THURSDAY, APRIL 4, 1901.

SPACE, ATOMS, MOLECULES AND THE ETHER.

Matter, Ether and Motion. By A. E. Dolbear, Ph.D. English edition edited by Prof. Alfred Lodge. Pp. vii+376. (London: Society for Promoting Christian Knowledge, 1899.)

La Constitution du Monde, Dynamique des Atomes. Par Madame Clemence Royer. Pp. xxii+800. (Paris: Librairie C. Reinwald, 1900.)

Mutmassungen über das Wesen der Gravitation, der Elektricitäts und der Magnetismus. Von Dr. med. Hermann Fischer. Pp. 42. (1899.)

Ueber mögliche Bewegungen möglicher Atome. Von Dr. med. Hermann Fischer. Pp. 92. (Dresden: Hellmuth Henkler, 1900.)

A QUARTER of a century ago the Society for Promoting Christian Knowledge published a small book of 125 pages on "Matter and Motion," by Prof. Clerk Maxwell, and it is interesting to reflect that the necessity of adding the ether to the title of a new book issued by the same publishers is largely due to the important modern developments of the ideas which, in his more abstruse writings, the author of the original book suggested. There is, no doubt, a considerable demand at the present time for a book dealing in a popular way with general notions about molecules and the ether; but it is desirable that, in attempting to meet this demand, scientific accuracy no less than simple and popular treatment should be aimed at.

Dr. Dolbear is fortunate in having it stated conspicuously that his book is "edited by Prof. Lodge," who in his preface remarks that

"the luminous manner in which the author deals with the great problems as to the nature of electricity, magnetism and the kinetic relations between ether and matter will make this book interesting and instructive to a wide circle of readers."

But even the editor is bound to admit that

"I do not agree with all the author's statements, particularly that on p. 75, where he maintains that transfers of energy are always from bodies having higher rates of motion to those having lower rates. . . ."

An examination of the book shows that it contains many statements quite as open to objection as that cited by Prof. Alfred Lodge. A few extracts will give an idea of the style of the book.

On pp. 14-17 the author takes a great deal of trouble to prove that we shall never be able to construct a microscope sufficiently powerful to see individual molecules. To prove this, he tries first to argue from a rather far-fetched analogy between the powers of the microscope and the stage-coach and the railway; then he refers to the impossibility of seeing molecules owing to their rapid motions; and finally he states that

"there is every reason to believe that the molecules of all bodies are so perfectly transparent that they could no more be seen than the air, even if there were no difficulty from their smallness and their motions."

It would be more correct to refer to p. 149 and to point out that the limits of microscopic vision are defined by the wave-length of light.

On pp. 48-49, speaking of different kinds of motion, we are told:

"For instance, a compound of a free path motion with a vibratory motion will give a wave or sinuous motion if the direction of vibration be at right angles to the free path."

A little further down, on p. 49, the author says:

"Indeed, we know that some sorts of motion are propagated in the ether. For instance, what we call light is an example. Its form is *undulatory*; and as we have seen an undulatory motion is a compound of a re ctilinear and a vibratory. . . ."

While seven lines lower down he says:

"I am not aware that any simple rectilinear motion is known to occur in the ether; there may be, and likely enough is, such."

In speaking of non-Euclidean geometry, he suggests a rather curious idea of the relations between men of science of different countries:

"This new geometry I have alluded to has been worked at by the best mathematicians of all civilised nations, and they agree in their conclusions. They certainly would not do so if there were the slightest apparent reason for rejecting them; for national jealousies are too strong, and a sense of the value of truth too great, to allow any such notions to gain currency anywhere if there were any possibilities of breaking them down."

Here is how the author defines mass, on p. 61:

"It has become necessary to find some measure for matter that shall be independent of position, and this has been found by dividing the weight of a body at a given place by the value of gravity at that place and calling the quotient the mass, so that if w represents the weight of the body at a given place and g the value of gravity at the same place, that is the velocity per second that gravity will give to a body if left free to fall, then $w/g = m$, the mass."

This definition is calculated to make any reader think that the mass of a body weighing 1 lb. is 1/32·091 at the equator and 1/32·255 at the poles. How is such an inference to be reconciled with the statement that it is "independent of position"?

Further on (p. 346) we have another definition of mass:

"Mass as a property of matter is generally defined as the amount of matter considered, and is measured by what is called acceleration, that is, the velocity it acquires in a second when acted on by a constant force or push."

On p. 106 we have the following definition of temperature:

"The word 'temperature' is used to denote the degree of heat there may be in a unit volume of the substance. . . ."

According to this, calorimetry would be made easy, for (*e.g.*) a cubic foot of lead and a cubic foot of air at the same temperature should contain the same "degree of heat"! As a final sample, we quote the author's explanation of the heating of a gas by compression on p. 322:

"When a gas is condensed by pressure the individual molecules have less free space to move in, and they consequently collide with each other more frequently. Being

elastic their average amplitude of vibration is increased proportionally, and a greater number of them will strike with greater velocity upon the walls of the containing vessel per second than before. Thus the temperature and the pressure of the gas are increased. We say that mechanical energy has been converted into heat energy, or sometimes simply into heat, though what has really happened has been the transformation of external translational motion into internal vibratory motion, which the elasticity and mobility of the molecules permit. When by friction or percussion a body is heated, the same thing precisely has happened; translatory motion has been transformed into vibratory, through the agency of the molecules, which have, therefore, acted as machines for transformation."

Madame Royer has produced a volume of 800 pages, in which she has endeavoured to expose fallacies in the existing theories of matter and to formulate a new theory of her own. The book is illustrated by coloured plates and pretty pictures of molecules built up of atoms. It deals in turn with the history of theories of matter, properties of atoms, vibratory phenomena (including heat, light, sound, smell and taste), solid bodies, liquids and gases, vital processes, gravity, theory of the tides and cosmic evolution.

Madame Royer seems to believe that atoms are fluids in their nature (the indivisibility of atoms has long been a thing of the past) and that there are three states of the cosmic substances, namely, the initial or ethereal state, in which the atoms are without mass and preserve the properties of perfect fluids; the material state, in which the atoms only possess a variable finite portion of their initial expansive substance and all their fluid properties are attenuated; and the vitaliferous state, in which the atoms are not subjected to the laws of inertia and gravity, but can overcome these in producing automatic movements. No such thing as attraction is supposed to exist, but the fluid atoms are held together by an ethereal pressure; they would be spherical when isolated, but when formed into molecules they become compressed into polyhedral forms. The authoress takes exception to the accepted theory that quantity of matter is synonymous with mass; but does not this mainly depend on what we define to be *matter*?

The explanation of gravity attributes this phenomenon to pulsating pressures in the ether—an idea by no means novel, the hydrodynamical theory of pulsating spheres being well known. How far Madame Royer has worked on old lines, and how far she has invented a new theory, it is not our present purpose to examine. We cannot discover anything very remarkable in her new theory of the tides, the principal point of which appears to be that it is necessary to discuss the tides in the earth and the atmosphere as well as in the sea.

It may be convenient here to state roughly in an abridged form the fundamental assumptions stated on pp. 68–70:

"(1) The primary elements of cosmic matter are volumes of fluid, which tend to expand by reason of their internal activity, but are kept from so doing by external and mutual pressures. (2) The cosmic elements constituted by centres of emission of an indefinitely expansive substance are active, and repel one another according to the law of the inverse square. (3) Ponderable bodies are constituted of elements in which the expansive forces are attenuated, and their inertia is inversely proportional to the radius of their virtual sphere. (4) The masses of ponderable bodies are equal to the sums of the inertiæ of their elements, and vary directly as their number and inversely as the cube roots of their expansive forces. (5) The variations of volume of complex bodies under changes of pressure and temperature are the result of correlative variations in volume of their elements, which remain always in contact and are bounded by planes of mutual intersection. [Is it certain that the boundaries are always plane?] (6) It follows that the universe is absolutely filled [with a medium, of course] under constant average pressure, and the local and temporary variations of pressure are the cause of all motion."

The book is evidently the outcome of many years of thought and study on the part of its writer, and it would be of little use to express a single opinion, favourable or unfavourable, on it in a review. Some of the ideas give one the idea that there is much to be said in their favour. The suggestion that what we call atoms may be represented better by portions of fluid than by solid bodies is, whether tenable or untenable, certainly worth careful consideration, and should, if new, certainly be labelled and consigned to its proper place in the storehouse of accumulated thought which is being built up under the general title of "theories of matter." But is it new?

Dr. Fischer, in his first paper, takes as his starting point Korn's theory, according to which gravitation and electricity are referred to a periodical pressure to which the whole solar system is exposed. He considers, however, that it is not necessary to go outside the solar system to find an explanation of the phenomena, but that they can be explained very well by certain ordered motions within the system itself. He assumes the existence of two kinds of atoms, namely, the atoms of chemical elements and those of the ether. The majority of element-atoms are supposed to be elongated, those of the ether being spherical, of average equal size and practically of the nature of mathematical points.

"Possible motions of possible atoms" is an inviting title for his second paper. Its sections deal with space and time, matter and force, the chemical atoms, the ether atoms, the motion of chemical atoms and molecules, and cosmogony. In summing up, Dr. Fischer arrives at the following conclusions:—(1) Discrete deformable active atoms can only be of approximately spherical shape, never with sharp corners or edges; (2) Element-atoms of the most varied forms can be built up of such discrete atoms; (3) Owing to their activity atoms can move, and every motion is due to some force acting on matter; motion is only produced by leaps or bounds, after which it remains constant in magnitude and direction, and can only increase and decrease by jerks. A curvilinear motion is to be regarded as made up of a series of elementary rectilinear motions; (4) Elastic stresses presuppose deformable active atoms; (5) After elastic repulsions, deformable active atoms of certain dimensions may either designedly come into contact or separate; (6) With regard to oscillatory motions, approximately spherical atoms move uniformly, while element-atoms and molecules, especially those of elongated form, can either be turned about their axes or they can perform elliptic or circular oscillations made up of elements of rectilinear motion in directions along, perpendicular to, or inclined to their

axes; or the parts of a molecule may oscillate about their common centre of mass; (7) All oscillations are either ordered or unordered motions.

The various types of oscillation are held by Dr. Fischer to account respectively for chemical light-vibrations, electric light-vibrations, heat, gravity, electric and magnetic phenomena.

While Madame Royer's speculations on the nature of things lead her to think that the laws of nature are never disturbed by "that imaginary being called God, who has no place in an autonomous universe," Dr. Fischer concludes his paper with the quotation

"Die Himmel erzählen des Ewigen Ehre."

We far prefer the spirit of the latter writer, who in the course of his work clearly sees that theories of matter can but be approximate mechanical representations of the truth. It is true that a good deal of progress has been made of late years in the conception of elements and media which reproduce more or less closely the physical phenomena known to us; but whether we regard the universe as filled with a single medium and atoms as singularities occurring in it, or regard everything, including the ether, as built up of discrete atoms, a reduction of the number of varieties of atoms and media is not necessarily synonymous with an advance in physical theory. What is rather wanted is to reduce to their minimum the number of fundamental hypotheses required for the mathematical deduction of the physical phenomena known to us. This was the spirit which actuated Maxwell, and while since his time we have become more and more familiar with molecules and the ether, it is doubtful whether our advances in reducing their properties to mathematical formulæ have been so great as they ought to be. With the exception of Larmor, there are few physicists now carrying on the work of Maxwell, and there is, unfortunately, a growing school who conceal their ignorance of the causes of things by referring everything to "molecules" or "the ether," and endowing these with new properties without troubling much if such properties are reconcilable with those previously attributed to them. What is equally important, as our theories of matter advance, fresh properties become known to us, so that as soon as we have climbed to the summit of one hill, we see a still higher one ahead. G. H. B.

ALLEGED HYPOSTOMIAL EYES IN THE TRILOBITES.

Researches on the Visual Organs of the Trilobites. By G. Lindström. Kg. Svn. Vet. Akad. Handlg., Stockholm. Bd. 34, No. 8. Pp. 74; 6 plates. (1901.)

THIS memoir of 74 pp., illustrated by six most beautiful plates, deals in reality with the joint labours of the author whose name appears upon the title-page and his talented assistant, G. Liljevall, to whom the first detection of the central fact of the presence of supposed eyes on the labrum (hypostome), the labour of cleaning and preparing the specimens described, and, above all, of making the original drawings (for which no praise can be too high) are due. The material described is mostly a rich collection preserved in the Swedish National Museum; but it is explained, with comment none too flattering, that "collections of foreign species and the waste (vast) European and American literature" have been taken into account. The work opens with a short introduction, dealing mainly with the detailed surface anatomy of the hypostome and the orientation of the supposed hypostomial eyes, or "maculæ," as the authors name them, together with an account of the first observations upon which, by comparison with the cephalic eyes of the compound type, they were led to regard the maculæ of the facetted kind as visual in function. There then follows a chapter upon the blind Trilobites. A detailed dissertation upon the origin and nature of the ridge hitherto designated the "eye-lobe," "ocular fillet," or "Augen Leiste," and known by a variety of other names, next follows; and the authors, finding that "in a long series of genera succeeding each other it has no connection whatever with any eye," prefer to term it the "facial ridge"; and they subdivide the blind species into series characterised by its presence or absence.

In the foregoing section much is made of the young larvæ of Olenellus, discovered by Ford and Walcott, as furnishing a clue to the development of this facial ridge, and of the fact that during the growth process of the higher forms the pygidium follows the head region in order of appearance, and that the intervening "thorax" or body-segments are intercalary in origin. Passing to detail concerning the head, Bernard's terms, "rhachis" and "pleura" are preferably employed, and in dealing with its anatomy a passing compliment is paid to the Japanese embryologist, Kishinouye. Attention is next drawn to an important series of growth stages of Liostracus, described by Brögger in 1875, but generally overlooked, and from the study of these the conclusion is reached that the developmental changes of the head segments in the higher Cambrian and Silurian forms are of a different order to those of the Olenellidæ and Paradoxidæ, which Dr. Lindström would apparently regard as representative members of distinct series; and the final result is arrived at that the earliest oculate genus was Eurycare of the Olenellus schists, and that Olenus and Parabolina were probably blind.

The succeeding section is devoted to the consideration of the eyes of the Trilobites, the detailed structure of which the authors, with immense labour, have investigated, by sections taken at various planes and by other means at their disposal. They have been thus enabled to distinguish four types of cephalic eye, which they believe to have probably succeeded one another in the following order, viz. the simplest or Harpes type, of simple ocelli; the Eurycarid, biconvex or lentiform type; the Megalaspid or prismatic type; and the Phacopsid or "aggregate" type—each of which is duly figured with as much detail as is forthcoming, and in section as observed for thirty-six species. Further detail under this head is impossible in these pages; and we pass at once to the fuller consideration of the "maculæ," or hypostomial eyes so-called.

Although the authors record these organs for some 136 species of thirty-nine genera, they state at the outset that the genera in which they have found them lens-bearing are relatively few, and that the lenses or "granules," even where recognisable, have been found to be present only

over the lower third of the macula, with the exception of the Asaphidæ, Illænus and Lichas, of which they remark the entire macula shows "the structure which characterises" it as a visual organ. Beyond this, the macula, for which an average diameter of 0·99 mm. is given, is described as "oblong or ellipsoidal, and for two-thirds of its surface perfectly smooth or rather glossy," and its "granules" or lenses are estimated to be but 0·055 mm. in diameter at their largest.

With the maculæ, as with the cephalic eyes, a wide range of modification is recognisable, which, if the authors' assumption of a visual function for the former be correct, leaves little doubt that the facetted type is for it a culminating one. They state that the maculæ, "whether they show any organic structure or not," have commonly an "excessive thinness of their shell," and in so far as they enter into comparison with other Crustacea, while they call attention to the similarity "in the formation of the superior surface of the head in the Trilobites and the embryos and newly-hatched larvæ of Limulus," they incline to the belief that, concerning the cephalic eyes, Limulus "stands completely isolated amongst all Arthropods," except for a certain resemblance between its cornea and that of Peltura." They similarly deny resemblance to the Phyllopods, and regard "the eyes of the Trilobites" as showing "the greatest conformity with those of the recent Isopods."

Full perusal of the details which they attribute to the hypostomial macula shows them to have discovered an interesting and important organ. Comparison is instituted between it and a thin area of the hypostome of the living Apus; but, if sound, there is not much to be said from this standpoint for the "eye" theory in any but the facetted forms. For the types which remain, the study of the remarkable details described in the memoir leaves us in doubt as to the evidence for the supposed visual function. Convinced of its actuality, however, in an attempt to bring the living Crustacea into line, the authors fall back upon the fact that in the embryo Limulus the median eyes have been described by Packard and others as originally ventral, and that there have been recorded for the Lepadidæ two ventro-lateral eyes in an adult by Darwin, two ventro-lateral and a ventro-median one in a larva by Claparede, and similar indications by Hesse and Spence Bate.

Remarking upon the supposed habits of the Trilobites, of which we know nothing very definite beyond that a burrowing habit has been suggested, our authors express themselves averse to the popular idea that they "lived in abyssal depths . . . where the most intensive darkness prevailed." There are, however, considerations arising out of recent discovery concerning these animals worthy of note in this association. Owing to the wonderful conditions for preservation which characterise the Utica slate deposits near Rome, N.Y., certain Trilobites, during the last six to seven years there unearthed, as all zoologists are well aware, in the hands of Dr. Beecher, of Yale College, Conn., have yielded results of importance second to none in the palæontology of the period. The proof that but one pair of antennæ were alone present, and that they were uniramous, brings the adult Triarthrus at once into line with the Nauplius larva, as distinct from all other known Crustacean forms; while that of a simple uniformly jointed condition of the post-oral appendages, most, at least, of which were biramous, and of the Phyllopodan tendency of those posterior and last developed, more than fulfils the highest expectations of the philosophic morphologist, and amply justifies our trust in the larval form. One conspicuous feature of these appendages is the recurrent development from each of an inwardly directed and tapering gnathobase, most assuredly concerned with its fellows in the seizure of the prey and, by transfer of this from limb to limb, with its passage to the mouth. We know nothing of the habits of these animals as they swam, but from this feature the possibility is suggested that, like the living Apus, they may have swum upon their backs; and, if so, the presence of hypostomial eyes would become the more readily intelligible. On the other hand, the possibility that the "maculæ" may have been luminous organs must not be overlooked; and bearing upon this surmise, it is well to remember that such organs are known to exist in a lenticulate and aggregated form, and that the probable presence of one of simple type in a sponge, taken in conjunction with the extent to which like organs are functional as a lure to the prey, would dispose of any anomaly in their possession by blind animals. And finally, inasmuch as the remarkable organs present in the Chitons, some of which, being lens-bearing, were by Moseley described as eyes, so far as experiment with light has yet progressed, have given but negative results, it becomes a question whether, until we know more concerning even these, the term "æsthete" may not be well extended to them all. Arguing by analogy from these to the Trilobite "maculæ," it must be admitted that their visual function is not proved.

