THURSDAY, APRIL 5, 1900.

## CELESTIAL PHOTOGRAPHS.

*Photographs of Stars, Star-clusters and Nebulae, together with Records of Results obtained in the pursuit of Celestial Photography.* By Isaac Roberts, D.Sc., F.R.S. Vol. ii. Pp. 178. Plates. (London: *Knowledge* Office, 1900.)

IT is now nearly six years ago since Dr. Roberts published his first volume on celestial photographs, which was noticed at some length in these columns (vol. l. p. 447). It was there remarked that the volume was the result of a "remarkable example of what can be done single-handed in a new line of research," and we might echo the same statement as regards the contents of the present issue.

Every astronomical reader is familiar with the first publication; indeed, Dr. Roberts's celestial photographs of long exposure were, and still are, so remarkable that many of them have been reproduced in most of the more recent works on astronomy. It is interesting to remark that in commencing astronomical photography it was the author's original intention to make a photographic chart of the sky between the north pole and the equator, so that those who came after him could, by taking similar photographs and comparing them with his, detect any changes that might have taken place during the interval that had elapsed. After he had secured many photographs on a definite programme of work, the international scheme for making a photographic chart of the whole heavens was suggested and commenced under the direction of the late Admiral Mouchez. Dr. Roberts therefore discontinued his charting work, and began the important investigation of photographing, on a large scale and with long exposures, the various star-clusters and nebulæ with the object of securing exact pictures of them, so that any changes that might take place in them might be detected after the lapse of some years.

The first volume indicated to the astronomical world the great and well deserved success which rewarded the labours of Dr. Roberts in this, perhaps, the most interesting branch of astronomy, and he may be said to have continued with the photographic plate the work that the Herschels accomplished visually with their giant telescopes. Like these celebrated observers, he has photographed "double and treble nebulæ variously arranged: large ones, with small, seeming attendants; narrow, but much extended, lucid nebulæ and bright dashes; some of the shape of a fan, resembling an electric brush, issuing from a lucid point; others of a cometic shape, with a seeming nucleus in the centre, or like cloudy stars surrounded with a nebulous atmosphere; a different sort, again, contains a nebulosity of a different kind, . . . .; while others shine with a fainter, mottled kind of light, which denotes their being resolvable into stars."

Of the seventy-two objects enlarged from the original negatives, and here beautifully reproduced in collotype by the London Steroscopic Company, thirty-three are of spiral nebulæ, fifteen of clusters, fourteen of nebulæ, irregular and cloudlike in form, six of crowded star areas, and four of annular nebulæ. The original photographs which are 15 centimetres square, were all obtained, as formerly, with the silver on glass reflector of 20 inches aperture and 98 inches focal length. It may be here mentioned that Dr. Roberts has added to his instrumental equipment a specially made Cooke triplet portrait lens of 5 inches aperture and 19·22 inches focal length, with a photographic field of 15 degrees diameter.

In the work before us, the arrangement of the plates differs from that adopted in the first volume. The photographs, instead of following each other in the order of right ascension, are here divided into classes or groups, each of which indicates apparent physical relationships, and the members of each group are arranged as far as practicable in the order of right ascension. The scale of enlargement is given in each case, as well as a table for converting the measured right ascensions of the stars shown on the photographs into intervals of time for each degree in declination. It may be remarked that the table of corrections to be applied to the scales of the photo-plates which appeared in the first volume has been dispensed with, owing no doubt to the improvement in the manufacture of photographic films. The co-ordinates of each of the fiducial stars are given for the epoch 1900, and on the plates these stars are marked with dots as formerly.

In the reproduction of such difficult objects as those here illustrated, it is well known that much fine detail is lost in the process. Reproductions, although approximating closely, yet never come up to the quality of the original negatives. The last mentioned, however, are subject to many vicissitudes. They can become broken, the films become discoloured after some time, images fade, and faint nebulosities disappear entirely. That such is the case is clearly proved by the experience of Dr. Roberts, which is related in his introduction.

To mention only one instance of many, he tells us how, shortly after a photograph of a certain region of the sky was taken (in February 1886), he counted 403 star images on the negative. On May 29, 1895, or after an interval of nine and a quarter years, no less than 131 stars had disappeared from the same plate, he being only able to count 272 images.

