance of an unalloyed metal continually diminishes with temperature and in each case appears to approach to a definite asymptotic value below which no further lowering of the temperature seems to reduce it; and (2) that the parabolic connection between temperature and resistance is no longer tenable at very low temperatures.

Of the different thermometers constructed on the electric resistance principle, fifteen were serviceable throughout the investigations; the others broke or failed from various causes. The metals employed were platinum, gold, silver, copper, palladium, iron, nickel, and two alloys, platinum-rhodium and German silver. Every endeavour was made to attain the highest purity in the samples. In the Bakerian lecture a table (Roy. Soc. *Proc.*, vol. lxviii. p. 363) was given containing the constants of seven of these thermometers, and in the present paper similar results are tabulated for the remaining eight.

The observed resistances, after all corrections were made, were reduced both by Callendar's and by Dickson's methods, and the results are in close accord.

Platinum, gold, silver, and copper show a remarkable agreement between the two methods of reduction. In the platinum and gold groups the centigrade temperature, at which the resistance would vanish, rises with the purity. This is still seen in copper, but something of the reverse appears in the case of silver. However, the general rule is again apparent in palladium.

It is also remarkable that in the cases of all the purest metals examined, their resistances calculated by either method of reduction vanish at temperatures above $-273°$ C. As measurers of temperature gold and silver seem to be the best metals.

As a matter of interest, one line in the table which accompanies the paper records the ratio in which the

[1] In continuation of Art. 3 of the Bakerian Lecture (Roy. Soc. *Proc.*, vol. lxviii. p. 360.)

resistance of each metal at 0° C. is reduced on cooling it to the boiling point of hydrogen. This seems to be a quantity showing no connection with other properties of metals.

While the results obtained may be considered from the point of view of metals as thermometers, yet the question of the general relation between resistance and temperature in metals is of greater importance.

The temperatures at which liquid oxygen and hydrogen boil under atmospheric pressure are known to within one- or two-tenths of a degree, namely, −182°·5 C. and −252°·5 C. Further observations made with the constant-volume hydrogen gas thermometer lead to the conclusion that hydrogen freezes about 5° below its boiling point. In the present experiments the author has been able to get eight observations in liquid hydrogen boiling under pressures varying from 5–50 mm., and the temperatures of these observations may be taken as (say) 4° below the boiling point. If the law connecting resistance with temperature be parabolic, the very gentle curvature at the boiling point of hydrogen will allow the rate of drop in resistance per degree of temperature for the 4° below the boiling point of hydrogen to be considered as roughly the same as that between the boiling points of oxygen and hydrogen (70°), so that the ratio of these two drops on this supposition should be about 4 : 70, or say one-eighteenth.

These ratios all prove to be much smaller than one-eighteenth, hence it is inferred that the curves have taken a more or less quick turn in the neighbourhood of the boiling point of hydrogen, or perhaps above it.

The observed resistances are displayed graphically in the paper, and the curves thus obtained show some instructive peculiarities. The magnetic metals present the most striking curves, being at first sight quite unlike any of the others. But closer inspection shows that this is not so, and in fact they give the clue to the general connection between resistance and temperature in metals. The curves of the other metals are all concave towards the axis of temperature, for the arcs extending from the boiling point of water, through the freezing point, down to the boiling point of oxygen; while below the boiling point of oxygen these curves are convex to this axis. On the other hand, gold and the magnetic metals are already convex to this axis from the boiling point of water to the lowest temperature reached.

It appears that in no case can anything parabolic connect resistances and temperatures ranging from the boiling point of water to that of hydrogen. The two parabolas for high and low temperatures are not only different, but also may differ from each other by any amount, within certain limits depending on the nature of the unknown curve of temperature and resistance.