In the further inquiry into the nature of these remarkable organs there lies a most promising field. As we cannot experiment with them, we provisionally retain an open mind concerning their functions; and while we are profoundly grateful to our authors for their intensely interesting memoir and the great labour they have bestowed upon it, we shall await with much interest the further results of their inquiry. G. B. H.

THE RELATIONS OF THE OSTRICH-LIKE BIRDS.

On the Morphology and Phylogeny of the Palaeognathae (Ratitae and Crypturi) and Neognathae (Carinatae). By W. P. Pycraft. *Trans.* Zool. Soc. London, vol. xv. pp. 149-290, pls. xlii-xlv.

THE relation of the flightless ostrich-like birds (Mr. Pycraft says we must no longer call them Ratitæ) to more typical representatives of the class Aves has long been one of the puzzles of ornithology, and it is therefore a matter for satisfaction that the author of this important memoir has undertaken the task of revising and extending our knowledge of the anatomy of the existing members of the former group. The work was undertaken in connection with Mr. Walter Rothschild's revision of the cassowaries, of which, indeed, it forms the sequel; and the thorough manner in which it has been carried out forms a model of what such researches should be, and enables zoologists to draw their own conclusions on the questions at issue, if they are unable to accept all those at which the author arrives.

For a long time ornithologists have been hesitating whether or no to include the tinamus of South America in the same group as the ostrich-like birds; but this hesitating spirit does not commend itself to Mr. Pycraft, who boldly says that the affinities between the two imperatively forbid their separation. And it is this innovation which leads him to reject the time-honoured title, Ratitæ.

The inclusion of the tinamus in the group renders it necessary to assume (even if we had not to do so on other grounds) that the ancestors of the ostrich and its kindred were formerly endowed with the power of flight. Further, the author regards the group as a convergent one, which has had a multiple origin from the common avian stem before this began to split up into the more specialised "Carinate" types. The cassowaries and emeus are regarded as representing the most primitive branch, which culminated, perhaps, in the more advanced ostrich. From this it apparently follows, although it is not stated in so many words by the author, that the divergence of the Ratites (to call them by their old name), including the tinamus, took place while birds still retained teeth. While this may be so, it must be confessed that some palæontological evidence in its favour would be most welcome.

It may be added that, according to the genealogical tree given by Mr. Pycraft, the loss of the teeth in birds must have taken place at a still later epoch, for we find the cretaceous Ichthyornis branching off long after the divers and ducks had been differentiated. This seemingly implies that the origin of the latter is to be carried back to the Jurassic epoch, when, so far as we yet know, Archæopteryx was the sole representative of bird life. The author promises a supplementary memoir on Apteryx, where he will, perhaps, explain how we are to get out of this difficulty.

A slight discrepancy between the aforesaid "tree" and the text likewise stands in need of explanation. On p. 264 of the latter it is stated that the ostrich-like birds "are to be regarded as polyphyletic—probably triphyletic," and yet in the "tree" we find them arising from five distinct branches.

Space does not allow of allusion to the many interesting observations on the osteology and pterylosis of the group recorded by Mr. Pycraft, but these really form a storehouse of information of the utmost value to future workers. As he himself would doubtless be one of the first to allow, opinions may legitimately differ in regard to many of the conclusions arrived at by the author, but as to the value of his investigations all opinion must be in accord. R. L.

OUR BOOK SHELF.

Researches on the Past and Present History of the Earth's Atmosphere. By Dr. T. L. Phipson. Pp. xii + 194. (London: Charles Griffin and Co., Ltd., 1901.)

IN style and scope, Dr. Phipson's book reminds us of essays submitted to the Smithsonian Institution for the Hodgkins Fund Prize, and afterwards published in the Smithsonian Report. A more or less popular description is given of the atmosphere in its various relationships to man, and in its meteorological aspects; while in many places short statements are made of observations and investigations carried out by the author himself. The book should thus prove of interest to general readers as well as to meteorologists and other students of science.

In the early chapters, the thesis which Dr. Phipson seeks to establish is "that the primitive atmosphere of the earth was nitrogen, into which volcanic action poured more or less carbonic acid and vapour, and that after vegetable life appeared, free oxygen made its appearance in the air, and has increased in quantity from those primitive times to the present day." In connection with the subject of the variations in the amount of carbon dioxide in the air, it might have been well to refer to the work of Arrhenius, Chamberlin and others on the effect of variations in the proportion of the gas in air upon the mean annual temperature, and past geological conditions.

Dr. Phipson regards argon as allotropic nitrogen or a carbide of nitrogen. The hydrogen gas driven off from meteorites when heated is, he holds, produced by the decomposition of water vapour by the meteorite during the passage through the air, or the absorption of water, the oxygen of which combines with some of the constituents of the meteorite when it is heated, thus setting hydrogen free. He refers to the variation in brightness of the star Algol as "still a mystery to astronomers," though the spectroscopic work of Vogel has placed the cause of variability almost beyond doubt. Like many other writers who have not followed closely the physical geography of recent years, Dr. Phipson believes in the Gulf Stream myth, going so far as to commit himself to the statement that "The mild climate of the British Isles is very greatly due to this immense current of warm water, without which we should be no better off, in this respect, than people who live in the Arctic circle." To understand how unfounded this statement is, we refer the author to a paper in the U.S. *Monthly Weather Review* of September 1900.

In a short chapter on meteorites the remark is made, "They are, no doubt, of the same composition as the moon; and are, I believe, minute satellites of our earth, thrown off like our larger satellite was thrown off, in the earliest stages of its existence." Here again we have statements with little evidence to support them. Nothing is known of the exact composition of the moon, so the words "no doubt" in the sentence quoted are, to say the least, gratuitous.

While, therefore, we think the book contains an interesting account of the earth's atmosphere, we suggest that in several places statements are made as if they were accepted conclusions, whereas they are often opposed to the opinions of competent authorities.

Catalogue of the Mesozoic Plants in the Department of Geology, British Museum (Natural History). The Jurassic Flora. I. *The Yorkshire Coast.* By A. C. Seward, F.R.S. Pp. xii + 341; plates xxi. (London: British Museum (Natural History), 1900.)

FOSSIL plants from Gristhorpe Bay and neighbouring parts of the Yorkshire coast are so widely distributed among museum collections that Mr. Seward's descriptive catalogue of them will be welcomed by many museum curators in Britain and on the continent. But the volume is more than a catalogue; it is a history of Oolitic plant-remains of Yorkshire, exemplified by the fine series preserved in the British Museum. In addition to the data provided by this material, the descriptions are based upon specimens in many other collections which have been examined and considered. As might have been expected, the identification of type-specimens was a difficult task, and in many cases it has been found impossible to specify the type, which fact, remarks Mr. Seward, "has afforded a practical demonstration of the need of some system for the centralisation and cataloguing of all specimens which have served for the diagnosis or illustration of new species."

In an introduction a brief historical survey is given of our knowledge of the Jurassic plants of Yorkshire, and also of the Jurassic plant-bearing strata of France, Germany and other countries which resemble those of the Yorkshire coast.

In the descriptive part of the catalogue the specimens are grouped, so far as possible, in accordance with their natural affinities. Fifty-five species are described, and are distributed as follows:—Bryophyta, 1; Equisetales, 2; Filices, 20; Cycadales, 23; Coniferæ, 9. There is a resemblance between this flora and the Wealden flora, among the common characteristics being the absence of Angiosperms and abundance of Cycads and Ferns.

In conclusion, Mr. Seward remarks: "It is in the southern tropics that we must look for existing forms which afford the most striking links between the vegetation of to-day and that which has left imperfect records in the Jurassic sediments of the Yorkshire coast. The climate was presumably more tropical than that of North Europe at the present day; there is no evidence that the plants of Jurassic times grew under conditions which induced xerophytic characters, moisture being probably abundant and favourable to the luxuriant growth of Equisetums and Ferns."

Practical Electrical Testing in Physics and Electrical Engineering. By G. D. A. Parr. Pp. vi + 392. (London: Longmans and Co., 1901.) Price 8*s.* 6*d.*

MR. PARR is head of the electrical engineering department of Yorkshire College, Leeds, and the book before us represents the instructions and experiments given to students in the practical course in that department. It is not our object to criticise that course, the value of which must largely depend on the theoretical teaching accompanying it; suffice it to say that it is apparently modelled very closely on that given by Prof. Ayrton at the Central Technical College. Whether there is sufficient justification for the publication of Mr. Parr's book must depend on whether the details of the system and apparatus are sufficiently widespread; in the majority of cases the instructions given for each experiment imply the provision of special apparatus for carrying out the test, and the instructions are given, if we may use the phrase, in terms of that apparatus. A more general description of the experiments would be of wider use, though probably not so convenient for the student actually passing through Mr. Parr's course. There is a good appendix describing the chief instruments and apparatus used, and another appendix giving solutions of the various problems raised by the experiments which we do not think so valuable, except as a labour-saving device to the demonstrator or idle student. The experiments are, on the whole, well devised to bring out clearly the fundamental laws of electricity and magnetism. We are sorry, however, to see included an experiment to "prove" Ohm's law, in which P.D. is measured by a high-resistance galvanometer; a galvanometer can only be employed to measure P.D. if Ohm's law be true, so that it cannot logically be used for this purpose in an experiment to prove the law. The method given second by Mr. Parr, in which an electrometer is used to measure P.D., is the only satisfactory one for proving Ohm's law. Technical teachers who are seeking to develop a practical course will find this volume a valuable guide.

LETTERS TO THE EDITOR.

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Audibility of the Sound of Firing on February 1.

IT is an interesting question how far the accounts of various observers as to the sound of the minute guns on February 1 having been distinctly heard at many distant stations and not heard at others comparatively near by attentive listeners, and as to the character and duration of the sound, can be explained by known laws of the propagation of sound in the atmosphere. To this question I should like here to offer such answer as I have been able to arrive at after careful consideration and some rough calculation.

The firing line extended from the *Majestic* at the eastern end to the *Alexandra* at the western, in a direction some 6° N. of W. for about 8 miles. The eastern half was a double line of 16 pairs of ships, the distance between the two lines being about ¼ mile, nearly the same as that between the successive ships in each line (2½ cables or ¼ sea mile); while the western half was a single line of 14 ships.

Some stress has been laid by observers near the firing line on the want of simultaneity in the discharges from the different ships. There is doubtless need of more accurate information on this point, but I cannot help thinking Mr. Hinks's estimate that, as "the firing ran down the double line, the interval between the successive pairs of flashes was about half a second," is excessive. This would add, to an observer at Southsea, 8 seconds over and above the 19 to 20 seconds by which the sound of the westernmost pair of the double line was necessarily behind

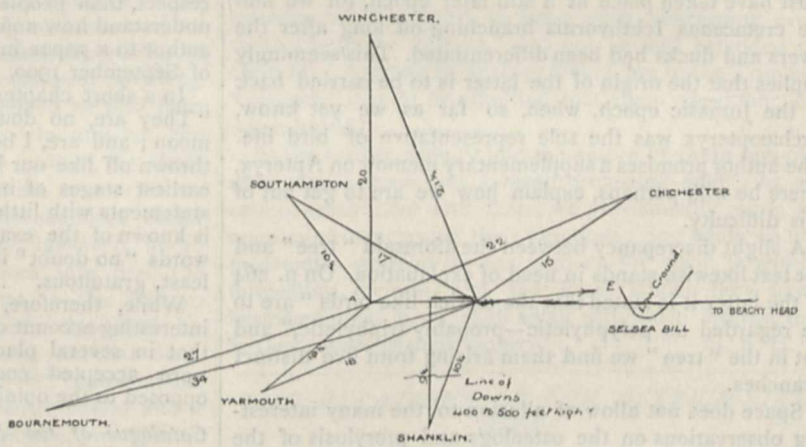

FIG. 1.

that of the first pair, whereas he says that the whole sound "lasted only about 20 seconds." I do not think, therefore, in the absence of more exact information, account need be taken in a general explanation of the supposed want of simultaneity, which I estimated on such information as I could get as not amounting to a difference of more than 2 or 3 seconds.

Mr. Hinks's observation is in another respect important, as it would seem to show that the second half of the firing line was unheard at the distance of 4 to 5 miles from its eastern end.

The known causes which would or might affect the audibility of the sound impulses arriving at any station are, I think, these: the position of the station relatively to the firing line, the direction of the wind and the variation in its speed with the height above the earth's surface, the variation in temperature of the different strata of the atmosphere, and for greater distances the curvature of the earth's surface.

Of these, for distances not exceeding 30 to 35 miles from the firing line, I believe the dominant factor to be the first, that is, relative position of the station.

The accompanying diagram (Fig. 1), drawn roughly to scale, shows this, I think, conclusively.

At Shanklin the reports were heard, but they were not very

loud or at all comparable with such as are heard there (and felt too) when gunnery practice with big guns is going on near Portsmouth. This is what might have been expected, since the nearest distance from the firing line was 9½ miles from a point close to the west end of the double line of ships, and the distance from its extremities about 10¼ miles. Hence the sound impulses from the whole line arrived within the interval required by sound to travel ¾ of a mile, or about 3½ seconds, and thus concentrated were audible, although a line of downs 400 to 500 feet high intervened at a distance from Shanklin of about 4 miles.

At Yarmouth a gentleman, who went on to the pier specially to listen, heard "not a single gun." This is explained by the fact that he was so near the prolongation of the firing line westward that, though only 10½ miles from the western end, he was 18 miles from the eastern extremity, and so the sound impulses, spread over an interval corresponding to 7½ miles, or about 36 seconds, must have arrived at intervals of a little more than a second as separate sounds from the successive ships, each by itself too feeble to be audible.

The same explanation holds for Bournemouth west and a little south of the prolongation, and for Chichester east and a little north of the same, where the sounds were not heard, the impulses being spread over an interval of about 33½ seconds.

Winchester is 20 miles nearly due north from the western end of the firing line, and its distance from the eastern end is about 21½ miles. The difference of 1½ miles corresponding to about 7 seconds might perhaps have been expected to have produced sufficient concentration to make the reports audible, but they were not heard, and probably this is partly due to the intervention of the downs at the foot of which Winchester lies.

As to Southampton I have no information, but as it corresponds in position to the N. of the line almost exactly to Yarmouth on the S., there can be little doubt but that there too the firing was inaudible.

Thus far an explanation founded on the supposition of a still atmosphere of uniform temperature appears to be sufficient. But we have good evidence of the reports having been distinctly heard at distances of sixty, seventy, and even to seventy-five miles from Portsmouth in directions varying, from the eastern prolongation of the firing line, northwards through north-east to due north; but, so far as I know, not west of the north line. For these, at any rate for stations not far from the prolongation of the firing line, some totally different explanation must be found, and the first step must be to consider the effect of the wind.

Prof. Sir G. Stokes first pointed out in 1857 that, if the speed of the wind increases with the height above the earth's surface, the path of a sound ray cannot be straight, but must be curved and bent *downwards* towards the surface for rays *in the direction* of the wind, but *upwards against* the wind.

Now on February 1 there was a steady gentle wind, estimated at somewhere about five miles an hour, from the west with a cloudless sky, and no *visible* irregularities of cloud or fog to interfere with the normal propagation of sound. Hence for places west of the firing line the sound rays, on Stokes's principle, were diverted upwards into the upper atmosphere, and so passed over the heads of places at even moderate distances, so that no sound reached them. For places east of the same the contrary effect was produced, and closer examination is necessary to trace the consequences.

Proceeding from Stokes's principle, it is shown in Lord Rayleigh's "Treatise on Sound," ch. xiv., that on the hypothesis of the speed of the wind increasing upwards from the surface in direct proportion to the height, the path of a ray of sound advancing with the wind would be a catenary whose axis is vertical and directed downwards from its vertex, so that the ray, after ascending in its curved path to the vertex, would descend in a similar path again to the horizontal line through the point whence it started. Thus a ray starting from A (Fig. 2) in the direction AT would reach B in the horizontal line through A by the path ACB of the catenary, whose vertex is C, midway between A and B; and hence all the sound energy, which in air with no differential motion of its strata would have been spread over the circular sector TAB, must be concentrated between the curve ACB and the horizontal base AB. Now the angle TAB, when not large, is very nearly proportional to the distance AB, and hence in a vertical plane the concentration of the energy is proportional to the distance AB. On the other hand, in the horizontal plane the energy is spread out in azimuth proportionally to the distance AB, and thus the concentration in the vertical plane is balanced by the spread in the horizontal plane, so that the sound energy reaching two observers at different distances from A in the horizontal line AB would be about the same in amount.

There is, however, this difference, that, as the distance AB is greater, the difference in length between the curved path ACB and the direct line AB is greater, and this produces a greater retardation in time between the extreme curved ray and the horizontal ray, so that, the same energy being received in a longer time, the impression on the ear at a distant station would be enfeebled as compared with a nearer one.

Assuming this general reasoning to be correct, I have endeavoured to apply it quantitatively to the case of Eastbourne, or rather Beachy Head, for which we have the valuable observations of your correspondent, "H. D. G."

The firing line extended eastward passes directly to Beachy Head over a sea surface, with the exception of about two miles across the low peninsula of Selsea Bill. I have assumed the direction of the wind to coincide with this line, as it approximately did, and, farther, in the absence of definite data as to the rate at which the wind speed increased upwards, I have assumed it to amount to five miles per second for each mile of vertical height. I find then that at the distance of sixty miles from any firing point, which is about the distance of Beachy Head from Spithead, all sound rays starting at a less elevation above the horizon than about 11° 23′ would be bent round to the horizon between these two points, the extreme ray having reached an elevation of just over three miles; and the length of its path exceeding the direct horizontal distance by about four-tenths of a mile, it follows, from the known speed of sound, that the sound energy from a single gun would be at Beachy Head spread over an interval of very nearly two seconds. I conclude, therefore, that no single gun or pair of guns could have

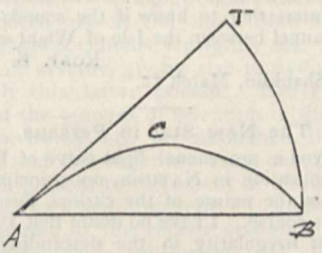

FIG. 2.

been heard there. But since the interval along the line between successive ships or pairs of ships corresponds only to a sound interval of just over one second, the sound impulses from successive ships would overlap (as they would not do at smaller distances, such as Chichester), and might so reinforce one another as to become audible. Doubtless the reflections of rays from the smooth sea surface would also contribute to this result.

Of course, the assumed data are too hypothetical for any dependence to be paid to these figures as exact results, but I think they suffice to show that the observations of "H. D. G." may thus be fairly accounted for.

His description of the sound heard as "er-er-pup-pup" would correspond with the general roll and the explosion from a pair of guns in the double line not fired exactly simultaneously, while the duration which he notes of about eleven seconds for the whole sound would correspond fairly well with the interval, some eighteen seconds, by which the sound from the last ships of the double line would be behind that from the first, and would seem to prove that the sounds from the single line farther westward were inaudible.