With such facts before us, it is therefore of great importance that as each negative is secured an impression of it should be made in permanent form, such as in printer's ink. If the work be done well, as is the case with the beautiful illustrations in this volume, future astronomers will have valuable data at their disposal for making direct comparisons.

In the introduction, Dr. Roberts refers to several points of great interest, which will be read generally with advantage, but especially by those who expose their plates to the sky for long intervals of time. He first gives us an account of his experiments regarding the effect of "atmospheric glare," which is due to starlight, causing a general fogging of the whole photographic plate. For exposures extending over several hours, Dr. Roberts is led to deduce that, at any rate for this country at least, by the time that the image of an eighteenth magnitude star is well impressed on the photographic plate, the whole plate has become so generally fogged that the density of a star of the nineteenth magnitude, or of even nebulosity of the same brightness, is not distinguishable. This glare, therefore, apparently places a limit on the photographic penetrative power of the instrument employed, and, as far as Dr. Roberts's conditions of observation are concerned, the limit for luminosity of the feebleness of about the eighteenth magnitude is reached. Perhaps for such a clear atmosphere as is experienced at Arequipa, in Peru, and like stations, and with instruments of larger aperture, even fainter stars might be reached. This is a subject, however, which requires considerable research before any very definite statement can be accurately made.

The next point dealt with is perhaps the most important of all. It is the general impression that if a photographic plate be exposed in a telescope for several hours, it will, on development, show more stellar images than if it had been exposed for one hour; indeed, the longer the exposure, the more detail will be impressed on the photographic plate, and one can quite imagine that if exposure were sufficiently long, the whole plate would be covered with images, indicating that we are practically surrounded by a wall of stars.

This, however, is not the case according to the investigations of Dr. Roberts, and he produces very strong evidence in his favour. If two exposures be made on one object, say, one lasting one and one-half hours, and another for twelve hours, and should the same amount of detail be depicted on each, the natural deduction would be that the longer exposure did not show any more detail than the shorter one, because there would be no more images to record. From a minute examination of photographs of the great nebula in Andromeda, in Orion, the group of the Pleiades, and the region of the Milky Way about Cygnus, Dr. Roberts finds that such is the case, and that lengthened exposure need not necessarily mean an increased number of stellar images. He is thus led to accept the fact as a demonstration "of the accuracy of the surmises of astronomers in the past, that the part of the starry universe visible from the earth is limited in extent, and that notwithstanding the enormous assistance afforded by the photographic method, we are again brought to a check because of the inadequacy of the powers we possess to enable us to peer beyond that part of space in the midst of which we are placed. . . ."

It would be interesting to inquire whether Dr. Roberts has examined other photographs of these regions taken by different observers who have also employed long exposures and other instruments, and, if so, whether his opinion as regards this point has been endorsed. Such an examination as here suggested might lend additional strength to the conclusion he has already drawn.

In directing attention to the evolution of stellar systems, the author places before his readers a series of beautiful illustrations of his plates showing rich fields of stars of various degrees of condensation; spiral nebulæ varying as regards symmetry; circular, annular and irregular nebulæ; and lastly, nebulæ of a cloud-like nature, which cover enormous areas and are conspicuous by their great irregularity. The wonderful groupings into lines and curves of many of the stars in these clusters and nebulæ, and the forms of the nebulous matter, leave, as Dr. Roberts points out, no room for doubt that they are the effects of physical causes, and, on account of their persistency on the plates, are very improbably due to coincidence only. The author further differentiates between those stars which are actually involved in nebulæ, and those which are situated simply in the line of sight, but do not conform with the trend of the spirals or with the curves of the nebulous stars involved in them.

Many other points of interest are referred to in these pages, among which we may mention the variability and motion of nebulæ; these and others, however, we must leave to those of our readers who have the good fortune to examine the volume for themselves.

In the publication of this work, Dr. Roberts has not only nobly enriched astronomical science, but has raised a monument to himself which will last as long as astronomy has any interest for mankind. This handsome book, besides being a most valuable mine of information, serves not only as a demonstration of the success that has rewarded his efforts after an infinite amount of most skilful instrumental adjustment and working, but as an excellent example of the valuable work that can be accomplished single-handed when one is endowed with both the love for and the means of studying the oldest of the sciences. WILLIAM J. S. LOCKYER.