Entomological Society, March 16.—Prof. E. B. Poulton, F.R.S., president, in the chair.—Mr. G. T. **Porritt** exhibited a pair of *Æschna isosceles*, taken by him with others in the Norfolk Broads last summer. The species had been regarded as almost lost to the British list for many years.—Mr. J. E. **Collin** exhibited *Phora formicarum*, Verr., which is parasitic on the ant *Lasius niger*, obtained by sweeping the herbage in a paddock at Newmarket. These flies belong to the genus Phora and to a hitherto unnamed species which has not been found or recognised by Continental dipterologists. He also exhibited Phora sp. found in a garden at Newmarket, running about at the entrance to the nest of a species of Bombus. Specimens received from Dr. Sharp, labelled "from Bombus nests," are also the same species. It is evident that its life-history is in some way connected with that of the Bombus, but because of the different shape and form of the female ovipositor, it is probably not parasitic on the bee like *P. formicarum* is on the ant, but acts as a scavenger by living on the dead pupæ in the nest.—Commander J. J. **Walker** exhibited a series of Buprestidæ from Sydney, N.S.W., comprising about 120 species, of which 70 belonged to the genus Stigmodera. Also a dried specimen of *Angophora cordifolia*, Cav., a small tree of the natural order Myrtaceæ, the flowers of which are the great attraction in New South Wales for the Buprestidæ, as well as for very many other Coleoptera; specimens of the "bugong" moth, *Agrotis spina*, Guenée, from Jervis Bay, N.S.W. (referred to at the previous meeting); and *Carthaea saturnoides*, Walk., a remarkable moth from Perth, W.A., referred to the Geometrina, but possessing an extraordinary superficial resemblance to a Saturniid.—Mr. A. J. **Chitty** exhibited a specimen of *Peribalus vernalis*, Wolff., a rare bug of which only five or six specimens appear to have been taken, and pointed out that as the records in Saunders's "Hemiptera" included Cumberland and Weston-super-Mare, and his own specimen was taken at Huntingfield, Kent, it was probably overlooked.—Dr. F. A. **Dixey** exhibited a remarkable pale form of *Mamestra brassicae*, taken by Dr. G. B. Longstaff and himself at Morthoe, North Devon, on July 16, 1903.—The president, Prof. Poulton, read some observations on the gregarious hybernation of certain Californian insects, communicated to him by Prof. Vernon L. **Kellog**, of the Leland Stanford Junior University, California. He also read a paper on the hill-top habit of some insects.—Mr. O. E. Janson contributed on behalf of Mr. F. P. **Dodd** a note upon maternal instinct in Rhynchota, and Mr. H. Rowland-Brown read a note on *Oncoptera intricata*, a moth extremely destructive to pastures in Tasmania, by Mr. F. M. **Littler**, of Launceston, Tasmania. He also exhibited examples of the imago and larva of the species, the latter closely resembling that of a Hepialid.

Chemical Society, March 16.—Prof. W. A. Tilden, F.R.S., president, in the chair.—The following papers were read:—Mercuric nitrite and its decomposition by heat: P. C. **Ray**. Mercuric nitrite, obtained by evaporating *in vacuo* the solution left by decomposing mercuric chloride with silver nitrite, occurs in groups of light yellow needles. The solid salt is largely decomposed by water. When heated it decomposes for the most part into mercurous nitrate and nitric oxide.—Note on the higher glycerides: J. B. **Hannay**. The higher glycerides, as represented by purified stearin, olive oil, linseed oil, castor oil, cotton-seed oil, rape oil, and earth-nut oil, are all capable of entering into direct combination with lead oxide, forming new compounds of wax-like consistence and character. In the case of the olein derivative, the composition may be represented by the formula $C_3H_5O_3{\cdot}Pb_3(C_{18}H_{33}O_2)_3$, the three atoms of lead replacing six atoms of hydrogen, three in the alkyl and three in the acyl portion of the molecule.—Isomeric change of diacylanilides into acylaminoketones: transformation of the dibenzoyltoluidines into the isomeric benzoylamino-methylbenzophenones: F. D. **Chattaway** and W. H. **Lewis**.—The action of ethyl β-iodopropionate on ethyl disodioethanetetracarboxylate: O. **Silberrad**.—The heat of formation of glucinum chloride: J. H. **Pollok**. A sample of ground beryl from Limoges was employed in the preparation of pure glucina and ultimately of the metal. On dissolving the latter in hydrochloric acid it was found that the heat of formation of glucinum chloride *in solution* was 199·5 calories, whence that of *anhydrous* glucinum chloride was found to be 155 calories.—A note on the composition of distilled oil of limes and a new sesquiterpene: H. E. **Burgess** and T. H. **Page**. This oil was found to contain *l*-terpineol, an isomeric terpineol of lower boiling point, and a new sesquiterpene, limene.—The nature of a solution of iodine in aqueous potassium iodide: C. H. **Burgess** and D. L. **Chapman**. The authors confirm Jakowkin's statement that in such solutions a dissociable compound KI_3 exists.—The reduction of 2 : 6-dinitrotoluene with hydrogen sulphide: J. B. **Cohen** and J. **Marshall**. In the course of an experiment in which 2 : 6-dinitrotoluene was reduced by hydrogen sulphide in alcoholic ammonia, a quantity of 2-nitro-4-amino-*m*-cresol was obtained, together with 6-nitro-*o*-toluidine.—Acid esters of methylsuccinic acids: W. A. **Bone**, J. J. **Sudborough**, and C. H. G. **Sprankling**. An enumeration of the principal physical constants of these esters is given.—A note on phenyldimethylallyl-ammonium compounds: A. W. **Harvey**.—Estimation of hydrogen peroxide in the presence of potassium persulphate by means of potassium permanganate: J. A. N. **Friend**. It is shown that fairly accurate estimations may be obtained if (1) the time of titration is short, (2) the volume titrated is small, and (3) the concentration of the sulphuric acid is fairly great.—A comparison of the products of the hydrolysis of potato starch with those obtained from cereal starches: J. **O'Sullivan**. It is shown that the products of the hydrolysis of potato starch by diastase bear no quantitative relationship to those yielded by the cereal starches.