It is well known that the speed of sound in air does not depend directly on the density, but is affected by temperature, so that in an atmosphere of varying temperature the course of a ray must be curved. In the normal condition it is stated that the fall of temperature is about 1° C. in 330 feet of vertical height, and the consequence is that every ray of sound must be deflected *upwards*, and so at a little distance from the source would pass to the upper regions of the atmosphere over the heads of observers on the same horizontal line. This effect is probably small compared with that due to the wind. It would add to the upward bending effect for rays proceeding against the wind (in our case

westward), and somewhat flatten the curved paths with the wind; but it would not probably affect materially the general explanation above.

"H. D. G." truly observes that, owing to the curvature of the earth, his station was nearly 2000 feet below the horizontal line of Spithead, but this also would not materially alter our explanation.

So far for the sound heard at distant stations not very far from the east-west line from Spithead. When, however, we come to consider the case of Oxford and other places nearly due north, where the sound was heard, and in particular the duration of continuous sound (20 seconds) and succession of sounds and silences noted by Sir W. J. Herschel, our explanation entirely fails. It is true that the differences of distance from Oxford to the different ships were so small that the impulses from all the forty-six ships must have arrived within the interval of about half a second, but they would have diminished in intensity (according to the law of the inverse square of the distance, which in the absence of wind in their direction must be assumed) so as to be less strong than the impulse from a single gun at the distance of ten miles, a distance at which, we have seen, it would have been inaudible.

Was there a southerly current in the upper atmosphere between the Solent and Oxford? Or was the state of the atmosphere abnormal as to temperature, so that the upper regions were warmer than the lower, as hardly seems probable? Or, lastly, were the sounds heard by Sir W. J. Herschel diffraction effects outside the upward curving sound rays, as the intervals of sound and silence seem to suggest? Or is any other explanation possible from known laws?

Possibly some light may be thrown on these questions by other correspondents, or such experts as Sir G. Stokes, Lord Rayleigh or Prof. Osborne Reynolds.

The Cherbourg Peninsula at its northern end is about the same distance to the south of Spithead as Oxford to the north. It would be interesting to know if the sounds were heard by ships in the channel between the Isle of Wight and Cherbourg.

ROBT. B. HAYWARD.

Ashcombe, Shanklin, March 12.

The New Star in Perseus.

IN sending you a provisional light-curve of Dr. Anderson's new star for publication in NATURE, my principal purpose has been to ascertain the nature of the curious fluctuations in the latter part of its course. I have no doubt that they are real, as even the slight irregularity in the descending curve, about March 5, has been independently detected in Leyden, and probably elsewhere also; but the periodicity that seems to establish itself in the past six or seven days may be only apparent. In this country the weather has been generally unfavourable for some weeks, and it is possible that astronomers in other parts of the world will be able to fill the gaps between the observed parts of the descending curve (on February 25, March 1, 3, 5, 6, 13, 17, 20, 21, 22, 23, 25, 27).

This star is remarkable in still another respect. It is a well-known fact that new stars have almost exclusively made their appearance in the Milky Way; moreover, it has been pointed out recently by Sir Norman Lockyer in this journal that the Novæ are not equally distributed along the galactic zone; like the "Wolf-Rayet" stars, they seem to avoid the region comprised between Cassiopeia and Carina. Nova Persei 1901 is no exception to the general rule, it being situated on a feeble distance of the central plane of the Milky Way, but as in the case with the other new star discovered by Dr. Anderson, in Auriga, it lies in a relatively poor region of the galactic zone, in which phenomena of this kind have but rarely occurred. Notwithstanding this, I think that the tendency among the new stars to group themselves in the opposite region of the Milky Way holds good as a rule.

C. EASTON.

Rotterdam, March 27.

NOVA PERSEI.

THE observations of the new star in Perseus have not decreased in interest since they were last referred to in NATURE. Strictly according to precedent a nebular spectrum, somewhat similar to that observed by Gothard in Nova Aurigæ, followed the disappearance of the dark lines in the spectrum; but about the same time a new phenomenon in relation to Nova was observed; the star behaved like a "collision-variable."

Sudden changes of magnitude have been one of the most interesting features of this new star. Since the time (February 23) that the Nova attained its greatest brilliancy, the star gradually diminished in brightness, decreasing rather rapidly till the 13th March, and somewhat more slowly up to the 17th. Since this date periodical variations have occurred, the star decreasing to a 5·5 magnitude star and rising to about 4·2 in a period of three days (about). Thus minima were observed on March 19, 22, 25 and 28. On the evenings of the 30th, 31st and April 1 the star was of mag. 4·2, 4·3, 4·4, so that either another minimum had occurred between the times at which these observations were made or the periodicity is undergoing a change. It is important, therefore, that the light of the Nova should be observed as often as possible, so that such changes may be accurately determined.

Whether this result is due to the complete capture of the denser swarm or to other changes brought about in the sparser one, it is as yet impossible to say.

We append some extracts from a paper communicated to the Royal Society by Sir Norman Lockyer last Thursday.

Colour.—The colour has undergone some distinct changes since the observation on March 5 last, when it was shining with a claret-red hue. On the 9th and 10th it was observed to be much redder, due probably to the great development of the red C line of hydrogen.

On the 23rd and 24th the star was noted as yellowish-red, while on the 25th (after the sudden drop in magnitude) it was very red with perhaps a yellow tinge.

Since that date the star has again become much less red than formerly, and on April 1 was distinctly yellow with a reddish tinge.

The Visual Spectrum.—Since March 5 the spectrum has become much fainter, the bright lines of hydrogen being relatively more prominent than they were before; indeed, C and F throughout this period have been the most conspicuous lines, especially the former, while the bright lines λλ 5169, 5018 and 4924, and the line in the yellow at or near D, were the most prominent of the others.

All these lines have been gradually becoming weaker, but there is an indication that λ 5018 has been brightening relatively to λ 5169.

Accompanying the great diminution in the light of the Nova observed on the evening of the 25th, the spectrum was found to have undergone a great change: the continuous spectrum had practically disappeared, and a line near D (probably helium D^3) became more distinct. The other lines were hardly visible.

The Photographic Spectrum.—The spectral changes recorded in the photograph in one part of the spectrum follow suit with those observed visually in the other.

On March 6 the photograph was very similar to those obtained in the earlier stages, the only apparent difference being in the relative intensity of the bright hydrogen lines as opposed to those having other origins, most of which have been shown to be probably due to iron and calcium. The hydrogen lines have sensibly brightened, while the others have become much feebler.

The photograph of March 10 shows a further dimming of the bright lines other than those of hydrogen.

On March 25, when the next good photograph was taken, the spectrum had undergone great modifications. The hydrogen lines are still very bright, though they do not show the structure which they did in the photographs taken between February 25 and March 10. The bright lines other than those of hydrogen which are seen in the earlier photographs have now disappeared and other lines become visible. The continuous spectrum has also greatly diminished.

Rough determinations of the wave-length of these new lines have been made by Mr. Baxandall by interpolation between the hydrogen lines. They are as follows:—

387. Brood and merging into Hζ (3889).
436. Faint.
447. Not very strong. Probably Helium (λ4471·6).

456. Faint.

464. Very strong broad line. Possibly the 465 line of the bright-line stars.

468. Moderately strong. Possibly new hydrogen (λ 4686) seen in bright line stars.

471. Weak. Probably helium (λ 4713).

The hydrogen lines in the spectra are Hζ, Hε, Hδ, Hγ and Hβ.

The lines at λ 370 and 464 are perhaps identical with those observed by von Gothard[1] in the spectrum of Nova Aurigæ, after it had become nebular, but associated with these lines in his record there is the chief nebular line at 5006, no trace of which is yet visible in the spectrum of Nova Persei. On the other hand, Hβ, which is the brightest line in the present spectrum of Nova Persei, does not appear at all in von Gothard's spectrum of Nova Aurigæ.

Characteristics of the Hydrogen Lines.—A detailed examination of the lines as photographed on several evenings shows that their structure has been undergoing changes. On February 25 there were three points of maximum luminosity on the F line, the two maxima on the blue side being of equal intensity and greater than the third on the red side. By March 1 the centre one had greatly been reduced in magnitude, and on the 3rd it had been broken up into two portions, thus making four distinct maxima.

Rough measures made on the relative positions of these points of maxima show that the difference of velocity indicated between the two external maxima is nearly 1000 miles per second, while that between the two inner maxima is 200 per second. We thus have indications of possible rotations or spiral movements of two distinct sets of particles travelling with velocities of 500 and 100 miles per second.

A similar examination of the F and G lines of hydrogen in the photographs obtained with the 30-inch reflector has also been made by Dr. Lockyer. In this longer series the most important fact comes out that the change of maximum intensity changes from the more to the less refrangible side of the bright hydrogen line,[2] and the narrowing of the bright maximum in the middle.

So far as the observations have gone they strongly support, in my opinion, the view I put forward in 1877, that new stars are produced by the clash of meteor swarms. I have suggested some further tests of its validity.

We may hope, since observations were made at Harvard and Potsdam very near the epoch of maximum brilliancy, that a subsequent complete discussion of the results obtained will very largely increase our knowledge. The interesting question arises whether we may not regard the changes in spectra as indicating that the very violent intrusion of the denser swarm has been followed by its dissipation, and that its passage has produced movements in the sparser swarm which may eventuate in a subsequent condensation.

THE BEER POISONING EPIDEMIC.

THERE is now a pause in the literature of the most interesting, but at the same time most disastrous, beer poisoning epidemic, and the present seems a fitting opportunity to summarise the chief facts ascertained with regard to it, the deductions to be drawn from them, and, last but not least, the lessons which they teach so far as concerns the prevention of a recurrence of the calamity.

The first fact of transcendental importance was ascertained by Dr. Reynolds, namely, that the beer consumed by these unhappy individuals contained arsenic in such an amount as undoubtedly in many cases to account for the symptoms from which they suffered. So far as subsequent workers are concerned, their results have amply confirmed this fact, and there can be no doubt that the majority of patients in Manchester suffered from what has always been called arsenical poisoning. The next step was directed to ascertain how the arsenic got into the beer. Of this, fortunately, there can be no doubt it came into the beer from the sugar, and it got into the sugar through the sulphuric acid used either directly or indirectly in the manufacture of the invert sugar or the glucose. It is beside our purpose here to discuss whether all the cases of poisoning were due to the use of sugar made from sulphuric acid supplied either by one firm or prepared from one variety of pyrites. This, although a matter of paramount importance, is not essentially a matter for the man of science to decide. A definite answer to this question can only be obtained by the careful sifting of evidence, the examination of the books of various firms, &c., and is, indeed, a matter for the lawyer rather than for the chemist or pharmacologist. There can be no doubt, however, that the majority of cases observed could be traced to the consumption of beer and stout in the preparation of which sulphuric acid, supplied since the spring by one firm, had been used.

The next actual fact with regard to the causation of the epidemic was, unfortunately, discovered too late to allow of its full significance being thoroughly worked out. Two full months after the consumption of arsenicated beer had ceased, Dr. Tunnicliffe and Dr. Rosenheim demonstrated the presence in relatively large quantities (0·3 per cent.) of selenious acid in the sulphuric acid which was used in the preparation of the invert sugar supplied by the firm implicated in the recent epidemic. These observers subsequently further demonstrated the presence of this substance, which was, indeed, from their earlier work *a priori* almost certain, in the invert sugar itself and also in two different samples of beer identical with that consumed by the poisoned patients in Salford. They also pointed out at the same time that this substance is highly poisonous, certainly as, if not more, poisonous than arsenic, giving rise to symptoms almost identical with this latter poison. Exact quantitative estimations of the amount of selenium in the beer are, so far as we are aware, not yet published, but reckoning from the acid and the sugar we may calculate that this substance was present to the extent of about one quarter the amount of the arsenic present. It follows, then, that the beer consumed in the recent epidemic contained at least two poisonous substances, viz., arsenic and selenium, both of which got into the beer from the sulphuric acid used in the preparation of the sugar.

So far as concerns the actual ætiology of the epidemic, the above are all the facts which we have at present in our possession. Incidentally, however, numerous other points of extreme interest to the physician, the pharmacologist and toxicologist have arisen in the course of the inquiry.

So far as the pharmacology of arsenic is concerned, it is greatly to be regretted that our information concerning the exact amount of arsenic consumed by the individual patients is so inaccurate. This inaccuracy arises from two conditions. Firstly, it has not been in all cases absolutely established that the beer quantitatively examined for arsenic, although coming from the same source as, was identical with that consumed by the respective patients; secondly, the actual amount of beer taken by each patient was in many cases an unknown quantity. The largest amount of arsenious acid found in beer during the epidemic was 1·4 grains per gallon. Some of the sufferers undoubtedly consumed more than a gallon of beer per diem; some, however, did not consume more than a pint. This would mean that, although the former received a highly poisonous dose of arsenic, the latter would do so only in the cases of the very highly arsenicated beers, which were relatively rare. If we assume that arsenic was the only poisonous agent at work, we must also admit that it caused grave poisoning in very minute doses; in some cases, from the published records, these must have been as small as 1/200th of a grain per diem.

[1] *Ast. Phys. Journ.* vol. xii. p. 51, 1891.

[2] The latest photograph, taken on April 1 shows this peculiarity in a far more pronounced manner, the intensity of the less refrangible component of the hydrogen lines being more than four times that of the more refrangible component.

These profound symptoms of poisoning from such minute doses have given rise to various explanations. The fact that the toxic power of arsenic varies largely according to the chemical form in which it is present, the arseniates, for instance, being barely half as poisonous as the arsenites, has led many to assume that the arsenic was present in the beer either as an arsene, or even in some more subtle biological form. The work of Gossio and others upon the power of the penicillium brevicaule to form highly poisonous gaseous substances from minute traces of solid arsenic compounds has been adduced by many in support of this hypothesis.

A further consideration of interest in this connection is the fact that arsenic must be considered, at any rate to some extent, a cumulative poison. The interesting and minute work of Gautier upon the excretion of arsenic under normal conditions by the skin, the hair and the menstrual fluid, and the storing of it in the thyroid gland, the thymus gland and the brain, are of especial interest. The recent researches of Sslowzow should also find mention here. This observer found that in animals poisoned with arsenic the arsenic was stored in the liver, and further, that it formed a compound with the nucleins, which showed itself to be resistant to the action of hydrochloric acid and pepsin, and that it was, in all probability, stored in this form in the cell nuclei. This work, so far as concerns the storing of arsenic in the liver and its excretion by the epidermal appendages, has been recently confirmed by Dixon Mann.

That arsenic is slowly excreted has been known for some time. E. Ludwig found arsenic in the urine of a dog forty days after the last dose had been ingested, Wood found it in the urine of patients eighty and ninety days after intoxication with arsenic.

Although arsenic may be in this sense cumulative, it does not follow that its poisonous action is cumulative. In fact, its forming an indigestible nuclein compound speaks against this. Further, we know from clinical experience, from the Styrian arsenic eaters, and from numerous pharmacological experiments on animals, that tolerance to arsenic is easily produced. Indeed, continued small doses of arsenic, so far from causing symptoms allied to those which occurred in the beer poisoning epidemic, as a rule improve nutrition and have a general tonic action.

If we pass from the consideration of the nature of the poison to the symptoms which occurred in the Manchester patients, we find many points of extreme interest. Speaking generally, the phenomena present corresponded more or less closely with the classical symptoms of arsenical poisoning. It must be remembered, however, that the discovery of selenium opens the whole question of arsenical poisoning afresh. So far as pharmacological experiments upon animals go, the only difference between the chronic poisonous action of these two substances is that tolerance to selenium is apparently never produced, and that this substance, in continued small doses, produces wasting by virtue of a specific stimulating action which it exerts upon the breaking down of the nitrogenous constituents of the tissues. Thus we must confess that the presence of selenium along with arsenic in the Manchester beer explains many otherwise anomalous symptoms.

It has long been known that excess of alcoholic beverages causes in the drinkers a disease known as peripheral neuritis. The *rôle* played by alcohol in this disease has heretofore been regarded as sufficiently important to justify the designation of alcoholic neuritis for this condition. It has, however, been observed that the drinkers of certain kinds of alcoholic beverages are much more prone to this affection than the drinkers of others, and further, that the strength of the beverage in alcohol seems to bear no proportion to its proneness to cause so-called alcoholic neuritis. Drinkers of distilled spirits and wines are much less liable to suffer from peripheral neuritis than beer and stout drinkers. These considerations have led many physicians to look upon this disease as caused by the beverage rather than by the alcohol (C_2H_5OH). Peripheral neuritis was a prominent symptom in the Manchester epidemic, and there can be little doubt it was caused by the arsenic and selenium compounds in the beer. Other metallic and organic poisons, such, for instance, as beri-beri, give rise to a similar condition. This epidemic has, therefore, very much increased the previous doubt concerning the part played by alcohol itself in the so-called alcoholic neuritis.

With regard to the lessons to be learnt from the recent beer-poisoning epidemic, the chief one certainly is to beware of mineral acids in the preparation of all foodstuffs. It is difficult to see how mineral acids, or at any rate acids (in this connection must be observed the difficulty of freeing an acid like tartaric acid from lead) can be dispensed with. They can, however, certainly be put on the market, from whatever source they may be obtained, pure. Although absolute chemical purity must be regarded as a dream of the fatuous ignoramus, there should be no difficulty in the sulphuric acid manufacturers providing an acid which one can term at least harmlessly impure. A further important result of the investigations attending this epidemic is the discovery of selenium in poisonous doses in a beverage actually consumed. This substance has no doubt slipped in and out of many previous arsenic epidemics, escaping observation, as it were, between the stools of chemistry and pharmacology. Now that we are awake to its poisonous existence, in the next arsenic epidemic, which we hope may be long deferred, we shall be able, no doubt, to work out the exact part it plays. It is interesting to note in this connection that it is an impurity of both brimstone and pyrites acid, and that it occurs along with tellurium in certain Japanese sulphurs which are free from arsenic.

MUSICAL ARCS.

WE have already described in a previous issue (NATURE, December 20, 1900, p. 182) the discovery of a new musical instrument in the electric arc made by Mr. Duddell and communicated by him to the Institution of Electrical Engineers last December. The fame, if not the music, of Mr. Duddell's arc penetrated, it appears, to Vienna, where the experiments were repeated at the Technological Institute, and thence returned to the English lay Press. The *Daily Mail* of January 12 last contained an article on "Music in Flame," the result of an interview with Prof. Ayrton on the subject of Mr. Duddell's experiments, in the course of which he suggested that it might be possible to utilise the discovery for the purpose of public entertainment. Would it not be possible, for example, to play a tune upon the arc lamps used in lighting a hall, the musician being at a distance—even outside the building—and playing on the ingenious key-board devised by Mr. Duddell? At the time this article appeared the prophecy may have seemed somewhat extravagant. Mr. Duddell's experiments were conducted, it will be remembered, by shunting an arc burning between solid carbons—the cored carbon arc has no music in its soul—by a circuit containing capacity and self-induction, and the note emitted by the arc was varied by altering the capacity or self-induction in the shunt circuit. The shunt circuit was, however, placed directly across the terminals of the arc, and there was no evidence of any possibility of playing tunes on the arc from any distance; and, further, the arc lamps used in the experiment were hand-fed and it was not unreasonable to suppose that the mechanism and magnet coils of an automatic arc lamp would effectually interfere with the music.