## TWO MONSTROUS REPTILES.

(1) *A Complete Mosasaur's Skeleton and* (2) *A Skeleton of Diplodocus.* Being Parts iv. and v. of vol. i. of "Memoirs" of the American Museum of Natural History. By H. F. Osborn. With 8 Plates and 28 Text Illustrations. (New York: The Knickerbocker Press, 1899.)

THE memoirs above-mentioned are the latest of a series which, though not yet in their second volume, have already taken their place in the foremost rank of zoological publications. For this praiseworthy result the world is largely indebted to the author of the present memoirs, through his great monograph on "The Extinct Rhinoceroses"—the third in order of succession to appear. That came to those cognisant of his rich resources and familiar with his former doings as the fulfilment of a desire, and in itself set a high standard of excellence. In the memoirs under review this has been fully maintained, both as regards text and illustrations, which are alike highly finished works of art, worthy a pupil of Huxley. The two sets of remains dealt with are equally remarkable—one for the fact that parts usually lost by decomposition after death are here preserved; the other as furnishing us, for the first time in an undisturbed state, with well-nigh half the axial skeleton of a colossus, whose backbone was hitherto known only by some few isolated vertebræ.

The specimen of the Mosasaur is from the famous Kansas Chalk, which vies only with that of Mesvin in yielding the remains of the later aquatic reptiles, as evidenced by the grand series preserved in the Brussels Museum. The specimen under consideration measures some thirty feet in length, and is in detail noteworthy for the condition of its cervical vertebræ and limb skeleton, and for the preservation of the cartilaginous sternum, sternal ribs, and coracoids, and laryngo-tracheal supports. Of the cervical vertebræ there were indubitably seven, and the lesser parts of these are so well preserved that the author is able to give a detailed account of the "atlas complex" and individual relationships of the "inter-centra," admitting of comparison with the corresponding parts of recent reptiles. But one sacral vertebra is present, and of the twenty-two so-called "dorsals" ten are proved to have entered into the composition of the sternum. The limbs are of the usual Mosasaurian type, except for a broadening and shortening of the fifth metapodial in both fore and hind members; while the phalanges of the fourth and fifth digits of the manus are estimated as nine in number. The caudal vertebræ come in for consideration, and there is given a restoration of the entire skeleton in outline, and an accompanying attempt at that of the animal in the flesh. For this the author expresses his indebtedness to Mr. C. Knight, who, on the whole, does not seem to have been so successful as with some of his earlier efforts of the kind. The introduction of a "nuchal fringe" by analogy to *Platecarpus* is risky, and the contour of head and jaws grotesque, if not erroneous.

Concerning the affinities of the Mosasaurs, the author is unable to decide; for while showing them to be possessed of varanoid characters beyond those already recognised, he points to differences between the two groups, which he considers irreconcilable with the view that they sprang from a common stem. Here, however, he does not appear to have sufficiently considered the Dolichosaurian kinship, so strongly urged by Boulenger, supported by Dollo, and accepted by Smith Woodward; and his assertion that the presence of but seven cervical vertebræ is against this is unfortunate, since there is reason to believe that in some members of that suborder the number was thus small. The great expansion and non-fenestration of the unossified portion of the coracoid is a feature in respect to which this Tylosaurus is on a closer structural equality with the Rhynchocephalia than with the higher Lacertilia; and if it be that the bone claimed by Baur as the quadrato-jugal in *Platecarpus* really represents that, in consideration of the condition and inter-relationships of the palatines, pterygoids, and vomers, so well known in certain Mosasaurs, there can be little doubt that these struck off from some reptilian type intermediate between the Rhynchocephalia and the higher Lacertilia as to-day represented, *i.e.* that they arose "at an early stage in the evolution of the Squamata, before the modern Lacertilia and Ophidia had become differentiated," as Smith Woodward has so aptly remarked. Our greatest desideratum in the osteology of these creatures is a fuller knowledge of the posterior portion of their maxillo-jugal arcade, and it is unfortunate that with the present specimen, in which the conditions for preservation have been so favourable, that has been crushed.