Royal Microscopical Society, March 16.—Dr. D. H. Scott, F.R.S., president, in the chair.—Prof. A. E. **Wright** communicated the purport of his paper on some new methods of measuring the magnifying power of the microscope and of lenses generally. His remarks included the description of a piece of apparatus which he had invented for taking the magnifying power of the microscope and for the rapid measurement of microscopic objects. The instrument is placed over the eye-piece without disturbing any of the adjustments of the instrument, and the object on the stage can be instantaneously measured.—A short note by Mr. E. B. **Stringer** on the separation of ultra-violet light was read by the secretary.—Mr. Abraham **Flatters** exhibited on the screen a series of sixty hand painted lantern slides illustrating botanical histology.

Mineralogical Society, March 22.—Prof. H. A. Miers, F.R.S., vice-president, in the chair.—Irregularly developed crystals of zircon (specific gravity 4·0) from Ceylon: L. J. **Spencer.** The crystals were sent recently by Mr. A. K. Coomáraswámy to the British Museum for determination, and at first were thought to be rutile. They are of a dark brown colour and almost opaque; the specific gravity is 4·09, and is unaltered by heating. A section cut perpendicular to the principal axis shows interesting variations in the optical characters, successive portions being isotropic, uniaxial and biaxial; the mean refractive index is about 2·0. After being heated to redness and cooled, the material is bright green in colour, and a crystal section is now entirely biaxial, although the interference figures and birefringence vary in different parts.—Notes on "feather-ore": identity of "domingite" (="warrenite") with jamesonite: L. J. **Spencer.** "Feather-ore" is usually considered to be a variety of jamesonite, but since the latter has a good cleavage perpendicular to the length of the fibres, only brittle "feather-ore" can be included in this species; on the other hand, "feather-ore," the fibres of which are flexible, may be either stibnite, zinckenite, plumosite ($2PbS.Sb_2S_3$), boulangerite, or meneghinite. "Warrenite" is a brittle "feather-ore," and further has the same chemical formula ($3PbS.2Sb_2S_3$) as that originally given for the cleavable Cornish jamesonite.—Note on the indices of refraction of antimonite: A. **Hutchinson.** A prism, of refracting angle 8° 51′, was found sufficiently transparent to red light for the refractive indices to be determined in the usual way. The results obtained are 4·129 and 3·873 for rays vibrating parallel to the axes of Z and X respectively. Measurements of the deviation of the ultra-red rays indicate high dispersion in this region of the spectrum. The investigation is being continued.—The connection between the atom arrangements of the crystals of certain allied carbon compounds: W. **Barlow.** Using balls of the same relative size as were employed in his previous work, for instance, in models of calcite, the author forms a carboxyl slab. By uniting such slabs with balls representing barium, a structure is obtained which has the symmetry of barium formate. Again, by uniting the slabs with balls representing hydrogen, a structure with the symmetry of oxalic acid is formed. The author showed that in certain cases, in order to effect close packing, a relative shift was necessary between successive layers. He also briefly discussed the tartaric acids.—On the construction and use of the moriogram: G. F. Herbert **Smith.** The moriogram is a diagram devised by the author for the graphical determination of the angles between tautozonal poles, obeying the law of rational indices.—Note relative to the history of the Caperr meteorite: L. **Fletcher,** F.R.S.—On the meteoric irons of Bethany, Lion River, Springbok River and Great Fish River, South Africa: L. **Fletcher,** F.R.S.—Prof. J. W. **Judd,** F.R.S., exhibited two Gardette twins of quartz.