Extravagant, however, as Prof. Ayrton's suggestion may have seemed, it appears from Mr. Duddell's reply to the discussion on his paper (just published in the *Journal* of the Institution of Electrical Engineers) that it is more than justified by the truth. During the time that Mr. Duddell was experimenting on the musical arc at the Central Technical College, Mr. Bradfield noticed that an arc with which he was experimenting in Sir W. de W. Abney's laboratory started playing tunes. About the same time also Sir Norman Lockyer noticed that the arc in his laboratory was behaving in an erratic manner, though he did not detect any definite tune. At the time neither Mr. Bradfield nor Sir Norman Lockyer were able to account for this strange behaviour, but on the publication of Mr. Duddell's paper the explanation became evident. All the arcs were being supplied from the street mains and the disturbances were due to the shunt circuit with which Mr. Duddell was working at the Central Technical College. The arcs at Sir W. Abney's and Sir Norman Lockyer's laboratories were thus able to detect and repeat the tunes Mr. Duddell was playing on his arc, although they were in no way adjusted to make them specially sensitive, and were only connected to Mr. Duddell's arc by virtue of being on the same distributing network of supply mains. Sir. W. Abney's laboratory is on the opposite side of the road to the Central Technical College and at a distance of about 400 yards in a straight line, and at a much greater distance if measured along the street mains. Sir Norman Lockyer's laboratory is at about the same distance, on the same side of the road as the College.

If such remarkable results as these can be obtained without any design or arrangements of the circuit, who shall say what cannot be effected by a proper study of the best conditions and attention to the necessary details? Those who heard the music discoursed by the arcs at the Institution of Electrical Engineers will agree that some improvement is necessary before the arc can compete as a musical instrument with the violin or grand organ. But it is sufficiently demonstrated, we think, that Prof. Ayrton's prophecy is by no means excessive, and the time is perhaps not far distant when every central station will have its resident musician to play patriotic airs on the street arcs at the Coronation of the King and like occasions, and we shall be able to realise something of the grandeur of "the morning stars singing together."

LITTLE'S EXPEDITION TO OMI AND THE TIBETAN BORDER.[1]

A HOLIDAY trip from Central China (Chung-King), through the red sandstone basin of western Sze Chuan to the granite frontiers of Tibet, and back again by the traditional water-highway of the Yangtse, is not an experience which falls within the reach of every mercantile explorer in the East; and it derives additional interest in Mr. Little's case from the fact that he was accompanied by his wife. The story of the expedition is told in the form of a diary, a form in which it is almost impossible to avoid a certain amount of monotonous reiteration of incident in the daily record of progress, and which is, perhaps, a little too official in its method for an ordinary traveller's tale; but it is interesting all through, and the deductions which Mr. Little draws from his observations afford valuable food for reflection to those who look to the opening up of China to western methods of economic development. From Chung King to Kia ting, the town which lies at the foot of the classical Omi (the Fusilama of western China), Mr. Little and his wife adopted the Chinese traditional mode of transport, which consists of a sedan chair carried on the shoulders of coolies; and it is a method which, in the present stage of Chinese social advancement, secures for a traveller as much respect and attention as a coach-and-four would in England. It at once lifts him morally and physically above the steaming crowds of humanity which, in a region which is free from the depleting processes of famine, swarm together in one great pitiless struggle for existence. The whole basin of the Yangtse to the foot of the western mountains presents the same aspect of overcrowded population. Every acre of available soil is cultivated, every yard of productive land is occupied. There is no room to pitch even the smallest of tents, and travellers have perforce to put up with the accommodation afforded by the indigenous hotel. It is the varied nature of the sort of entertainment which is found at these Chinese inns, with the everlasting accompaniment of personal unrestrained curiosity on the part of a people who look on all foreign devils (especially a feminine devil) as fair game for their inquisitiveness, which forms the leading feature in Mr. Little's account of his outward journey. The trip was made in 1897, and it is worthy of remark (*àpropos* of more recent events in China) that even then Mr. Little was able to discern a very considerable change for the worse in the attitude of the people towards strangers; and this change had taken place during the previous ten years. Fifteen years before Mr. Little's journey that delightful writer and traveller, Baber, had visited western Sze Chuan and Mount Omi, and his account of his travels certainly tends to confirm Mr. Little's view that a growing antipathy to foreign incursions was gradually accumulating which would eventually tend to mischievous results. Our travellers were occasionally treated to something worse than the derisive jeers of the townspeople. "Clods of earth and cabbage-stalks" now and then followed the maledictions of the crowd. And yet there was much good-natured hospitality and courtesy frequently shown both by priests and people. How far the interference of missionaries with the old traditions of a form of Buddhism which seems to be of a far higher and purer type in western China than anything in Tibet, may have influenced the minds of the people is open to question. Mr. Little is evidently doubtful on the point. With every desire to give missionaries credit for their devoted spirit of enterprise, he seems to think that their efforts in the work of regeneration have not always been wisely directed.

Of the wonderful beauty of Mount Omi scenery, its temples and groves, its priests, its pilgrims and its precipices (from the summit of one of which the crowning "glory of Buddha" is to be seen), Mr. Little has much to say, and he says it well. When the Chinese introduce railways more freely into their country, along with that "western knowledge and machinery" which is to give to them the "command of the industrial world," Omi (beloved of Baber and photographed by Mrs. Little) will be as much an object of western pilgrimage as of eastern.

Mr. Little makes the height of Omi to be 10,500 feet above sea, and Sai King Shan (a mountain which he subsequently visited), 11,100. This exactly reverses the altitudes given by Baber, who makes Omi 11,100 feet—the height which is preserved in Mr. Little's map. Hypsometrical determinations are proverbially unsatisfactory, especially when the observations are made under the influence of very varied "weather" conditions. Possibly, also, Mr. Little's results may be affected by the fact that he "boiled his thermometer" (he says he did so, repeatedly) instead of registering the temperature of the steam.

The Littles did not penetrate far into Tibet. Indeed, it depends on whether Ta chien lu (Dar chen do; both names seem to be correct) is to be regarded as the frontier of Tibet, or whether the boundary is politically (as it is geographically) to be found in the Tung river.

[1] "Mount Omi and Beyond." By A. J. Little. Pp. xiv + 272. (London: W. Heinemann, 1901.)

Ta chien lu is a typical Tibetan town, with its "curved roofs, gilded pinnacles surrounded by a mediæval wall," and its extensive and gaudy "lamasarai" Walled in by gigantic mountains as it is, Ta chien lu has become a most important economic and strategical centre. Since the Koko Nor trade route has been abandoned, all the trade of Tibet (skins, wool, gold and musk) passes into China this way; and it is by this route that the soft, irruptive Chinese tide made its way, by sheer force of patient persistence, into the strongholds of the hardy Tibetan and reduced Tibet to a dependency. Mr. Little hardly appreciates the chicken-hearted nature of Tibetan morale, so much is it disguised by the stalwart, muscular personality of the mountain-bred nomad. The Tibetan submits to slipshod Chinese domination without a murmur.

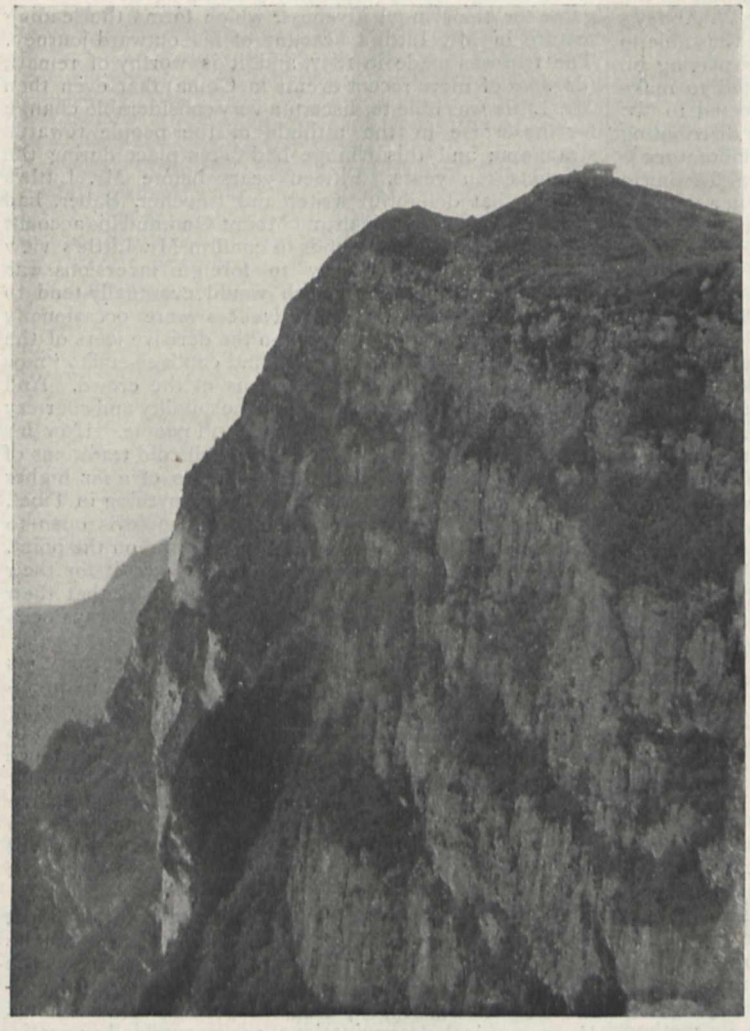

FIG. 1.—Summit of Mount Omi, with Temples.

Ta chien lu is the great western tea mart, and the trade (along with pawnbroking, according to other observers) is altogether in the hands of the Lamas. The manufacture of brick tea for the Tibetan market is faithfully described. It is enough to say that Tibetans like the tea so manufactured, and will "use no other." The bridge at Luting over the Tung, which alone makes the route practicable, is a work of Chinese enterprise which has now lasted for 200 years without repair. It is an iron suspension bridge, and for details of its construction (which are really worth attentive study) the reader cannot do better than refer to Mr. Little's book.

The return journey down the Yangtse, through the rapids and reaches of its upper course, is a feature in the story which will be more or less familiar to many recent travellers. The book is interesting throughout, and not the least value of it is the vista which it opens up of future economic possibilities in that teeming eastern region, the Yangtse basin.

PROF. JOSEF VON FODOR.

BY the death of Prof. von Fodor, of Budapest, the eastern part of Europe has lost its great teacher of hygiene, and the world one of its most diligent investigators in the domain of public health. His investigations had chiefly to do with the soil, subsoil water and ground air, and his authority on these matters is universally recognised. His chief treatises were on air, water and soil in connection with diseases, to which a happy reference was made by the public orator at Cambridge when von Fodor was awarded the hon. LL.D. degree on the occasion of the London meeting of the International Congress of Hygiene and Demography in 1891, as follows:—

"Quis nescit urbem florentissimam, quod Hungariæ caput est, nomine bilingui nuncupatam, fluminis Danubii in utraque ripa esse positam. Quis non inde nobis feliciter advectum esse gaudet salutis publicæ professorem insignem, virum titulis plurimis cumulatum, qui etiam de Angliæ salubritate opus egregium conscripsit? Idem, velut alter Hippocrates, de aëre, aquis et locis præclare disseruit. Olim Hippocrates ipse corona aurea Atheniensium in theatro donatus est; nos Hippocratis æmulum illustrem laurea nostra qualicunque in hoc templo honoris libenter ornamus.

Duco ad vos bacteriologiæ cultorem accerrimum, Iosephum de Fodor"

Of this degree von Fodor was justly proud, as he showed by wearing the scarlet gown to which it entitled him on important occasions.

He was a sincere, unaffected and amiable man, whose premature death has been a very severe shock to his many friends and admirers.

W. H. C.

NOTES.

A MEETING of the local branch of the general committee for the purpose of founding a memorial to the late Prof. Fitzgerald was held on March 28 in Trinity College, Dublin. Dr. Tarleton presided. The meeting was attended by representatives of the leading societies and clubs of the University. It was resolved that the proposed memorial would most appropriately take the form of an endowment of research in physical science by advanced students. In this manner the work of the late professor would best be carried forward. Letters were read from many distinguished scientific men expressing sympathy with the movement. An executive committee was elected and

empowered to take the requisite steps to afford the many friends and admirers of the late Prof. Fitzgerald an opportunity of forwarding the object in view.

M. SABATIER, professor of chemistry in the University of Toulouse, has been elected a member of the section of chemistry of the Paris Academy of Sciences, in succession to M. Haller, who has been elected a member of the Academy. Prof. Davidson, of the University of California, has been elected a correspondant of the section of geography and navigation.

THE American Academy of Arts and Sciences elected the following foreign honorary members at the last meeting:—Prof. J. H. Poincaré, Paris (Mathematics and Astronomy); Prof. Henrich Müller-Breslau, Berlin (Technology and Engineering); Prof. H. Kronecker, Bern (Zoology and Physiology); Prof. R. Koch, Berlin (Medicine and Surgery); Sir T. Lauder Brunton, London (Medicine and Surgery); Prof. A. V. Dicey, Oxford (Philosophy and Jurisprudence); Mr. W. E. Hearn, Melbourne (Philosophy and Jurisprudence); and Dr. Henry Jackson, Cambridge (Philosophy and Archæology).

THE ninth James Forrest lecture of the Institution of Civil Engineers will be delivered by Dr. Frank Clowes on April 25. The subject will be "Chemistry in its Relations to Engineering."

THE *Frankfurter Zeitung* announces the death, at Waiblingen, Wurtemberg, from malaria, of Dr. Schlichter, the well-known African traveller and geographer.

THE death is announced of Mr. W. Hodgson, who for more than half a century devoted his leisure to the collection of facts relating to the flora of his native county, Cumberland. He was the author of a "Flora of Cumberland," which was published about two years ago.

THE *Athenaeum* announces the death of Dr. Franz Melde, professor of astronomy and physics and director of the mathematical and physical institute of the University of Marburg, on March 17, at the age of sixty-nine. Dr. Melde distinguished himself in every branch of experimental physics, notably in his special subject acoustics, and his book on "Zeitbestimmungen" proved a valuable contribution to astronomy.

REUTER'S Agency is informed that the whaler *America*, which has been bought by Mr. Evelyn B. Baldwin, the American explorer, for his forthcoming journey to the North Pole, will sail from Dundee on June 18, by which date Mr. Baldwin expects to arrive from the United States. The *America* will proceed direct to Norway, where she will join the two other ships which are to form part of the expedition, and, after taking on board stores and equipment, will procee for the North.

THE ship which has been built for the German Antarctic Expedition was launched at Kiel on Tuesday. The Berlin correspondent of the *Times* states that among those who were present at the ceremony were Count Posadowsky, the Secretary of State for Home Affairs, Prof. von Drygalski, who will have charge of the expedition, and representatives of the Foreign Office, the Admiralty, and the local authorities. The vessel was christened the *Gauss* by Prof. Baron von Richthofen, who in the course of a short speech said that the German nation would follow the fortunes of the expedition with hope and with anxiety. The name *Gauss* was selected by order of the Emperor in honour of the Göttingen professor, the late Karl Friedrich Gauss, who did much to stimulate Antarctic research. A telegram was received from Count von Bülow cordially wishing the expedition every success.

THE following are among the lecture arrangements at the Royal Institution, after Easter:—Dr. Allan Macfadyen, six lectures on cellular physiology, with special reference to the enzymes and ferments; Mr. Roger Fry, two lectures on naturalism in Italian painting; Prof. Dewar, three lectures on the chemistry of carbon; Prof. W. M. Flinders Petrie, three lectures on the rise of civilisation in Egypt; Prof. J. B. Farmer, two lectures on the biological characters of epiphytic plants; Mr. J. Y. Buchanan, three lectures on climate: its causes and effects. The Friday evening meetings will be resumed on April 19, when a discourse will be delivered by Prof. J. J. Thomson on the existence of bodies smaller than atoms. Succeeding discourses will probably be given by Dr. Hans Gadow, Mr. Charles Mercier, Prof. J. Chunder Bose, Mr. R. T. Glazebrook, Mr. A. Henry Savage Landor, and other gentlemen.

THE annual meeting of the Iron and Steel Institute will be held in London on May 8 and 9. As a tribute of respect to the memory of her late Majesty the Queen, it has been decided that the usual annual dinner shall not be held this year. At the opening meeting on May 8 the retiring president, Sir William Roberts-Austen, K.C.B., will induct into the chair the president-elect, Mr. William Whitwell. The Bessemer Gold Medal for 1901 will be presented to Mr. J. E. Stead. Among the papers that are expected to be submitted to the meeting are the following:—On the properties of steel castings, by Prof. J. O. Arnold; on the physical properties of steel, by Mr. J. A. Brinell; on the heat of formation of carbides and silicides of iron, by Mr. E. D. Campbell; on the use of hydraulic power in the manufacture of iron and steel, by Mr. R. M. Daelen (Düsseldorf); on dust in blast-furnace gas, by Mr. A. Greiner; on the economical significance of high silicon in pig iron for the acid steel processes, by Mr. Axel Sahlin; on crystals of carbo-silicide of manganese and iron from a blast-furnace burden, by Mr. J. E. Stead; on the effect of copper in steel rails and plates, by Messrs. J. E. Stead and John Evans (Middlesbrough); on the measurement of Young's modulus for iron rods by tension and by bending, by Mr. H. E. Wimperis. The autumn meeting of the Institute will be held in Glasgow on September 3 and following days, simultaneously with the holding of the International Engineering Congress, of section V. (Iron and Steel), of which the Iron and Steel Institute has undertaken to take charge.

THE annual general meeting of the Chemical Society was held on Thursday, March 28. Dr. T. E. Thorpe, who occupied the chair, referred to the death of her late Majesty Queen Victoria, and said he was proud to think that the Chemical Society, in so far as it had ministered to the progress of chemistry, contributed in some measure to the lustre of a reign so pre-eminently associated with the development and spread of science in this country, and with the extension of those arts which rest upon chemistry. During the past year the publications of the Society were exceptionally full and valuable. The volume of *Transactions* for 1900 contained no less than four memorial lectures, giving an account of the life-work of Victor Meyer, Bunsen, Friedel and Nilson. The council had determined to issue those memorial lectures which had appeared up to the end of 1900 in a separate form. Acting upon the result of the voting of the Fellows on the question of the day and hour of meeting, the council had decided that the suggested change should be provisionally tried during the coming session. The ordinary meetings of next session would therefore be held on the first and third Wednesdays of the month, at 5.30 p.m. A reference was made to the movement for a uniform system of atomic weights, and it was announced that a committee of the Society had decided to recommend (1) that O=16 be taken as the basis of calculation of atomic weights; (2) that in assigning a number as the atomic weight of any element only so many figures should be employed that the last may be regarded as

accurately known to one unit in that figure. Prof. J. Emerson Reynolds was elected president of the Society, in succession to Dr. Thorpe. At the annual dinner of the Society, held on Wednesday, March 27, toasts were proposed and acknowledged by Dr. Thorpe (who presided), Prof. Tilden, the Lord Chancellor, Sir Herbert Maxwell, Lord Kelvin, Prof. Dewar, Mr. A. B. Kempe, Prof. S. P. Thompson, Prof. Emerson Reynolds, Sir W. S. Church, Sir Francis Mowatt and Sir Henry Roscoe.