Diplodocus is a notorious member of the Jurassic quadrupedal Dinosaurs, believed to have been an aquatic vegetable feeder; and, as already remarked, a full acquaintance with its axial skeleton has been a desideratum. The present specimen was obtained from the Como Bluffs of Wyoming, by a prospecting party led by the author in 1897. Hopes of the recovery of the entire skeleton proved false, but there were obtained a complete set of caudal vertebræ, together with the greater portion of the sacrum, hip-girdle and femur, all in an undisturbed state, and also fragments of the rest of the vertebral column and the ribs. Passing over important details concerning the cervical and so-called "dorsal" and pre-sacral vertebræ, with which the memoir deals in detail, it is as concerning the posterior of the latter, together with the sacral and caudal, and the ilium, that interest is greatest. The overlapping, by forward extension of the ilium, of certain free lumbar ribs with accompanying co-ossification of parts furnishes an interesting feature of convergence towards the Ratite bird type. Passing on, the author remarks that *Diplodocus* "gives us a new . . . conception of the Cetiosaurs," as involving the following interesting facts. He points out that the tail—some thirty feet in length—constitutes one-half of that of the whole animal, that the sacral spines mark the highest point in the backbone, and that the sacrum and ilium "come as a centre of power and motion"—the whole set of parts being so disposed as to lead us to regard the tail (which undoubtedly served as a propeller) as a "lever to balance the weight of the dorsal vertebræ" and the anterior portion of the body. He further points to a "balance between the opisthocœlous pre-sacrals and the procœlous post-sacrals," and draws the conclusion that the dominating principle of this great backbone is "maximum strength with minimum weight," while (to him) the whole is a mechanical triumph of great size, lightness and strength, which "baffles the Lamarckian as well as the Darwinian."

Beyond the more salient features above recapitulated, these memoirs are a storehouse of carefully recorded detail, of immense service for reference. Of the illustrations, no praise can be too high. There are eight plates, of which three are devoted to the Mosasaur, five to the Dinosaur; and all, with the exception of the third, which is an enlarged copy of a restoration of the skeleton incorporated in the text, are photographs of great merit. In addition, there are twenty-eight text illustrations, which, so far as they delineate parts of the actual remains, are ideal.

In conclusion, a word or two as to terminology and a looseness of expression, which we regret. In describing the unossified remnant of the coracoid as an "epicoracoid cartilage," and (using the term in its noun form) as an "epicoracoid" on one and the same page, the author is perpetuating a prevailing error against which we have more than once protested. The term "epicoracoid" is only applicable when a distinctly segmented element is present. Unfortunate, again, is the use of the term (p. 181) "sterno-coracoid plate." The sternum, which is apparently meant, is compared with that of certain living lizards; but when of these it is found that while at most three pairs of ribs contribute to its formation, in two of the species a second sternal cartilage is present, the comparison of *Tylosaurus*, with its ten pairs of costal ribs, is at least strained. Indeed, in its elongation and apparent longitudinal cleavage—its two most distinctive characters—the sternum of this aquatic reptile anticipates conditions independently realised later in time by that of certain Cetacea. Equally regrettable is the application of the term "dorsal" to those vertebræ possessed of free ribs. This term is one of orientation, and "thoracic" would have been preferable, except that in *Diplodocus* all the vertebræ between the third or fourth cervical and sacrum are rib-bearing. The old terms "thoracic" and "lumbar" have ceased to be tolerable in their original sense; and in view of the general presence of lumbar ribs among the terrestrial vertebrata and of the importance, both morphologically and physiologically, of the costal sternum, the suggestion that in the future we must enumerate the parts of the pre-sacral vertebral column of the Amniota in relation to the sternum may be revolutionary, but it will assuredly have to be adopted.

Zoology is pre-eminently that branch of pure science cultivated in the States, and our American *confrères* have a partiality for "big" game. It is pertinent to the present occasion, with its allusions to the Cetacea, to remark that rumour reaches us that they have lately come into possession of a complete *Zeuglodon* skeleton. If so, we can desire nothing better than that it may be monographed either in or on the lines of the memoirs under review; and we sincerely hope that the treasure in store will prove a more genuine concern than that of the famous giant Cetacean now preserved in the Palæontological Division of the Berlin Museum, which, having been publicly exhibited in that city as a mysterious creature of some 114 feet in length, was proved by Johannes Müller to embody the remains of individuals of two distinct species, and by him reduced to the less pretentious proportions of but some sixty to seventy feet.