Geological Society, March 23.—Dr. J. E. Marr, F.R.S., president, in the chair.—On the Moine gneisses of the East-Central Highlands and their position in the Highland sequence: G. **Barrow.** Communicated by permission of the director of H.M. Geological Survey. The paper is divided into two parts. The first deals with the parallel-banded grey gneisses or gneissose flagstones of the Perthshire and Aberdeenshire districts, which, in their field characters as well as in their composition and structure, are identical with the Moine gneisses of the North-West Highlands. A description is given of these gneisses, as seen in and about the Garry in Perthshire, and this is followed by a brief account of the same rocks in the ground to the east and north-east, extending to the Forest of Invercauld, north of Braemar in Aberdeenshire. Special attention is directed to the fact that towards the eastern end of the area large masses of highly quartzose gneiss occur, which are really part of the Central-Highland quartzites in what the author conveniently describes as a "Moine-phase," and should not strictly be included in the typical banded grey gneisses at all. In the second part, dealing with the mode of ending off of these gneisses to the south-east, it is shown that they cease to be recognisable as Moine gneisses, owing to the fact that they thin away and also become more finely banded, while at the same time they become less crystalline or cease to be gneisses. To prove this, an account is given of a series of sections lying along a belt 40 miles in length, extending nearly from Blair Athole to the east of Balmoral, in Aberdeenshire.

Royal Astronomical Society, April 8.—Prof. H. H. Turner, F.R.S., president, in the chair.—The secretary read a paper by Mr. H. C. **Plummer** on the optical distortion of the microscopes of the Oxford machine for measuring astronomical photographs. Dr. Russell and Mr. Hinks explained the form of the microscope of the Cambridge measuring machine, and the Astronomer Royal described that which was employed at the Royal Observatory, Greenwich.—Mr. F. A. **Bellamy** read a paper, being an analysis of the results of measurements of the 1180 plates in zones +25° to +31°, allotted to the University Observatory, Oxford, in connection with the International Astrographic Chart.—Mr. Thomas **Lewis** gave an account of his memoir, measures of the double stars in Struve's "Mensuræ Micrometricæ," collected and discussed.—Prof. **Turner** read a paper on the Rousdon variable star observations. In the course of the paper was a consideration of the sun as a variable star. The evidence appeared in favour of the sun being brighter at periods of maximum activity of sun-spots than at minimum.—Sir David **Gill** spoke upon recent work at the Royal Observatory, Cape of Good Hope. He gave an account of an improved spectroscope which the observatory owed to the generosity of Mr. McClean, illustrated by photographs of the instrument and its accessories. He specially described the electrical apparatus by which the spectroscope was kept at a uniform temperature during exposure of the plates. He also showed slides from a series of photographs of the spectra of stars taken with the instrument, with comparison spectra.

DUBLIN.

Royal Dublin Society, March 15.—Prof. J. A. McClelland in the chair.—Prof. W. F. **Barrett,** F.R.S., read a paper in continuation of his researches, in which he has the co-operation of Mr. W. **Brown** and Mr. R. A. **Hadfield,** on the physical properties of the alloys of iron. The paper, which forms part iv. of the series, deals with (*a*) microstructure, and (*b*) thermal conductivity.—Mr. P. E. **Belas** read a paper on the structure of water-jets, and the effect of sound thereon. The paper was illustrated by photographs.—Mr. J. J. **Hutchinson** described a simple arrangement for determining the maximum pressure of vapours at different temperatures.

PARIS.