AT the annual meeting of the Institution of Naval Architects, on March 27–29, the Earl of Glasgow was elected president. The next meeting of the Institution will be held at Glasgow, on June 25–28. An international engineering congress will be held in Glasgow early in September, and the Institution has undertaken the management of the section relating to naval architecture and marine engineering. The Earl of Glasgow delivered an address, in which he reviewed the progress of shipping during the past year, commenting upon the announcement recently made by the First Lord of the Admiralty, that, for the first time in our history, submarine boats have been ordered for experimental purposes. At the close of the president's address, Prof. G. H. Bryan, F.R.S., was presented with the gold medal of the Institution for his paper on the action of bilge keels. Prof. J. H. Biles then read a paper on naval construction in the United States. Among other matters he noted some rather important details common to the larger classes of American ships. Cofferdams filled with obturating material, which is expected to expand when in contact with the water, are fitted very generally at the sides of the ship. This material is the pith of the corn stock, and has been experimented upon very fully by the navy department, with the result that designs have been prepared with the intention of adopting it generally. It is evident that if the corn stock material swells when in contact with water sufficiently to fill up holes made by shot, it will have an important effect upon the margin of stability and probably of buoyancy of a ship in action. Another paper read before the Institution was on an instrument for measuring the rolling of ships, by Mr. A. Mallock, who, after pointing out the difficulty of accurately measuring the angle of roll of a ship, described an indicator which would give a very accurate measure of the rolls in all circumstances.

IMPORTANT papers were read at the meeting referred to in the foregoing note. Herr Otto Schlick described experiments to determine the cause of small vibrations in the *Deutschland* during her trial trip in June last. The conclusion arrived at from his experiments is that one blade of the propeller has a greater resistance in turning than the other blades, or that the opposite blade has a correspondingly less resistance. Such greater resistance of the one blade is in most cases probably to be attributed to its greater pitch. The least deviation in the pitch, which cannot be proved by ordinary instruments, appears to cause perceptible vertical vibrations, and therefore the greatest care should be taken in the manufacture of propellers, not only for the sake of doing away with vibration, but also to save power and prevent breakage of the blades. Mr. C. H. Wingfield discussed the view that the thrust of a submerged propeller is greatest on those parts of the blade which are most deeply immersed, and gave reasons for an opposite conclusion. Papers on the mathematics of engine-balancing were read by Mr. J. Macfarlane Gray and Prof. W. E. Dalby. Captain W. Hovgaard, of the Danish Navy, dealt with the motion of submarine boats in a vertical plane. He pointed out that for such submarine boats as are now generally constructed, of from 100 to 200 tons displacement, and with our present means of underwater propulsion, a speed above twelve knots must be considered high. Mathematical considerations show that such boats should be long, deep, and comparatively narrow, with great metacentric height. Moreover, the necessity for drawing the centre of gravity forward and the centre of lateral resistance aft leads to a deep, narrow forebody and a flat and broad aftbody, with large horizontal fins aft. The French submarine boats *Gustave Zédé*, *Morse* and others approximate to this type. Boats of less than six knots may be regarded as of low speed. In such boats great length is not necessary, and, on the whole, is objectionable as regards internal arrangements and weight of hull. In them it is not requisite to draw the centre of lateral resistance so far aft of the centre of gravity as in the high-speed boat, and they should, therefore, be of short length, small depth and great breadth. The metacentric height should be made as great as possible by a low centre of gravity, and large horizontal fins should be fitted aft. The Holland Torpedo Boat Company's first boat, the *Holland*, approaches this type, but differs in having greater depth and stability. For submarine boats to be able to travel below the surface for a distance of two, or perhaps three, miles is sufficient for most purposes.

MR. H. G. WELLS commences, in the current number of the *Fortnightly Review*, a series of speculative papers upon some changes of civilised life and conditions of living likely to occur in the new century. To construct a prehistoric animal from one or two fossil bones is a much easier task than the prediction of future developments from the point of view of the present; but Mr. Wells attempts to do this, and even if his prophetic visions do not materialise they will convince the conservative mind that there is some virtue in dissatisfaction at many of the methods of to-day. The subject of the first article is land locomotion in the twentieth century, and it scarcely requires a prophetic afflatus to know that the present systems will be largely superseded or modified. Horse traffic, with its cruelty and filth, while the animals exhaust and pollute the air, must give place to motor carriages in a few years. The railways will then develop in order to save themselves. There will be continuous trains, working perhaps upon a plan like that of the moving platform of the Paris Exhibition, or utilising the principle of the rotating platform outlined by Prof. Perry in these columns (vol. lxii. p. 412, 1900). Nothing is said about the possibilities of aëronautics, not because of any doubt as to its final practicability, but because "I do not think it at all probable that aëronautics will ever come into play as a serious modification of transport and communication." It is, of course, impossible to project ourselves into the future so as to say exactly what will or will not come to pass; for an estimate of future performances can only be made with the material now available, and it leaves out of account the completely novel discoveries which often revolutionise the whole conditions. Nevertheless, it is not unprofitable to meditate upon the promise of progress.

AN address on weather knowledge and agriculture, delivered by Dr. Richard Börnstein at the Royal College of Agriculture of Berlin, in celebration of the Kaiser's birthday and of the two hundredth anniversary of the foundation of the kingdom of Prussia, has recently been issued in pamphlet form ("Wetterkunde und Landwirtschaft." Berlin: Paul Parey). Its concluding pages refer in most complimentary terms to the Kaiser's generous share in the promotion of scientific ballooning in Berlin, but the bulk of the address deals with the development of the German service of weather forecasts, and with suggestions for improving their accuracy and utility. Dr. Börnstein would have forecasts issued by local meteorological authorities, based on information supplied by telegraph from a central department and supplemented by knowledge of local climatology; he would also secure a more intelligent use of the information conveyed in the forecasts by the extension of instruction in the laws

of atmospheric changes. It is not in Germany alone that such knowledge would be of advantage. There are occasions in which the weather in any one or more of the districts of the British Isles could be easily characterised by a single word of one or more syllables, but to go a little further into detail and make a forecast describing the weather of the ensuing twenty-four hours in ten words, and no more, requires, on the part of the recipient, some intelligent acquaintance at least with weather telegraphese. It appears that in Germany the local authorities have taken the matter up with the prospect, according to Dr. Börnstein, of securing a more effective weather service than any other country in Europe.

THE paper on combined trolley and conduit tramway systems, read by Mr. A. N. Connett at the last meeting of the Institution of Mechanical Engineers, is one of considerable interest and importance. Of the four systems of electric tramways only the conduit and the trolley can be considered to be commercially practicable, since the surface contact system, though not wanting many and distinguished advocates, can hardly be said to be properly out of the experimental stage, and the accumulator system is still waiting for a thoroughly satisfactory traction cell. The trolley and the conduit are both in wide use, especially in America and on the Continent, and there are many lines at work combining the two systems. The trolley is objected to in large towns on the ground of its ugliness, its potential danger and the disadvantage involved in using the track rails as a return conductor. The conduit, on the other hand, is too expensive for country or suburban lines where the cheaper trolley is admissible. We have, therefore, in the case of tramways running into crowded towns from the outlying districts, a need for a combined system; this involves a special construction of the car to enable a quick change to be made from the one system to the other at the point of junction, and it is the problem thus raised that Mr. Connett discusses. The paper also deals at some length with the relative merits of side and centre slots for the conduit system, and gives a comparative estimate of the costs of installing conduit and trolley systems respectively; it is to be noted that the conduit is about twice as expensive as the trolley.

ACCORDING to a recent report the expectations of the constructors of the great Chicago Drainage Canal, which was made for carrying away the sewage of the city, containing over a million inhabitants, have been realised. The idea of pouring the sewage of a large city, amounting to 50,000 cubic feet a minute, into an open channel and allowing it to flow away without any attempt at purification was both novel and startling. Now it appears, after eight months' working, none of the actions threatened by the towns bordering on the river below Chicago have been commenced, and it is reported by competent authorities that the water in the canal is free from objectionable features. In fact, the water-way is used largely by pleasure boats and the water taken by the manufactories situated on the banks. It has also been found, on investigation by the Government Commission, that so far no appreciable effect has been made in lowering the water in Lake Michigan, a consequence that excited at one time great fears on the part of the harbour authorities round the coast. The immunity from the objectionable conditions which prevail in the Manchester Ship Canal owing to sewage being discharged into it is due to the large volume of clean water that is always passing down the water-way from Lake Michigan, a stream 22 feet deep and running at the rate of a mile an hour being sufficient to neutralise the foul condition of the 50,000 cubic feet of sewage sent into it every minute.

THE embryos of the New Zealand tuatera lizard recently received in this country have afforded to Mr. H. S. Harrison opportunities for studying the early dental developments of that remarkable reptile, the results of which are published in the *Quarterly Journal of Microscopical Science* for March. The outcome of these studies is to show that Sphenodon (or, as it is often incorrectly called, Hatteria) in its early stages possesses numerous sharp-pointed teeth very similar to those of many ordinary lizards; and as these are of irregular size at a certain period, it is inferred that they represent several coalesced dental series. On the completion of this alternating series a period of repose occurs, after which a development of uniform teeth takes place. By a secondary formation of bone round their bases, these teeth acquire what may be called false sockets. Subsequently the sides of the jaws are invested with a highly calcified layer of bone, which, when the teeth become worn down and the sides of the jaws exposed, assists the edges of the latter in the assumption of dental functions in the adult.

TO those interested in domesticated animals, whether from the point of view of the breeder or of the study of variation under human influence, the spring number of *Bibby's Quarterly* should prove very welcome, as it contains an unusually large number of reproductions of photographs of prize and other cattle, sheep, horses, &c. As marking the changes introduced by breeders, such photographs are of very considerable importance, and their reproduction in a journal of this description renders them accessible to all. A feature of the present number is an article by Prof. J. C. Ewart on "Prepotency and Exclusive Inheritance." The numerous photogravures in this article illustrate the predominating influence of one or other parents on their offspring in many breeds of domesticated animals. In an article on Boer farm life, attention cannot fail to be arrested by the photogravures of an arum-field and of flocks of domesticated ostriches. Arums, it appears, are grown as food both for pigs and ostriches.

OPPORTUNITY to study the geology and physical geography of the basin of the Thames is afforded by the Saturday afternoon excursions of the London Geological Field Class, which commence on April 27. Visits have been arranged to places of geological interest both north and south of London, and the excursions provide exceptional facilities for examining some of the greater movements which the south-east of England has experienced. Particulars can be obtained from the honorary general secretary, Mr. R. H. Bentley, 43, Gloucester Road, Brownswood Park, N.

REFERRING to the periodic variations of glaciers, the remark was made in our issue of March 7 (p. 444) that, in the Swiss Alps "of fifty-seven glaciers observed in 1897, fifty were still decreasing, five were stationary and twelve were increasing." A correspondent points out that this would make sixty-seven glaciers observed, and the author informs us that the difference arose from a clerical error in copying the numbers from the original memoir. The number thirty-nine should be substituted for fifty, making the total number of glaciers observed to be fifty-six instead of fifty-seven.

THE first place in the March number of *La Geographie* is given to a review of Colonel Yates' book on Khurasan and Sistan, by Prof. Vambéry. M. Bonin continues his account of a journey from Pekin to Russian Turkestan by Mongolia, Koko-Nor, Lob-Nor and Dzoungaria. Papers on three expeditions in the French Congo region are contributed by MM. Jobit, Lœfler and Huot, and Mr. J. W. Hodge reviews recent ethnographic and archæological explorations in the United States.

WE have received a copy of the "Report of Progress of the Survey of Tides and Currents in Canadian Waters" for the year ending June 30, 1900, by Mr. W. Bell Dawson, engineer in charge. Considerable advance has been made in the preparation of tide-tables, and a pamphlet issued during the year on the currents in the Gulf of St. Lawrence has already been

noticed in these columns. The observations secured during the year will, when worked up, afford an accurate knowledge of the times of the tides and of the turning of the tidal streams in the lower St. Lawrence. Many new observations of the tide-levels at different stations have also been obtained.

A METHOD for the preparation of amides from the corresponding aldehydes, which appears to be of general application, is described by Messrs. Pickard and Carter in the April number of the *Journal* of the Chemical Society. The aldehyde dissolved or suspended in water is shaken with a slight excess of ammonium persulphate and a certain quantity of lime, and after the reaction is over there is no difficulty in separating the amide in quantities amounting to 30 to 40 per cent. of the aldehyde taken. The method also lends itself to the preparation of alkyl-substituted amides, potassium persulphate being substituted for the ammonium salt and the alkylamine being present.

THE following species, among others, have been taken at Plymouth recently by the Marine Biological Association:—Mollusca: *Æolis aurantiaca, Gastrochaena modiolina.* Crustacea: *Achaeus Cranchii.* Polychæta: *Magelona papillicornis, Owenia fusiformis, Scalisetosus assimile.* Echinoderma: *Ophiocnida brachiata.* Hydrozoa: *Heterocordyle Conybeari, Syncoryne Loveni.* The pelagic fauna is increasing in richness and variety. The following have been taken:—Medusæ: *Amphicodon amphipleurus, Margelium octopunctatum.* Crustaceæ: *Podon intermedius;* large numbers of the nauplii and the *Cypris* stage of *Balanus.* Polychæta: post-larval stages of *Arenicola,* Trochospheres and later larvæ of Polynoids and Phyllodocids. Among the species breeding may be mentioned the following:—Crustacea: *Porcellana platycheles, Zantho rivulosus*; several species of *Portunus* and *Stenorhynchus phalangium.* Polychæta: *Myrianida pennigera, Polynoe scolopendrina.* Hydrozoa: *Hydrallmania falcata, Tubularia indivisa, Syncoryne Loveni, Garveia nutans, Diphasia rosacea, Sertularia argentea, Eudendrium ramosum.*

THE additions to the Zoological Society's Gardens during the past week include a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Mr. R. Kirkwood; a Patas Monkey (*Cercopithecus patas*) from West Africa, presented by Mr. H. E. Jung; a Common Coot (*Fulica atra*), European, presented by Mr. M. C. H. Hammond; two Picui Doves (*Columbula picui*) from South America, a Red-vented Bulbul (*Pycnonotus haemorrhous*) from India, presented by Mr. D. Seth-Smith; a Huanaco (*Lama huanacos*) from Bolivia, a Tawny Eagle (*Aquila naevioides*) from the Seychelles, a Nilotic Crocodile (*Crocodilus niloticus*) from Africa, four Menobranchs (*Necturus maculatus*) from North America, a West African Python (*Python sebae*) from West Africa, deposited; two Straw-necked Ibises (*Carphibis spinicollis*) from Australia, purchased; a Sykes Oriole (*Oriolus kundoo*), received in exchange.

OUR ASTRONOMICAL COLUMN.

RUTHERFURD MEASURES OF PLEIADES.—In the *Contributions from the Observatory of Columbia University*, No. 17, Mr. Harold Jacoby furnishes a revised discussion of the series of measures made by Rutherfurd of photographs of the Pleiades group dating from the years 1872 and 1874. The results of the first investigation were published in 1892, and are slightly modified in the present paper. Special reductions have been made to test the possibility of there being systematic errors arising from some form of optical distortion of the object-glass, and comparisons are given of heliometer and photographic measures. The final data are collected to form a catalogue of seventy-five stars in the cluster.

CATALOGUE OF SOUTHERN VARIABLE STARS.—Mr. Alexander W. Roberts has recently published in the *Astronomical Journal* (Nos. 491 492) a catalogue of the positions, magnitudes and elements of variable stars south of −30° declination, reduced from observations made at the Lovedale Observatory with a 3¾-inch telescope during the years 1891–1899. In connection with the elements a new departure has been made by considering the epoch of a variable as the first maximum passage during 1900, all the stars being uniformly treated on this plan, except that Algol-variables are reckoned from the first *minimum* passage.

The author finds that the short-period variables have a mean variation of 1 magnitude, while the variation of the long-period class amounts to about 4·0 magnitudes. Reference is made to the possible connection of distinctive colours to the various types of variables.

The catalogue gives particulars of ninety-three variables, copious notes being included in explanation of individual stars.

ON A SOLAR CALORIMETER DEPENDING ON THE RATE OF GENERATION OF STEAM.

THIS instrument was shortly described in a note[1] which was communicated to the Royal Society of Edinburgh in July, 1882, and it has been fully described and figured in a paper[2] read before the Philosophical Society of Cambridge in December, 1900. In this paper the results obtained in Egypt in 1882 are detailed and discussed.

My object in designing the instrument and in taking it to Egypt was to find out for myself the amount of heat which can be actually collected from the sun's rays at or near the sea-level under favourable conditions. In such circumstances this amount must fall on land and sea alike, and it is the energy of this radiation which maintains the terrestrial economy.

The instrument measures the sun's heat in the same way as the calorific value of other fuels is commonly measured, namely, by the quantity of boiling water which a given quantity of it can transform into steam of the same temperature in a given time. The quantity of the sun's radiation used is measured by the capacity of the reflector which collects it. The reflector concentrates it on the boiler, which is a silver tube with blackened surface, placed in the focus of the reflector. Some radiation is necessarily lost at the reflector and some at the surface of the boiler, because perfect reflectors and perfect absorbers do not exist; but, when the distillation has been started and is in full running, the whole of the heat which penetrates the boiler is used in transforming water into steam, which is retransformed into water in the condenser and measured in the receiver. A portion of the heat of condensation is utilised in raising the feed water to the boiling temperature before entering the boiler.

The details of construction and the dimensions are fully set forth in the paper printed in the *Proceedings* of the Cambridge Philosophical Society. It will be sufficient here to give a brief summary. Fig. 1 shows a general view of the calorimeter mounted equatorially on a tripod. Fig. 2 shows the calorimeter in section. The sun's rays are collected by the reflector $B_1 B_2 B_3 B_4$, which consists of three conical mirrors, $B_1 B_2$, $B_2 B_3$ and $B_3 B_4$, so constructed that rays of light, parallel to the axis of the instrument O P, falling upon these mirrors are all reflected upon the length A B of the axis. A B is the *focal line* of the reflector. The mirrors are carried by arms, as shown, which are attached to the central tube C K. This tube, which is twelve inches long and has a diameter of two inches, is the condenser. It is connected by an india-rubber tube with the glass funnel Z, through which it is filled and by means of which the height of the water in the upper and narrower tube C A can be regulated. The portion A B of this tube is the boiler. It is of silver, blackened outside, and has a circumference of 37 millimetres. When the instrument is pointed to the sun all the rays which strike the mirrors are reflected upon this surface, which has an area of 18·8 square centimetres. The effective collecting area of the reflector is 904 square centimetres, so that the rays are concentrated 48 fold. The glass funnel Z is set so that the level of the water inside the calorimeter stands somewhere between E and F. F G H is a glass tube or dome which performs the functions of a water-gauge, a steam space and a means of watching the distilling operation with a view to being perfectly assured that there is no priming. The tube G L in the

[1] *Proceedings* of the Royal Society of Edinburgh, 1882, xi. 827.