We note that in the description of the Tylosaurus limb (Fig. 9) the word "left" should read "right"; and that in the table on p. 212, the reputed length of Diplodocus in metres is misleading, by omission of that of the caudal vertebræ, which, if added, would more than double the record given. G. B. H.

## A NATURALIST IN CHILE.

*Temperate Chile. A Progressive Spain.* By W. Anderson Smith. Pp. x + 400. (London: Adam and Charles Black, 1899.)

Mr. ANDERSON SMITH, formerly a member of the Scottish Fishery Board, is well known for his sympathetic descriptions of the wild life of the western highlands of Scotland. In the course of a visit to southern Chile a few years ago, the object of which is not clearly stated, but appears to have been some study of natural conditions, possibly on behalf of the Chilean government, he made notes on the country from many points of view, which are published in the volume before us.

The author's style is original, and indeed a little difficult on account of the wealth of simile and half-concealed allusion which it displays, so that the reader's mind is every now and then drawn from the matter in hand to think who "Thomas, not the rhymer, but the proser" may be, to marvel why Chile should be termed a "toy republic," to recollect where the "comforts of the Saltmarket" originated, or even to wonder if "Fresh fields and pastures new"—applied to a forest country too—may after all be the correct quotation. The arrangement of the matter in the descriptive parts is not systematic, and one can only gather the dates of the visits to various settlements with difficulty and without precision, which in a description of a progressive country is a real drawback. The map of Chile supplied, although clear and full for its scale, ought to have been supplemented by a cutting from the Admiralty chart of the neighbourhood of Chiloe, the topography of which cannot be found in any English atlas; without a detailed map the description of the various short journeys is not easy to follow.

Apart from these details of literary form and illustration, the book is both charming and valuable. It deals with a region of which little or nothing has been written in English by any naturalist since Darwin's "Voyage"; and it appears at a convenient time, for the Chilean government is again exerting itself to induce emigrants from northern Europe to make their home in the new lands of the far south.

The descriptions given of the civilisation, social life, and political systems of the Chileans are not attractive. How far they are just we cannot say; but it would perhaps be fairer to judge the people and methods of any republic in Latin America by comparison with those of the other republics than by any absolute standard or even by the criteria of Europe. Still, for any one who contemplates residence in Chile, the opinion of an observer so competent and impartial as Mr. Anderson Smith is of very great value, and should be carefully considered.

The struggle of high culture with barbarism in southern Chili is almost pathetic. Luxurious Pullman cars land the passenger in the midst of literally pathless forests, through which a track must be cut before a horse can pass. Yet wires fixed to the trees allow of telegraphic and telephonic communication with hamlets which lie weeks apart for the traveller. One reads with envy of a postal system so generous that newspapers are carried free in the mails, and with disgust of post-office administration so hopeless that letters lying in the head-office at Valparaiso are refused to the addressee on application, in order to save the trouble of looking for them, and afterwards returned to Europe.

The thriftlessness of the lower classes, half or wholly Araucanian, is horrifying even to one accustomed to the not too enterprising crofters of the West Highlands. They live contentedly in houses or huts without furniture, and in matters of food take little thought for the morrow or even for the day. Mr. Smith found a number of well-housed Indians with boats and fishing tackle at a station in Chiloe quite without food, and with the utmost difficulty induced them to take out a net. The result was good—"A second draw produced a fair supplement, but was purposely taken by the lazy rascals where the chance was less. A further draw we could not persuade them to try. Why? Because they would have required to carry the fish to the house, a hundred yards or so from the river, for there were at least three hundredweight of beautiful robalo some 6 to 8 pounds weight each. And yet these people were starving!"