Academy of Sciences, April 5.—M. Mascart in the chair.—On the pathogenic agent of human trypanosomiasis: M. A. **Laveran.** A comparative study of *Tr. gambiense* of Ford and Dutton, and *Tr. ugandense* of Castellani, showed that grown under similar conditions the two are morphologically identical. The study of the pathogenic action on various animals, the action of human serum and arsenious acid, and the fact that animals rendered immune to the one are also immune to the other, also lead to the same conclusion. The author suggests that the name *sleeping sickness,* since it represents only the terminal phases of the infection, should be abandoned, adopting the name human trypanosomiasis, as applying to all the forms of the disease.—On a necessary condition for the stability of an unlimited vitreous medium: P. **Duhem.**—Observations of the sun, made at the Lyons Observatory with the 16 cm. Brunner equatorial during the fourth quarter of 1903: J. **Guillaume.** The results are summarised in

three tables giving the sun-spots, their distribution in latitude, and the distribution of the faculæ in latitude.—On a class of multiform transcendentals: Pierre **Boutroux.**—The polaristrobometrograph, or a self-registering polarimeter: Gaston **Gaillard.** In order to follow the rate of chemical reactions accompanied by a change in the rotatory power, a combination of a Laurent polarimeter and kinematograph was designed, capable of giving from five to ten images per second, details of which are given.—On the satellite rays in the spectrum of cadmium: Ch. **Fabry.** A close examination of the cadmium ray 508·6, by the interference method previously described by the author, shows that in a tube without electrodes there are three rays, very close together, with intensities of the same order. In a tube fitted with electrodes the middle ray is very intense, the second is much enfeebled in intensity, the third being absent. The necessary condition for the clear appearance of the satellite rays is the absolute purity of the luminous gas, this condition being more easily fulfilled in tubes not fitted with electrodes.—On the structure and affinities of trypanoplasma: Louis **Léger.**—On the anomalous values of gravity in the eastern region of Etna: Gaetano **Platania.**—The geological constitution of the *massif* of Khakhadian (Soudan): H. **Arsandaux.** This part of Africa is composed of sedimentary rocks of unknown age, probably old, containing andesite tufas of volcanic origin; they are traversed by eruptive rocks of a varied nature, especially by granite.—On the origin of lactose. Urological researches during pregnancy: Ch. **Porcher** and M. **Commandeur.**—On the origin of precipitines: R. **Kraus** and C. **Levaditi.** The conclusion is drawn that the precipitines are made by the white corpuscles of the blood, the latter being probably the principal source of these anti-bodies.

DIARY OF SOCIETIES.

THURSDAY, APRIL 14.

ROYAL INSTITUTION, at 5.—Dissociation: Prof. Dewar, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Direct Reading Measuring Instruments for Switchboard Use: K. Edgcumbe and F. Punga. (Continuation of discussion.)—Eddy Currents and Eddy Current Losses in Cable Sheaths: M. B. Field.

MATHEMATICAL SOCIETY, at 5.30.—On a Plane Quintic Curve: Dr. F. Morley.—Mathematical Analysis of Wave-propagation in Isotropic Space of p Dimensions: H. T. Havelock.—On Functions Generated by Linear Difference Equations of the First Order: Rev. E. W. Barnes.—Note in Addition to a Former Paper on Conditionally Convergent Multiple Series: G. H. Hardy.—Spherical Curves. Part II: H. Hilton.—Perpetuant Syzygies of Degree Four: P. W. Wood.—Transformations of the function $F([\alpha]\ [\beta]\ [\gamma]\ x)$: Rev. F. H. Jackson.—An Extension of Sylow's Theorem: Prof. G. A. Miller.—Note on a System of Linear Congruences: Rev. J. Cullen.—The Extension of Neumann's Addition Theorem for Bessel Functions: Rev. F. H. Jackson.

FRIDAY, APRIL 15.

ROYAL INSTITUTION, at 9.—Korea and the Koreans: Rt. Rev. Msgr. the Count Vay de Vaya and Luskod.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—*Discussion*: Compound Locomotives in France: M. Edouard Sauvage.

SATURDAY, APRIL 16.

ESSEX FIELD CLUB, at 6.30 (at the Essex Museum of Natural History, Stratford).—Annual Meeting.—The Natural History of Pyrites and Gypsum, the Chief Minerals of Essex: F. W. Rudler.—On the Origin of the term "Sarsen Stones": T. V. Holmes.