[2] On a solar calorimeter used in Egypt at the total solar eclipse in 1882. By J. Y. Buchanan, F.R.S. *Proceedings* of the Cambridge Philosophical Society (1900), xi. pp. 37, 74.

axis of the instrument is the steam delivery tube. When everything was cold and the sun's rays were concentrated by the reflector on the tube A B, the water boiled in forty seconds. The steam rises in the glass dome, from which it finds exit through the tube G L. Condensation begins so soon as the steam has passed below the point B, and the water produced is collected at L in a graduated tube. After the distillation has been running for a certain time a considerable quantity of very hot water is collected at the upper part of the condenser, and it slowly rises through the narrow annular space B C to replace the water removed from the boiler by evaporation. The boiler is thus fed with water at the boiling temperature, and when the calorimeter has settled down into steady working, the whole of the heat which reaches the water from the sun is used in *transforming water at its boiling point into steam of the same temperature.* It is essential that the distillation be kept running continuously. If the meteorological conditions are such that the boiling is interrupted, then it is of no use making observations at all.

Locality.—Sohag, where the observations were made, lies on the left bank of the Nile, in lat. 26° 37′ N. The expedition

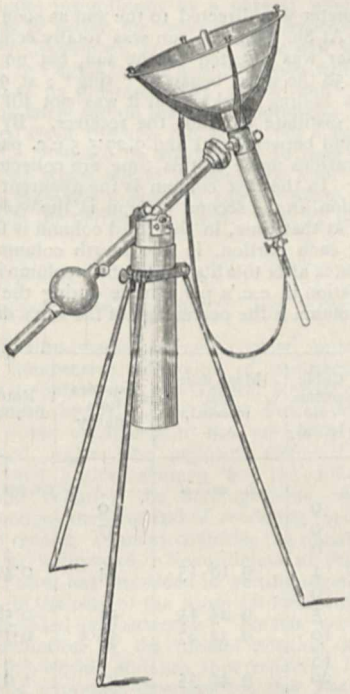

FIG. 1.

arrived there on May 8, 1882, and I was able to begin work on the 11th. As the instrument was new in every way, the work of the first few days was directed towards learning the manipulations and finding out and rectifying defects. Improvements of one kind or another were made every day up to the 15th. On the 16th, 17th and 18th experiments were carried out with the instrument in best working order, and under very favourable conditions. The sun's declination was 19° 22′ on the 17th, so that the mean meridian altitude during the three days was 82° 45′, corresponding to a zenith distance of 7° 15′. The following table gives the sun's zenith distance, as taken from the globe, at every half hour from noon to ± 4 hours, apparent time :—

Hours	0	0·5	1	1·5	2	2·5	3	3·5	4
⊙'s zenith distance	7°·25	10°·5	16°	22°·5	29°	36°	42°	49°	55°·5

The useful time for observation is from 9 a.m. to 3 p.m.

The principal object of the experiments was to ascertain the *maximum* rate of distillation under the most favourable circumstances. This occurred during the forenoon of May 18, when the meteorological conditions were as favourable as they could be. The sun shone steadily in a cloudless sky, and the air was motionless. The shade temperature reached 40°·5 C. in the course of the day.

Between 11h. 35m. 40s. and 11h. 39m. a.m., 5 cubic centimetres of water were distilled, being at the mean rate of 1·501 c.c. per minute at 11h. 37m. 20s. a.m. As the collecting area of the reflector is 904 square centimetres, this corresponds to 16·60 c.c. distilled per minute per square metre. At 11.37 a.m. the sun's zenith distance was 20°. Therefore we know that the sun's perpendicular rays, as received at or near the sea-level, have a heating effect sufficient to evaporate *more* than 16·6 c.c. of water per square metre per minute. Correcting this value for the obliquity of the sun's rays, by the method which shall be indicated presently, it becomes 17·04 c.c. per square metre per minute.

If we take the cubic centimetre of water to weigh one gramme and the latent heat of steam at 100° C. to be 535 gramme-degrees (grs.° C.), the evaporation of 17·04 c c. water requires 9116 grs.° C. of heat ; and this is the amount of heat in ordinary units per square metre per minute which can be collected from the rays of the vertical sun at the sea-level, and can be there utilised. Further, 9116 grs.° C. of heat are equivalent to 3875

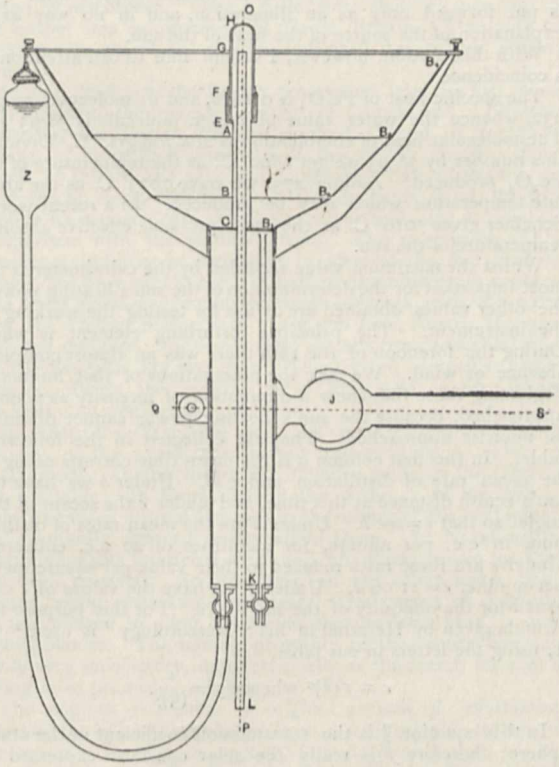

FIG. 2.

kilogramme-metres (kg.m.) of work, so that the working value of the sun's rays as collected by our calorimeter is 3875 kg.m. per minute, or 0·87 horse-power per square metre. No allowance has been made for instrumental imperfections. They certainly exist, but I do not think that more than ten per cent. need be allowed for them. If, however, we increase the working value of the sun's rays from 0·87 to 1·0 horse-power, the allowance is certainly sufficient ; and this is probably very close to the true heating value of the sun's rays as they reach the sea-level. Taking the earth's mean distance from the sun's centre to be 212 times the radius of the sun, the radiation emitted by one square metre of the sun's surface is spread over, in round numbers, 45,000 square metres of the earth's surface. Therefore the intensity of the radiation of the sun's surface is equivalent to at least 45,000 horse-power per square metre. This figure, especially when used in connection with so very small a surface as one square metre, conveys no definite idea to the mind. The following consideration may assist in giving definition to our conception. The specific gravity of solid iron at ordinary terrestrial temperatures is about 7·5 ; therefore one cubic metre of it weighs at the earth's surface 7500 kilogrammes. Taking the force of solar gravity at the sun's surface to be twenty-eight times that

of terrestrial gravity at the earth's surface, one cubic metre of cold solid iron on the sun's surface would exercise a pressure of 210,000 kilogrammes. To lift this mass through one kilometre against solar gravity would involve the expenditure of 210×10^6 kg.m. of work: and if this amount of work were done in one minute, the engine employed would have to develop 46,667 horse-power.

Further, the heat which is equivalent to 210×10^6 kg.m. of work is 494,100 kilogramme-degrees (Kg.° C.). When iron is burned in oxygen so as to form the magnetic oxide, the heat evolved is given by the thermochemical equation

$$Fe_3 + O_4 = Fe_3O_4 + 264{\cdot}7 \text{ Kg.° C.}$$

Using this constant, we find that the mass of iron which by its combustion would furnish the above amount of heat, would weigh on the surface of the earth 313·5 kilogrammes, and would occupy a volume of 0·0418 cubic metre, or 1 square metre × 4·18 centimetres. Therefore the heat required could be produced by burning 4·18 centimetres of liquid iron on a hearth of 1 square metre per minute. With a supply of oxygen of high tension this would not seem to be an insurmountable task. This is put forward only as an illustration, and in no way as an explanation of the source of the heat of the sun.

With this caution, however, I should like to call attention to a coincidence.

The specific heat of Fe_3O_4 is 0·1678, and its molecular weight 232, whence the water value of the gr. molecule is 38·93 grs. The molecular heat of combination is 264,700 grs.° C. Dividing this number by 38·93 we get 6800° C. as the temperature of the Fe_3O_4 produced. Adding 273, we have 7073° C. as the absolute temperature which may be produced. In a recent work [1] Scheiner gives 7010° C. as the most probable effective absolute temperature of the sun.

Whilst the maximum value recorded by the calorimeter is the most important for the determination of the sun's heating power, the other values obtained are of use for testing the working of the instrument. The principal disturbing element is wind. During the forenoon of the 18th there was an almost complete absence of wind. We take the observations of that forenoon, neglecting those that show a diminution of intensity as noon is approached, because the sun's heating power cannot diminish as noon is approached. They are collected in the following table. In the first column a is the mean time corresponding to the mean rate of distillation under d. Under b we have the sun's zenith distance at this time, and under c the secant of this angle, so that $c = \sec b$. Under d are the mean rates of distillation, in c.c. per minute, for quantities of 20 c.c. collected. Under e are these rates reduced to their value per square metre per minute, $e = 11{\cdot}06\, d$. Under f we have the values of e corrected for the obliquity of the sun's rays. For this purpose the formula given by Herschel in his "Meteorology" is used.[2] It is, using the letters in our table,

$$e = f(\tfrac{8}{9})^c \text{ whence } f = \frac{e}{(\frac{8}{9})^c}.$$

In this equation $\frac{8}{9}$ is the transmission coefficient of the atmosphere; therefore f is really the solar constant expressed in cubic centimetres water evaporated per square metre per minute. Under g it is given in grs.° C. per square centimetre per minute, whence $g = 0{\cdot}0535 f$. As we have assumed $\frac{8}{9}$ to be the transmission coefficient of the atmosphere, and have found the vertical intensity of the sun's rays outside of the atmosphere, we obtain at once its intensity at the sea-level $h = \frac{8}{9} f$. This is expressed in cubic centimetres water evaporated per square metre per minute, and it is practically unaffected by the value which we accept as the transmission coefficient of the atmosphere.

a	b	c	d	e	f	g	h
a.m.							
8.55	44°	1·390	1·264	13·97	24.57	1·314	16·38
9.12	39°	1·287	1·306	14·43	24·35	1·3^3	16·30
9.29	35°	1·221	1·326	14·65	24 06	1·287	16 11
10.39	20°	1·064	1·405	15·53	23·92	1·280	16·02
11.28	10°	1 015	1·447	16·00	24·16	1·293	16·18

[1] "Strahlung und Temperatur der Sonne." Von Dr. J. Scheiner, Leipzig, 1899, p. 39.

[2] "Meteorology," by Sir John Herschel, Bart., Edinburgh, 1861, p. 10.

The figures in this table show that the values of the heating effect of the rays of the vertical sun, deduced from observations made when the sun was at zenith distances ranging between 10° and 44°, are practically identical. This affords very strong evidence that the calorimeter is a trustworthy instrument.

Reverting to our maximum value with an allowance for instrumental imperfection, if we take one horse-power per square metre as the intensity of the rays of the vertical sun at the sea-level, their intensity outside of the atmosphere is 1·5 horse-power per square metre, using Herschel's value for the transmission coefficient. This is equivalent to 15,882 grs.° C. per square metre, or 1·588 grs.° C. per square centimetre per minute. In round numbers we obtain 1·6 for the value of the solar constant. While it is possible that this value may be a little too low, reasons are given in the paper for believing that the values commonly received, which lie between 3 and 5 grs.° C. per square centimetre per minute, are much exaggerated.

Observations made during the Eclipse on the morning of May 17, 1882.

The calorimeter was directed to the sun as soon after totality as possible. At 8h. 34m. the sun was totally eclipsed; at 8.51 the calorimeter was directed to the sun, but no boiling took place. At 8.58 the water began to "sing"; at 9.1 it boiled; at 9.3 it was boiling briskly, but it was not till 9.17 that the first drop of distillate fell into the receiver. By 9.19·5 1 c.c. had passed, and between 9.21 and 9.29·5 5 c.c. passed.

The observations made at this time are collected in the following table. In the first column is the apparent solar time of each observation, in the second column is the volume of distillate collected at that time, in the third column is the mean date of collecting each portion, in the fourth column is the date stated in minutes after totality, in the fifth column is the average rate of distillation in c.c.'s per minute during the interval, and in the sixth column is the percentage of the sun's disc exposed.

Apparent solar time, A.M.	Cubic centims. collected	Mean date and interval, A.M.	Minutes from totality	Rate of distillation	Amount of sun's surface exposed
h. m. s.		h. m. s.		c.c.per min.	
8 34 0	0		0		0·000
9 1 0	0		27		0·329
9 17 0	0				
9 19 30	1	9 18 15	44	0·400	0·509
9 21 0	0				
9 29 30	5	9 25 15	51	0·589	0·609
9 36 5	10	9 32 47	58·5	0·759	0·703
9 40 55	15				
9 45 45	20	9 40 55	67	1·034	0·788
9 47 0	0				
9 51 15	5				
9 56 0	10	9 51 30	77·5	1·111	0·864
9 59 50	15				
10 4 5	20	10 0 0	86	1·237	0·924
10 5 0	0				
10 8 52	5				
10 14 35	11	10 9 45	96	1·146	0·987
10 18 40	16				
10 22 20	20	10 18 30	104·5	1·161	1·000

From this table we see that when distillation has begun, it increases at a much greater rate than the exposed sun's surface. This must be so in the early stages, because we see that it is not till 26 minutes after totality, and when already 33 per cent. of the sun's surface has been uncovered, that the water in the boiler boils, and it takes 16 minutes more before any distillate is collected. Even when 50 per cent. of the sun is exposed, the rate of distillation is only 0·4 c.c. per minute. After this more weight may be attached to the observations, but their numerical significance is not great. Still, they show that useful information could be obtained by arranging for making trustworthy observations during the progress of an eclipse.

In the case of a total eclipse there must be an interval during which the sun cannot keep steam, however large the reflector

may be and however great its concentrating power may be. We have seen that when exposed cold as soon as possible after the total phase of the eclipse, it was twenty-seven minutes after totality before the water boiled. One-third of the sun was then uncovered. It is, therefore, reasonable to suppose that, if the eclipse had happened at noon, so that the first half of it could have been utilised as well as the second half, the sun would have kept steam in the calorimeter, and it would have continued to distil until two-thirds of the sun's surface had been obscured. Then distillation, if it did not cease, would become so slow that its rate would have no value, and fifty-four minutes would elapse before one-third of the sun would again be uncovered, during which the calorimeter would get cold. During this interval *steam must be kept artificially*. This is very easy. The glass tube which forms the steam dome is attached to a metal collar which screws down on a washer. It can, therefore, be easily detached. If, then, the steam tube of the calorimeter be connected by means of an india-rubber tube with a flask in which water is kept boiling, steam can be passed through the calorimeter at the normal rate until it is judged suitable to expose it again to the sun. There is no difficulty about this.

Although quite insignificant as a natural phenomenon, an annular eclipse is better for calorimetric experiments than a total one. On November 11, 1901, there will be an annular eclipse visible in Ceylon. The annular phase will last over ten minutes, and, at its greatest, 0·875 of the sun's disc will be covered. It is fairly certain that the calorimeter used in 1882 would not keep steam through this phase, but a larger reflector might be used. It would be worth while to have a reflector of such a size that steam would certainly be kept through the whole eclipse, especially during the annular phase, when all the radiation is from the peripheral region. J. Y. BUCHANAN.

THE MINING STATISTICS OF THE WORLD.

IT is impossible to imagine a more concise, more intelligible, or more inexpensive collection of comparative mineral statistics than is contained in the General Report on Mines and Quarries prepared by Dr. C. Le Neve Foster for the Home Office, and it would be difficult to find an editor possessing in a more marked degree the requisite technical knowledge, literary skill and critical acumen for the difficult task of abstracting and collating the heterogeneous official mineral statistics of foreign countries and of rendering them intelligible to the general reader. In many countries the statistics published are imperfect or antiquated. Nevertheless, as regards output, Dr. Le Neve Foster has succeeded in getting together a mass of figures which, in the case of the more important minerals, may certainly be regarded as trustworthy. He has brought into one focus a representation of the present position of the mining industries of the world, and has thus rendered it possible to comprehend the enormous development that has taken place within recent years. The statistics given are of the greatest importance from a commercial point of view. In the United Kingdom alone the value of the minerals raised in 1899 was 97,470,000*l*., and the vast sums representing British capital invested in mines in all parts of the world will be readily appreciated. Some indication of the remarkable strides made by the mining industry during the past ten years is afforded by the following comparison of the world's output of metals in 1889 and in 1899:—

	1889 Metric Tons	1899 Metric Tons
Iron	26,000,000	39,136,000
Gold	182	477
Silver	3,900	5,445
Copper	266,000	507,000
Lead	549,000	676,000
Zinc	335,000	511,000
Tin	55,000	74,000

In 1899 the world produced 723,239,000 tons of coal, 16,755,000 tons of petroleum, and 12,890,000 tons of salt. Nearly one-third of the coal supply was furnished by the British Empire. The United States supplied nearly another third, and Germany more than a sixth. The remainder was contributed mainly by Austria-Hungary, France and Belgium. The coal production of the principal countries was as follows:—

	Metric tons.
United States	230,254,000
United Kingdom	223,627,000
German Empire	135,824,000
Austria-Hungary	37,562,000
France	31,218,000
Belgium	22,072,000
Japan	6,761,000
India	5,016,000
New South Wales	4,671,000
Canada	4,142,000
Spain	2,671,000
Transvaal	1,938,000

In 1889 the United States for the first time outstripped Great Britain as a coal-producing country. In twelve months the British increase was 18,000,000 tons, but that of the United States was 30,000,000 tons. This enormous increase is undoubtedly due to the extended use of coal-cutting machinery. In the United States 23 per cent. of the total output of coal was mined by machinery. Only a little more than 1½ per cent. of the output was so obtained in Great Britain. The path of progress is, therefore, clearly indicated to British colliery owners.