The heavy rainfall and mild climate of the south of Chile produces a forest growth of a luxuriance and variety more to be expected in the torrid than in the temperate zone. Yet in many parts this growth appears to be recent. Near Osorno great trees were found growing in deserted gold workings of the present century, and an old Indian woman remembered the time when there were no trees and the guanacos (which do not inhabit forests and now keep to the eastern side of the Cordillera) used to come down from the mountains to the pastures where all is now grown with timber. On Chiloe and the islands and coasts further south the forest seems to be primeval. The great trees are smothered by long slender canes and creepers, and every branch drips with a rich variety of moss and ferns, while the bird-life is of remarkable variety and beauty. On the coast, where the trees come down to the very edge of the sea, the tropical humming-bird and pelican may be seen together with the penguin of the antarctic. The water-fowl of the rivers, many of which are quite overgrown with forest trees rooted in the midst of the permanent stream, are equally varied. Mr. Smith has much to say of the quetru or steamer-duck, so-called from its curious stroke like the action of a paddle steamer, a bird with a head like an anvil and a skin so tough that it can hardly be penetrated by shot.

The fish, and still more the edible molluscs, of the rivers and coasts are referred to very frequently, but from the economic rather than the scientific point of view. There are oysters of good quality, but the gigantic mussels of several species are more sought after. These, as well as limpets and other "shell-fish," are dried in immense quantities, and strung together like onions find their way over the whole of Chile, being much esteemed as food.

As to the colonists who are struggling to clear the forests and form homes in that land of perpetual cloud, Mr. Smith gives the first place for thrift, cheerfulness and ingenuity to the French; the Germans have established themselves firmly as the commercial and manufacturing people of southern Chile; but although many capable and prosperous British settlers were met with, the attitude of the author towards the bulk of his countrymen in Chile is that of the candid friend who recognises room for improvement rather than matter for praise.

HUGH ROBERT MILL.

## *RECENT PUBLICATIONS FROM KEW.*

*List of Published Names of Plants introduced to Cultivation*, 1876–1896. *Kew Bulletin of Miscellaneous Information.* Additional series iv. Pp. ix + 410. (London: Eyre and Spottiswoode, 1900)

*Hand-List of Tender Dicotyledons cultivated in the Royal Gardens, Kew.* Pp. xxx + 691. (Kew: Royal Gardens, 1899.)

WHEN a collection of dried plants is received from any quarter, there is generally no particular necessity for naming them at once. Time can be expended in sorting, examining and naming the specimens.

It is otherwise with cultivated plants. These are for the most part introduced by the nurserymen; and when it suits their purpose to launch them into commerce, a name must be given to them at once.

To the credit of the great nursery firms, it may be stated that they do endeavour to ascertain, from Kew or elsewhere, the true name of the plant they are about to "send out." Very often, most often, perhaps, the material sent for investigation is not sufficient for the purpose. Years, it may be, may elapse before a particular plant flowers and reveals its identity.

It is obvious that the business man cannot wait. The only course left to him, therefore, is to adopt a conjectural or a provisional name. Long experience in handling plants often enables the plantsman to make conjectures, which afterwards prove to be correct. In other cases, where there is no obvious clue, a provisional name is adopted. The abbreviation "hort." is, or should be, appended in such cases when writing the name, in order to avoid unnecessary trouble to the student and monographer.

Natural hybrids are not unfrequently imported, especially among orchids, and these have to be named according to their presumed parentage.

Not unfrequently the guess of the importer is borne out by the skill of the cultivator, who, by impregnating the flowers of one species with the pollen of another, gives rise to a hybrid corresponding with that produced naturally. Such hybrids, natural or artificial, are generally honoured with specific names in Latin, but differentiated by the addition of a X.

Nowadays, the number of species introduced by collectors is, at any rate, relatively much smaller than it used to be. Nevertheless, the aggregate of so-called "new plants" is much larger.

Of late years, too, new forms have been obtained in great abundance, either by selection or by cross-breeding, and these new forms require to be named. It is among the secondary hybrids and selected "strains" of particular species that we get the names which afford amusement to the public, and which, moreover, indicate what is occupying the public mind. Of late, we have seen plants named in honour of Lord Roberts and other South African heroes; whilst, as if to show the cosmopolitanism of horticulture, the names of President Kruger and General Cronje have not been wanting from the labels of plants exhibited before the Royal Horticultural Society.