MONDAY, APRIL 18.

SOCIOLOGICAL SOCIETY, at 5.—Woman in Early Civilisation: Dr. E. Westermarck.

TUESDAY, APRIL 19.

ROYAL INSTITUTION, at 5.—The Transformations of Animals: Prof. L. C. Miall, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—On Mammals collected during the Uganda Boundary Commission by Mr. W. G. Doggett: Oldfield Thomas, F.R.S., and H. Schwann.—Contributions to the Anatomy of the Lacertilia. II. On some Points in the Structure of Tupinambis: F. E. Beddard, F.R.S.—On the Disposition and Morphology of the Intestinal Coils in Mammals: Dr. P. Chalmers Mitchell.—On the Characters and Affinities of the Triassic Reptile, *Telerpeton elginense*: G. A. Boulenger, F.R.S.—Descriptions of some New Species of Butterflies belonging to the family Erycinidæ from Tropical South America: H. Druce.

SOCIETY OF ARTS, at 8.—The Sentiment of Decoration: A. East.

ROYAL STATISTICAL SOCIETY, at 5.—Five Years' Experience of the Effect of the Workmen's Compensation Acts, with Especial Reference to Schemes Certified Thereunder: W. H. Tozer.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Aërial Suspension Cableways: J. M. Henderson.

WEDNESDAY, APRIL 20.

SOCIETY OF ARTS, at 8.—Motor Cars for Popular Use: Mervyn O'Gorman.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Exhibition of Pond Life.

ENTOMOLOGICAL SOCIETY, at 8.—Nature's Protection of Insect Life, illustrated by Colour Photography: F. Enock.—*Discussion*: On Specimens of the Dipterous Families Stratiomyidæ to Cyrtidæ: G. H. Verrall, Colonel Yerbury, and others.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Variation of the Population of India compared with the Variation of Rainfall in the Decennium 1891–1901: W. L. Dallas.—The Cause of Autumn Mists: J. B. Cohen.

CHEMICAL SOCIETY, at 5.30.—(1) The Vapour Density of Hydrazine Hydrate; (2) The Combining Volumes of Carbon Monoxide and Oxygen: A. Scott.—(1) Ammoniacal Double Chromates and Molybdates; (2) Double Chromates of the Series $M'_2M''(CrO_4)_2 6H_2O$ Magnesium and Nickel Compounds: S. H. C. Briggs.—Experiments on the Synthesis of the Terpenes. Part I. Synthesis of Inactive Terpineol, of Dipentene and of Terpin Hydrate: W. H. Perkin, junr.—A Lævorotatory Modification of Quercitol: F. B. Power and F. Tutin.—The Constituents of the Essential Oil of Californian Laurel: F. B. Power and F. H. Lees.—Some Derivatives of Umbellulone: F. H. Lees.

THURSDAY, APRIL 21.

ROYAL INSTITUTION, at 5.—Dissociation: Prof. Dewar, F.R.S.

LINNEAN SOCIETY, at 8.—On British Freshwater Rhizopoda: J. Cash.—*Exhibitions*: Drawings by Mrs. C. Reid of Fruits and Seeds of British pre-Glacial and inter-Glacial Plants. II. Calycifloræ: Clement Reid, F.R.S.—Holograph Letter of Linnæus to Haller, dated from Upsala, May 12, 1747: R. Morton Middleton.

INSTITUTION OF CIVIL ENGINEERS, at 8.—"James Forrest" Lecture: Internal Combustion Engines: Dugald Clerk.

FRIDAY, APRIL 22.

ROYAL INSTITUTION, at 9.—Sleeping Sickness in Uganda: Colonel David Bruce, F.R.S.

PHYSICAL SOCIETY, at 5.—Calculation of Colours for Colour Sensetometers and the Illumination of "Three Colour" Photographic Transparencies by Spectrum Colours: Sir W. de W. Abney, F.R.S.—On Normal Pileing as connected with Osborne Reynolds's Theory of the Universe: Prof. J. D. Everett, F.R.S.—Note on the Diffraction Theory of the Microscope as applied to the Case when the Object is in Motion: Dr. R. T. Glazebrook, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—No. 2 River-pier of the Beckton Gasworks: A. Trewby.

CONTENTS.