As gold producers the British possessions take the first place, and, thanks to the increased output of Canada and of Western Anstralia, the British Empire reached a total of 5,475,000 ounces, or more than one-third of the world's supply. One-fourth of the world's salt, and more than half of the tin, are produced by the British Empire. On the other hand, the production of copper, lead, petroleum, silver and zinc is small in comparison with the world's output. The magnitude of the petroleum industry is surprising in view of the fact that its growth has been within the last half of the nineteenth century. The chief producing countries were:—Russia with 8,340,000 tons, the United States with 7,247,000 tons, Austria-Hungary with 325,000 tons, Roumania with 313,000 tons, and the Dutch East Indies with 217,000 tons. The United States has had to cede to Russia the position it so long held as first in the production of petroleum.

In 1899 the Transvaal was the greatest gold-producing country of the world, the output representing a value of 16,273,000*l*. Owing to the war, detailed statistics for 1899 are not available. In Cape Colony the outbreak of the war in October caused a rapid decrease in the output of the coal mines, and eventually stopped nearly all of them. In Natal, again, coal-mining was interfered with, and no official report for 1899 has been received. In Rhodesia, on the other hand, gold-mining made remarkable progress. The output of gold was 65,304 ounces in 1899, whilst in the previous year it was 18,085 ounces. The mining prospects of the country are certainly very satisfactory, more especially as the search for coal is giving most promising results.

The copious references to original sources of information given by the editor in footnotes form a very valuable feature of the report. In this connection it is noticeable that in his capacity of juror at the Paris Exhibition Dr. Le Neve Foster has had access to numerous special reports which, but for his assiduity, would hardly have come to the knowledge of English engineers. The great development of the iron ore resources of Luxemburg during the last thirty-two years, for example, was clearly illustrated in a table shown at the Paris Exhibition. In 1868 the output of iron ore was 691,000 tons, whilst in 1899 it was 5,995,000 tons. At another place in the volume the latter figure is given as 6,014,000 tons, there being apparently a slight discrepancy between the figures obtained by the Home Department of the Grand Duchy and by the German Customs Union, of which Luxemburg forms part. The political classification of the various States is in several cases a matter of difficulty, and has been attended to by Dr. Le Neve Foster with scrupulous care. It is possible, however, that in dealing with Austria and Hungary under one heading, while Sweden and Norway are dealt with separately, he will cause offence to the ultra-patriotic Magyars. Since the compromise between the two States, renewable every ten years, was not renewed in 1897, the Union is merely personal through the Emperor and Apostolic King, and in order to make it evident that Hungary is not a vassal State, the official denomination of the Austro-Hungarian Monarchy is to be preferred to the term Austro-Hungarian Empire used in the report.

Although not so trustworthy as the figures relating to mineral output, the statistics of persons employed and of accidents in mines are quite as important. The number of persons employed at mineral workings in 1899 throughout the world amounted to 4,312,000, of which 1,635,000 were engaged in the British Empire. The United Kingdom headed the list with 862,000 persons. Then followed Germany with 527,000, the United States with 488,000, France with 302,000, Russia with 239,000, Austria-Hungary with 219,000, Belgium with 164,000, and Japan with 133,000. Prior to the war the late South African Republic employed 100,000 miners. It appears that the British Empire employs more than one-third of all the persons engaged in mining and quarrying in the world. It must, however, not be forgotten that published figures are far from being absolutely accurate, and those cited by Dr. Le Neve Foster are merely the best obtainable at the present time. As an example of inaccuracy, the official returns from Ceylon give 1,108,306 persons employed in 1898 in mining in that island. It is incredible that the mining industry of Ceylon, which is comparatively insignificant as regards output, should afford occupation to as many persons as are employed in mining in all the other countries of the British Empire put together. Such figures are utterly useless for calculating death rates, and have, consequently, been discarded. The standard adopted for death rates is the number of persons killed per 1000 employed, and a comparison of the figures in different countries affords a good idea of the relative safety of the miner's occupation. In Great Britain, in 1899, there were killed in coal mines 1·24, in other mines, 1·76, in quarries 1·19, and in all mines and quarries 1·26 per 1000 employed. For the British Empire the average was 1·27 for coal mines and 1·64 for metal mines, and for the world 1·83 for coal mines and 1·64 for gold mines. In foreign countries the average was 2·25 in coal mines. It is evident, therefore, mining is conducted in Great Britain with a far smaller risk of accident to the workers than in most other countries. This gratifying result is due in no small measure to the untiring efforts made to improve the conditions of mining by means of legislation and Government inspection.

BENNETT H. BROUGH.

THE MINERAL CONSTITUENTS OF DUST AND SOOT FROM VARIOUS SOURCES.[1]

NORDENSKJÖLD collected and described three different kinds of dust, one consisted of diatoms, a second of a siliceous and apparently felspathic sand, both from the surface of the ice in Greenland; while a third consisted of sooty-looking particles composed of elements invariably associated with iron meteorites and of uncommon occurrence in terrestrial matter, namely, besides metallic iron, cobalt, nickel, carbon, silicon and phosphorus. He concluded that it was meteoric matter showered down upon the earth, and that cosmic dust is falling imperceptibly and continually.

A great variety of mineral matters, including dust from various sources, having been examined spectrographically by the authors, they give an account of its composition. Specimens which fell from the clouds were compared with those from known terrestrial sources. The first comprised (1) solid matter forming the nuclei of hail-stones collected during a storm on April 14, 1897; (2) solid matter from hail and sleet collected during a heavy shower from 2.30 p m. to 3 o'clock on March 28, 1896; (3) pumice from the Krakatoa eruption of 1883. These were examined for Prof. J. P. O'Reilly, who had collected them. (4) Dust from a dish exposed on November 16 and 17, 1897, in the outskirts of Dublin; and other samples with a similar origin which had fallen into porcelain dishes placed on a grass-plat in a garden. Varieties of flue-dust, (4) from Crewe gas-works, (5) iron-works, (6) sulphuric acid works, and (7) copper-smelting works, (8) volcanic dust from three different sources, (9) soot from laundry, laboratory, kitchen and bedroom chimneys. Flue-dust is characterised by the larger proportions of lead, silver and copper than other varieties of dust and coal ashes contain. Nickel and manganese are notably present, but the most striking feature is the quantity of rubidium, gallium, indium and thallium in all samples. Volcanic dust shows the bands of lime and magnesia with strong spectra of the alkali metals, and these are evidently its leading basic constituents.

[1] By Prof. W. N. Hartley, F.R.S., and Hugh Ramage. Abstract of a paper read at a meeting of the Royal Society, February 21.

Soot is of variable composition, not so much with respect to the substances present as to the relative proportions of each in any two samples. Its larger proportion of lime distinguishes it from dust collected from the heavens. Nickel, manganese, copper, silver and lead are constant constituents. The presence of nickel is probably due to minute quantities of this element being disseminated in coal, which is first converted by the carbon monoxide produced in the fire into nickel tetracarbonyl, which is naturally volatile but subsequently becomes decomposed and nickel or nickel oxide is deposited.

Dust from the clouds, collected either by itself or in hail, snow, sleet or rain, exhibits a regularity in composition not seen in other varieties of dust. It contains, apparently, the same proportions of iron, nickel, calcium, copper, potassium and sodium. The chief difference occurs in dust suddenly precipitated in sleet, snow and hail, since lead is found in larger proportions in these, and particularly so in one specimen from sleet.

It is evident that the presence of nickel is not positive evidence that the dust from the clouds comes from other than a terrestrial source.

The dust which fell on November 16 and 17, 1897, with its similarity in composition to that of meteorites, its being attracted by the magnet and its appearance are quite in favour of its being of cosmic origin. On the other hand, in its composition it is unlike volcanic dust, flue-dust or soot.

STUDIES IN VISUAL SENSATION.[1]

THE object of these studies is to frame if possible a scale of visual sensation analogous to, and in correlation with, a scale of physical luminosity. The method is the employment of rotating discs.

If a disc be divided into eleven concentric areas of equal width, of which the inner is all white and the outer all black, while the intervening areas have sectors giving a series of 10 per cent. increments of white, this gives on rotation a series of grey rings between the black and white; but they are of very unequal values for sensation. While the step from black to the darkest grey involves a large stride in sensation, seemingly almost half-way towards the white, that from white to the lightest grey is of no great amount.

A contrast effect is very noticeable. Each grey annulus, especially in the darker rings, is differentiated in sensation into a darker moiety where it adjoins a lighter ring, and a lighter moiety when it adjoins a darker ring. But although contrast introduces a factor which somewhat distracts the judgment, the disturbance is not sufficient to invalidate the conclusion that equal, or approximately equal, increments of stimulus produce increments of brightness which differ widely in value.

By the use of slit discs on Maxwell's method the proportions of white stimulus may be so adjusted as to give, say, three rings intervening between white and black which do give approximately equal sensation steps. It is somewhat difficult, however, to estimate their value, and contrast again introduces a disturbing element. We obtain only a first approximation to a scale of sensation. Taking the black employed (admittedly only a very dark grey and not an absolute black) as a zero, and calling the value of the white 100 per cent., both for sensation and stimulus, we have, on the arbitrary scale thus formed, the following percentages:—

	Sensation.		Stimulus.	
	Increment.	Sum.	Increment.	Sum.
Black ring	0	0 ...	0	0
Dark grey	25	25 ...	6·5	6·5
Mid grey	25	50 ...	13·5	20
Light grey	25	75 ...	27	47
White ring	25	100 ...	53	100

Here the equal increments of sensation are correlated with increments of stimulus very nearly in geometrical progression.

By interpolation a smoothed curve can be drawn through the observed mid-point of 20 per cent. stimulus and translated on to a disc. But this does not give a smooth increase of sensation from black to white through intervening greys. The value of the mid-point is too high.

Experiments with smoothed curves show that a mid-point of

[1] Abstract of the Croonian Lecture delivered at the Royal Society on March 21 by Principal C. Lloyd Morgan, F.R.S.

12 per cent. gives an approximately even passage from black into white.

The discrepancy between the ring-grading and the smooth shading is shown to be probably due to the contrast effects before mentioned, of which a rough quantitative estimate can be given.

The curve through 12 per cent. mid-point, with equal increments of sensation correlated with increments of sensation in geometrical progression, is accepted as affording an arbitrary and empirical scale for increase of brightness due to increase in physical luminosity.

Colours are dealt with and even shading is obtained from black into blue, and into red, orange, &c. ; white into similar colours, and one colour into another—for example, red into blue through intervening shades of purple.

The luminosity of these colours is determined in terms of the arbitrary scale on Sir Wm. Abney's method ; and the results, as deduced from the empirical curve, are compared with those directly observed by the method of shading in rotating discs.

For comparison, the results are given in terms of the mid-points of curves analogous to that for the shading of black into white :—

Mid-point Percentages.

	Deduced from luminosity.	Observed by method of shading.
Yellow on black ...	13·8 per cent.	13·5 per cent.
Orange ,, ...	18·6 ,,	18·0 ,,
Light blue ,, ...	19·7 ,,	19·0 ,,
Red ,, ...	23·6 ,,	23·0 ,,
Full blue ,, ...	29·5 ,,	28 0 ,,
White on full blue ...	24·7 ,,	25·0 ,,
,, red ...	30·6 ,,	30·0 ,,
Orange on full blue ...	35·4 ,,	36·0 ,,
Yellow on light blue...	39·1 ,,	40·0 ,,
Red on full blue ...	43·0 ,,	44·0 ,,

If these results be accepted as giving a sufficiently close agreement, it follows, first, that for colour shading the percentages of stimulus required are dependent on the luminosity of the colours employed ; and, secondly, that all the data obtained by the method of shading can be plotted on a single curve which exhibits the relation of stimulus to sensation in visual impressions.

If we assume that the black on the arbitrary scale has a value of 1·87474, and if this amount be added to the stimuli throughout the scale, so that the white becomes 101·87474, the mid-point 13·87474, and so on, the scale becomes, so far as stimulus is concerned, an absolute scale. And on this absolute scale of stimulus, the sensations, plus some undetermined constant, form an arithmetical series, while the stimuli which are in relation to them form a geometrical series. In other words, the addition of this constant to the summed increments of stimulus at any stage of the scale causes these summed increments to fall into line as the terms of a geometrical progression. The stimulus value of the mid-point on the absolute scale is the geometrical mean between the values of the extremers on the same scale. *On this assumption*, therefore, and *between these limits*, Weber's Law and Fechner's expression of it hold good.

Its validity beyond these limits is questionable. Dr. Waller has shown good reasons for believing that near the threshold of sensation the completed curve shows change of sign, and becomes sigmoidal. Apart from the evidence he adduces, some such assumption seems to be well nigh necessary if we are to attempt to give a complete curve, which, near the threshold of sensation, does not land us in the maze of difficulties arising from the asymptotic character of a wholly logarithmic curve.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. J. J. SUDBOROUGH, senior lecturer and demonstrator in chemistry of Nottingham University College, has been appointed professor of chemistry at the University College of Wales, Aberystwith.

RECENT gifts in aid of the funds of the McGill University, Montreal, amount to more than 42,000*l.* Of this sum, nearly one-third was provided by the chairman, Sir William C. Macdonald, who has already given over half a million sterling to the same institution. As the development of the University has recently been mainly on the lines of applied science and medicine, it is the faculty of arts which will mainly benefit by this new donation.

IN the Court of Appeal, on Monday, it was decided that School Boards cannot provide out of the rates for instruction in subjects prescribed by the Department of Science and Art, either in day schools or in evening continuation schools. It is thus declared illegal for a School Board to expend money out of a local rate for any purpose other than elementary education. In schools in which instruction is given in subjects such as those in the Science and Art Directory any assistance afforded to them must come from funds other than those provided by the ratepayers for primary education. As many School Boards have been providing instruction of this kind, it is evident that the decision accentuates the urgent need of an authority to describe the powers of the various bodies concerned with primary and secondary education.

THE Association of American Universities recently met at Chicago and discussed, among other topics, (1) inter-university migration of graduate students ; (2) fellowship ; and, (3) the examination for the degree of doctor of philosophy. From a report in *Science* we learn that with regard to the first topic it was considered desirable to promote by all possible means the inter-university migration of graduate students, to the end that they may come under the guidance of teachers of varying points of view, and so may receive the broadest possible introduction to their chosen field of study. As regards the question of fellowships, the opinion was expressed that it would be advisable to make some of the fellowships distinctly research fellowships, to be awarded only to students who had already taken the degree of doctor of philosophy, and who had, therefore, received their academic equipment for their life work. In discussing the best type of examination for the doctor's degree, it was held very emphatically that the practice which is growing up in American universities, especially in some of the departments dealing with natural science subjects, of permitting the candidate to pass his examination course by course, as is usual in undergraduate instruction, is a pernicious one, and one which stands in the way of the attainment of the best and broadest scholarship. It was held that the examination for the doctor's degree should, in all cases, be upon subjects and not upon courses of instruction, the underlying principle being that the courses of instruction which a graduate student attends are but a small part of the work which he is supposed to do in order to prepare himself for his examination.

MR. ANDREW CARNEGIE has presented to the Iron and Steel Institute thirty-two 1000-dollar Pittsburg, Bessemer and Lake Erie Railroad Company 5 per cent. debenture bonds, the income derived from which will be applied to awarding annually one or more research scholarships of such value as may appear expedient to the council of the Institute. The awards will be made on the recommendation of the council irrespectively of sex or nationality. Candidates, however, must be under thirty-five years of age, and application must be made on a special form to the secretary of the Institute before the end of April in every year. The scholarships will be tenable for one year, but the council will be at liberty to renew them for a further period if thought desirable instead of proceeding to new elections. The object of this scheme of scholarships is to enable students who have passed through a college curriculum, or have been trained in industrial establishments, to conduct researches in the metallurgy of iron and steel and allied subjects, with the view of aiding its advance or its application to industry. It is suggested that the National Physical Laboratory—on the governing body of which the Iron and Steel Institute is represented—would for many reasons be a very suitable establishment in which such researches could be carried out. There is, however, no restriction as to the place of research that may be selected, whether University, technical school, or works, the only absolute condition being that it shall be properly equipped for the prosecution of metallurgical investigations. The results of the researches are to be communicated to the Iron and Steel Institute in the form of a paper to be submitted to the annual general meeting of members. If the paper appears to the council to be sufficiently meritorious, the author will be awarded the Andrew Carnegie gold medal.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 7.—"Some Physical Properties of Nitric Acid Solutions." By V. H. Veley, F.R.S., and J. J. Manley, Daubeny Curator, Magdalen College, Oxford.

In continuation of their former investigations, the authors have studied the densities with especial reference to the contractions per unit mass, and also the refractive indices. The various experimental and instrumental errors are fully discussed, as also the several effects likely to be produced by the various substances with which the acid solutions of necessity came into contact. The results obtained for the physical properties are given in series of tables and compared with those calculated from various equations for straight lines; these show that the physical properties are discontinuous at points corresponding very approximately to the concentrations required for simple molecular combinations only of nitric acid and water. In the case of the contractions the best defined points of discontinuity correspond to the composition of the hydrates with 14, 7, 4, 3, 1·5 and 1 molecular proportions of water; in the case of the refractive indices, the most marked points correspond to the 14, 7 and 1·5 hydrates; a remarkable discontinuity at 95-100 per cent. concentration was also observed. These points of discontinuity, though to some degree, yet to another degree are ideal in that within the limits of 1 to 2 per cent. in the vicinity of such points there is a transition stage.

The values for μ are further expressed in terms both of Gladstone and Dale's and of Lorentz's formula, and it is shown that the values in neither case are constant, but decrease with increase of concentrations.

Anthropological Institute, March 12.—Prof. Haddon, F.R.S., in the chair.—Prof. Victor Horsley exhibited some trephined skulls from New Britain, and read a communication by Rev. J. A. Crump describing the methods employed by the natives and the objects aimed at. The operator is the medicine-man of the tribe, and he employs a flake of obsidian or piece of shell; with this he scrapes the exposed bone until a piece the size of half-a-crown is removed. As a rule the operation is resorted to in cases of fracture, and the mortality is about 80 per cent. In New Ireland, however, some forms of insanity, and even headache, are treated in the same way, and there are cases in which people have undergone the operation five times at various periods.—Mr. J. Gray read a paper on cephalometric instruments and cephalograms. An instrument was shown for taking head measurements, which was devised for field work and required no delicate adjustments. Two other instruments for obtaining diagrams of the contour of the head were also described, and head contours taken by them shown on the screen.—Prof. H. Louis described the "kingfisher" type of Malay kris, the handle of which resembles a kingfisher's head and beak; according to the Malay legend they were made in memory of a chief named Kingfisher, who invaded the peninsula from the Bugis Islands many centuries ago.

Zoological Society, March 19.—Dr. Henry Woodward, F.R.S, vice-president, in the chair.—Mr. Sclater exhibited and made remarks on some specimens of mammals from the Protectorate of Uganda recently received from Sir Harry Johnston, K.C.B. Amongst them were a skin and bones of a chimpanzee, which, so far as was known, was the only complete specimen of this ape that had reached this country from Eastern Africa. Other interesting objects in the collection were flat skins of two apparently new antelopes of the genera Cobus and Cephalophus. Mr. Sclater also laid upon the table a small case of Lepidoptera collected in St. Lucia, West Indies, by Major A. H. Cowie, R.E.—Mr. Tegetmeier exhibited a very fine head of the sable antelope (*Hippotragus niger*) from Barotseland.—A communication was read from Dr. G. Stewardson Brady which contained descriptions of a collection of Ostracoda belonging to the Zoological Museum of Copenhagen, most of the species represented in it being new to science. The collection was very varied in character, embracing examples of both marine and freshwater species from widely different localities.—Dr. C. I. Forsyth Major read a paper on *Lemur mongoz* and *Lemur rubriventer*, in which he pointed out that the species of Lemur which was generally called *Lemur mongoz* had absolutely nothing to do with the Linnean species of that name, which had been based on the description and figure of Edwards in his "Gleanings." The only ascertained localities in which the true *Lemur mongoz*, L., occurred were the neighbourhood of the Bembatoka Bay (N.W. coast of Madagascar) and the two islands Anjuan and Mohilla of the Comoro group. The earliest available name for the usually so-called *Lemur mongoz*—a very variable species, spread over a great part of Madagascar—seemed to be *Lemur fuscus*, E. Geoffr. The two species, as indeed were all the species of the genus, were easily distinguishable by the characters of their skulls.—Dr. Forsyth Major also showed that *Lemur rubriventer*, I. Geoffr. (of which *Prosimia rufipes*, Gray, was a synonym), was not, as had been supposed, the female form of *L. nigerrimus*, Scl., but a very well-marked species. A peculiar feature of the skull was a huge pneumatic cavity in the palatal, which invaded the whole bottom of the orbit.—A communication was read from Mr. P. Cameron containing an account of the Hymenoptera collected in New Britain by Dr. Arthur Willey. Owing to the fact of the locality having been but little explored previously, most of the specimens represented in the collection belonged to new species.—Mr. G. A. Boulenger, F.R.S., described four new species of freshwater fishes discovered by Mr. F. W. Styan, at Ningpo, China.—Mr. F. E. Beddard, F.R.S., read a note upon Garnett's Galago (*Galago garnetti*), in which he pointed out that a spiny structure, nearly similar to that previously described on the wrist of *Hapalemur griseus*, was also present on the hind foot of this animal.

Mineralogical Society, March 19.—Prof. A. H. Church, F.R.S., president, in the chair.—Mr. H. L. Bowman read a paper on the micas, tourmaline and associated minerals occurring in pegmatite at Haddam Neck, Connecticut. The occurrence resembles that at Auburn, Maine. A peculiar pink fibrous mineral surrounding prisms of lepidolite is shown to be a variety of muscovite.—Mr. G. F. Herbert Smith discussed crystals of calaverite from the Cripple Creek District, Colorado. They are triclinic, but pseudo-monoclinic owing to twinning about an axis parallel to the edge of the prism zone. The two individuals are interpenetrant with no apparent plane of separation. The crystals are also twinned in the ordinary way. Quantitative analyses made by Mr. G. T. Prior show that the material is nearly pure telluride of gold, $AuTe_2$, with only about 1 per cent. of silver.—Mr. W. Barlow exhibited models to show arrangements for the chemical atoms of crystals in harmony with the symmetry. The models are composed of closely-packed india-rubber balls of various sizes, each ball representing a single atom. Boracite, boric acid and cassiterite were dealt with. The structure assigned to boracite suggests an explanation of the peculiar dimorphism of this substance discovered by Mallard, and that representing cassiterite shows the twinning of this mineral.

Entomological Society, March 20.—Mr. G. H. Verrall, vice-president, in the chair.—Mr. C. J. Watkins sent for exhibition a series of larch twigs illustrating the winter condition of *Coleophora laricella*, the special feature being the manner in which the cases of the larvæ assimilated in colour with the bark of the larch.—Mr. G. B. Routledge exhibited a specimen of *Hydrilla palustris* taken on the wing by Mr. J. E. Thwaytes near Carlisle in 1899—the first male taken in that district. He also exhibited specimens of *Bembidium schuppeli*, a rare beetle captured on the banks of the river Irthing.—Mr. R. McLachlan exhibited Trichopterous larva-cases of the form known as "*Helicopsyche*" from the Prony River, New Caledonia, sent to him by Mr. J. J. Walker, R.N. They were large and remarkable for the size of the individual sand-grains of which they were built up. These sand-grains, Mr. Walker informs him, were water-worn particles of the heavier minerals of the river bed, such as chrome, nickel and iron ores. It is possible that similar cases were alluded to by Hagen in the *Stett. Entom. Zeitung*, 1864, p. 129, from the Munich Museum.—Mr. G. T. Porritt exhibited specimens of an almost black form of *Acronycta menyanthidis* from Skipwith Common, near Selby, and, for comparison, specimens from the moors near Huddersfield. The chief interest in the exhibit consisted in the fact that in both the districts where the melanic *menyanthidis* occurred, melanism was not a common feature: whereas in the Huddersfield district, where only the pale form of *menyanthidis* was taken, melanism was a conspicuous feature in many species, even in, and close to, the grounds, where only pale *menyanthidis* could be found.—Mr. H. W. Andrews exhibited a female specimen of *Amphidasys betularia*, with hind wings aborted and scarcely developed, taken at Paul's Cray, Kent, in May, 1896.—In connection with an announcement that the County Council had under consideration the feasibility of stocking the London parks with butterflies, Mr. H. Rowland-Brown stated that according to the

latest observations thirty-nine species of Rhopalocera were recorded within, roughly speaking, a ten mile metropolitan limit, but that of these he only knew of *Pieris rapae*, *P. napi*, *Vanessa atalanta*, *V. urticae*, and perhaps one or two others which could strictly speaking be said to inhabit the metropolis itself. Mr. A. J. Chitty said that *Pieris brassicae* had occurred, and that he thought *Vanessa polychloros* might be added to the list of those open to experiment. Mr. G. H. Verrall advocated the introduction of tropical and other foreign species in the great conservatories of Kew, where, without danger to the plants, they would be objects of great beauty and attractiveness, and Mr. Merrifield, while recognising the difficulties arising from soil, climate and surroundings, expressed his belief that certain hardy species would successfully resist their bird enemies.

Royal Microscopical Society, March 20.—Mr. A. D. Michael, vice-president, in the chair.—Messrs. Staley and Co. sent for exhibition a Bausch and Lomb Camera Lucida. It was described in the *Journal* of the Society last December, and is intended for reproducing an object diagrammatically, natural size. —Mr. E. M. Nelson read a paper on the working aperture of objectives for the microscope, in which he showed that in recording delicate observations it was advisable to state the precise ratio of the utilised diameter of the objective to the full available aperture. He then proceeded to explain the different methods by which this ratio, which he termed the working ratio, or W.R., could be measured. Dr. Tatham confirmed Mr. Nelson's views in regard to the necessity for recording the working aperture of objectives, and expressed his appreciation of the value of the methods proposed by the author for obtaining this measurement.—A paper, by Mr. H. G. Madan, on a method of increasing the stability of quinidine as a mounting material, was read by Mr. Nelson in the absence of the author. Mr. Madan found that by keeping quinidine heated to a certain temperature for a considerable time it was converted into colloid quinidine, which condition it had retained for a year; but whether the tendency to revert to the crystalline form was entirely overcome, time alone could show. Mr. Karop said of all media, quinidine, on the whole, was the best yet discovered for mounting diatoms, but it was very troublesome on account of its tendency to crystallisation. He hoped the material prepared as suggested by Mr. Madan would be marketed.—Mr. Rousselet read a paper on some of the rotifera of Natal, by Hon. Thos. Kirkman, illustrated by mounted specimens shown under microscopes. Mr. Rousselet had appended a technical description of *Pterodina trilobata*, one of the rotifers mentioned in the paper, a mounted one of which was among those exhibited; an excellent drawing of this rotifer, by Mr. Dixon-Nuttall, was also shown.—Mr. W. H. Merrett read a paper on the metallography of iron and steel, demonstrating the subject by the exhibition of a large number of lantern-slides of sections of different classes of these metals under various conditions of hardness, stress, &c. The methods by which these sections had been prepared and polished were also explained.

Royal Meteorological Society, March 20.—Mr. W. H. Dines, president, in the chair.—Dr. Hugh Robert Mill delivered a lantern lecture on climate and the effects of climate. He remarked that climatology is as much a branch of geography as of meteorology, in fact more, for it not only deals with the distribution of atmospheric conditions over the earth's surface, which is a geographical question in itself, but all the varieties of climate that give individuality to different countries are produced by the disturbing or controlling influence of land forms. After making a few remarks on the principles of scientific photography and also calling attention to spurious photographs, the lecturer proceeded to distinguish between "weather" and "climate." Weather is the condition of the atmosphere at any moment with regard to wind, warmth, cloud, electricity and precipitation; whilst climate may fairly be called the average weather of a place. Dr. Mill then exhibited on the screen a large number of photographs which he had himself taken in many countries, in order to illustrate the peculiarities of climates in which heat, cold, wind and rain respectively predominate, showing how the varying conditions of climate created by the greater land forms are responded to by the various adjustments of minor land-forms and of plants, and how they are taken advantage of by man.

CAMBRIDGE.

Philosophical Society, March 4.—Prof. Macalister, president, in the chair.—The ossification and varieties of the occipital bone, by Prof. Macalister. These deviations from the normal type, which occur in one out of every four skulls, may be divided into two great groups, (1) those depending on variations in the union of the five elements of the squama, supra-occipital, interparietal right and left and pre-interparietals right and left; (2) the second group consists of the variations due to the development of new centres of ossification in the lambdoid suture.—On the fifth book of Euclid's elements, by Dr. M. J. M. Hill.—Exhibition of Mr. Graham Kerr's method of reconstructing objects from thin sections, by Mr. J. S. Budgett.—Note on the colour vision of the Eskimo, by Mr. W. H. R. Rivers. Ten men and eight women from Labrador were tested with Holmgren's wools and found to have normal colour vision. In naming colours a limited number of terms were used which were extensively modified by suffixes to express differences of shade and tint of colour. The language was exceptional in possessing names for green and blue which were as definite as those for red and yellow, but resembled most other primitive languages in having no word for brown.—Note on the influence of external conditions on the spore-formation of *Acrospeira mirabilis* (Berk. and Br.), by Mr. R. H. Biffen. Chlamydospores of this fungus sown on pea extract gave rise to a sterile mycelium; on Klebs' solution and 5 per cent. glucose or cane sugar to numbers of intercalary sporangia; on beer-wort to sporangia and chlamydospores; on chestnut extract to endoconidia and chlamydospores —the former being in the greatest abundance when the extract was most dilute. Sowings of the spore-balls gave very similar results, the chlamydospores being replaced by spore-balls except in the case of beer-wort, where "ascogonia" were formed. Intermediate forms between the loose spiral "ascogonia" and the closely coiled helices of the spore-balls could be raised by transferring the mycelium from chestnut extract to beer-wort. Increasing the rate of transpiration caused the chlamydospores to become smooth and thick-walled, while diminishing it caused them to become smooth and thin-walled, instead of being rather thick and warted. The envelope of the spore-balls instead of being a single layer became several layers thick on checking the rate of transpiration.—On a reserve carbohydrate, which produces mannose, from the bulb of *Lilium*, by Mr. J. Parkin. Besides starch, the bulbs of several species of the genus *Lilium* examined contain another reserve-carbohydrate which exists as a sort of mucilage in the cell-sap. The sugar obtained from it by hydrolysis with weak acid is *mannose*.—Notes on new and interesting plants from the Malay Peninsula, by Mr. R. H. Yapp. The only partially explored mountain ranges of this region possess a very rich flora, unaffected by the presence of introduced species such as form a marked feature of the vegetation of the inhabited districts of the plains. A number of the specimens exhibited (which were chiefly collected on one of these mountains) are probably new, and belong to various natural orders, chiefly among the gamopetalous Dicotyledons. An interesting and little known fact is the storage of large quantities of naturally filtered water in the hollow internodes of several species of bamboo. The paper concluded with a brief account of two curious epiphytic ferns, whose fleshy stems are tunnelled by galleries inhabited by ants; forming, in fact, living ants' nests. —The prevention of malaria, by Dr. J. W. W. Stephens. This paper, after a brief historical account of the discovery and the investigation of the malarial parasite, described the researches of Dr. Christophers and the author on the disease in several localities on the west coast of Africa. The result of the work there done leaves no doubt that malaria is avoidable under the conditions of life in West Africa.—On the effects of a magnetic field on the resistance of thin metallic films, by J. Patterson. A. C. Longden, in the *Physical Review*, xi, 2, 40, described a method of making standard high resistances from thin films of metals deposited on glass by means of the kathode discharge. He has shown that the resistance of these films is much greater than that calculated from the ordinary specific resistance of the metal. The author has made experiments to determine what effect a magnetic field would have on the resistance of a film deposited in this manner from a bismuth kathode. The results obtained show that the change of resistance in the magnetic field is entirely different from that of ordinary bismuth. A film of cobalt $1{\cdot}4 \times 1{\cdot}3$ cm. with a resistance of 682·2 ohms was made, but no change in a field of 27,500 lines could be detected.—On the theory of electric conduction through thin metallic films, by Prof. J. J. Thomson. The author applies the theory, developed by him in a report to the International Congress of Physics at Paris in 1900, to the case of electric conduction through thin metallic films. He shows that when the thickness of the film

becomes comparable with the mean free path of the negatively electrified corpuscles, which on that theory are supposed to carry the electric current, the specific resistance of the substance forming the film will increase, and how it is possible from measurements of this increase to approximate to the mean free path of the corpuscles. It is also shown that the effect of a magnetic field on the resistance decreases with the thickness of the film.

PARIS.

Academy of Sciences, March 25.—M. Fouqué in the chair.—On the Egyptian metals. The presence of platinum among the characters of a hieroglyphic inscription, by M. Berthelot. A metallic box, covered with inscriptions, and dating from about 700 B.C., had a portion of one of its characters made of an alloy of platinum. The specimen was too small for a complete analysis, but from its behaviour towards aqua regia it appeared to be a native platinum, possibly obtained from the alluvial deposits of Nubia or the upper regions of the Nile valley.—On the electrochemical relations of the allotropic states of metals, especially of silver, by M. Berthelot. The thermochemical behaviour of the different allotropic modifications of silver rendered it probable that a definite electromotive force could be observed in a cell containing the metal in two different states as electrodes. On experiment, this was found to be the case, the direction of the current agreeing with the thermal sign of the heats of transformation.—On secondary radio-activity, by M. Henri Becquerel. The radiation from a radium salt consists of three parts, the first, very easily absorbed, and capable of being deviated by a magnetic field; the second, similar in its nature to the kathode rays; and the third, very penetrating, but not capable of deviation by a magnet. Experiments are described showing the differences in the power of exciting secondary radiation possessed by these three classes of rays.—The origin of thermal sulphurous waters. Sulphosilicates and oxysulphides derived from natural silicates, by M. Armand Gautier. An experimental study of the mode of production of sulphurous waters. Granite and other igneous rocks, when finely powdered andtreated with water at 250°-300° C. give a liquid identical in character with ordinary thermo-sulphurous waters, although of greater concentration.—On some new derivatives of dimethylamido-benzoylbenzoic acid, by MM. A. Haller and A. Guyot.—A correction of a preceding communication by M. de Jonquieres.—On a formula of M. Fredholm, by M. G. Mittag-Leffler.—M. Sabatier was elected a correspondent for the Section of Chemistry in the place of M. Haller, named a member of the Academy, and Mr. Davidson a correspondent for the Section of Geography and Navigation, in the place of the late M. A. David.—On the general expression of the rational fraction approximating to $(1+x)^m$, by M. H. Padé.—On the formation of nodal lines of sand or dust, by M. C. Maltézos. A suggestion as to the cause of formation of small sandy hillocks on the sea shore.—The specific heat of a gaseous mixture of bodies in chemical equilibrium, by M. A. Ponsot.—The theory of the Wimshurst machine without sectors, by M. Bordier.—On the measurement of the period of the waves used in wireless telegraphy, by M. C. Tissot. The period of the oscillator was measured by the method devised by Fedderson and improved by Décombe. The periods measured were between $0{\cdot}6\times10^{-6}$ and $1{\cdot}8\times10^{-6}$.—The Ritchie telautograph, by M. Brauer. This apparatus transmits handwriting continuously without the use of clockwork.—On induced radio-activity and gases rendered active by radium, by MM. P. Curie and A. Debierne. It has been shown in a previous communication that the radio-activity induced by radium salts is effected through the intervening air. It is now found that the nature and the pressure of the gas are without effect upon the phenomenon, but that if a high vacuum is kept up the second body is not affected. On leaving the apparatus for some time, the secondary radio-activity is again observed, and if the gases evolved are again pumped off they are found to be extremely active in spite of their small mass. Their activity is so great that the glass tube containing them becomes fluorescent, and is visible in the dark.—The direct production of X-rays in air, by M. A. Nodon. Under the simultaneous action of ultra violet rays and an electric field X-rays may be produced without the use of a Crookes' tube.—A method for determining atomic weights founded upon the law of transparency of matter for the X-rays, and the application of this to the atomic weight of indium, by M. L. Benoist. The action of hydrogen upon realgar and the inverse reaction. The influence of pressure and temperature, by M. H. Pelabon.—The heat of formation of acetals compared with that of isomeric compounds, by M. Marcel Delépine.—On the acidimetric value of the monosubstituted benzoic acids, by M. G. Massol.—The passage from anisol to anisic acid by five successive oxidations, by M. J. Bougault.—On the law of the auxochromes, by M. P. Lemoult.—On naphthylol-naphthyl-oxynaphthylmethane, by M. R. Fosse.—The action of zinc upon the dibromide and diiodide of tetramethylene, by M. l'abbé J. Hamonet. On certain causes of variation in the quantity of gluten in wheat, by MM. Léo Vignon and F. Couturier.—Nervous conduction and muscular conduction of electrical stimuli, by M. Aug. Charpentier.—The variation of visual acuteness with lighting and adaptation; measurement of the migration of the pigment of the retina, by M. André Broca.—Curves of thermometric ascent, by M. S. Leduc.—On a parasite observed in the syphilitic, by M. H. Stassano.—On *Schistocerca americana*, its migration and area of geographical distribution, by M. J. Künckel d'Herculais.—The effects of lightning and "gélivure" upon trees, by MM. L. Ravaz and A. Bonnet. By an experimental study of the effects of electricity in motion upon the vine, the conclusion is drawn that the supposed disease of the vine known as "gélivure," and to which a microbial origin has been ascribed, is in reality due to the effects of lightning.—On the age of teschenite, by M. P. Choffat.

DIARY OF SOCIETIES.

THURSDAY, APRIL 4.

LINNEAN SOCIETY, at 8.—On some British Freshwater Rhizopods and Heliozoa: G. S. West.

THURSDAY, APRIL 11.

MATHEMATICAL SOCIETY, at 5.30.—Summation of the Series $\sum_0^\infty \frac{\Gamma^3(a+n)}{\Gamma^3(1+n)}$: D. F. Morley.

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