The personal authority for the names has been uniformly omitted from the book whose title stands at the head of this notice, as it was found in too many cases impossible to assign it with certainty. We may acquiesce in this omission, but we demur to the further statement that "the reference given is to the publication in which the plant is first described or figured." Take, for instance, on the first page, *Abies brachyphylla*. The reference given is to the *Revue Horticole*; whilst *Abies Eichleri* is attributed to the *Florist* and *Pomologist*. Both these plants were described elsewhere prior to their publication in the periodicals mentioned; and so with a large number of others.

It is, of course, very desirable that all names be duly registered. Some of them are important to the botanist, others to the physiologist, and others more particularly to the gardener. A tribute of recognition is due from each of these groups of workers to the authorities of the Royal Gardens, Kew, for the compilation of the volume before us, and to the Government for giving it publicity. Without attempting to gauge the scientific value of the names, the compilers have searched the records in the horticultural Press and tabulated them in the present volume. It makes no pretension to be a scientific enumeration, but it will be of the greatest service to those who occupy themselves with the numerous scientific questions that arise in connection with cultivated plants, such as heredity, adaptation to varying conditions, variation, selection, cross-breeding, the origin of species, &c.

The book has reference to the introductions made within a period of twenty-one years, and the total number of names registered is no fewer than 7600, of which the majority are orchids, an indication of the taste and fancies of the times.

It is of interest to note that whilst in the early part of the century New Holland and the Cape of Good Hope furnished a very large proportion of the introductions—now the majority of the actually new plants "have been derived from the United States of Colombia, the Malayan and Polynesian regions."

The second volume referred to at the head of this notice is another of those very serviceable hand-lists which we owe to the director of Kew and his staff. The list includes the majority of what are called stove and greenhouse plants, omitting orchids and other monocotyledons elsewhere treated. This list is not a mere compilation of published names, but is an enumeration drawn up with as much scientific accuracy as the nature of the case permits.

It will thus, with the lists previously published, be invaluable to the botanist and to the cultivator who is interested in the plants he grows for reasons other than the mere attractiveness of their appearance or their economic use.

The director contributes a preface containing some very interesting information concerning the history of the Kew collections, and of the structures built to contain them. The Temperate House, now completed by the construction of two wings, is no less than 628 feet in length, and, what is of more importance, it is filled with well-cultivated plants of botanical or economic interest. The part that Kew has played in the collection and distribution of cinchona, india-rubber and other products, is appropriately referred to in the preface. It reminds us that whilst we are proud, as we have every reason to be, of our National Garden as such, we have also reason to rejoice in the great benefits it has been the means of conferring on humanity at large.

MAXWELL T. MASTERS.

## OUR BOOK SHELF.

*Les arbres à Gutta-Percha, leur culture. Mission relativ à l'acclimatation de ces arbres aux Antilles et la Guyane.* Par Henri Lecomte. Pp. 95. (Paris: G. Carré et C. Naud, 1899.)

M. LECOMTE was charged by the French Minister of the Colonies to effect the plantation of gutta-yielding plants in the French colonies of the new world. For this purpose he took with him, in wardian cases, plants belonging chiefly to the genera *Palaquium* (*Dichopsis*) and *Sideroxylon*, and in the small *brochure* before us he embodies an account of his expedition in the form of a Report to the Minister of the Colonies, and also includes in it a statement respecting the indigenous trees, such as *Mimusops Balata*, which he found already growing wild in Guiana.

The first portion of his book is devoted to a short sketch of the various plants which yield gutta-percha, and it appears to be largely drawn from the monograph on the Sapotaceæ by Burck. It cannot be said, however, that M. Lecomte has contributed much to the story of the discovery of these economically important trees, and indeed he seems now and then to have fallen into inaccuracies. Thus he states that gutta-percha was introduced by Montgomery (*sic*) into Europe in 1832, whereas it would seem that Montgomerie, although he first met with the substance in 1822, lost sight of it for twenty years, and it was not until 1843 that he sent home his first specimens from the East. M. Lecomte states that *Palaquium* (*Isonandra*) *Gutta* is extinct, but nevertheless there appear to be still a few trees known in Singapore besides those growing in the Buitenzorg garden.

The chief source of the best gutta at the present day is, as the author remarks, the closely allied species *P. oblongifolium*, which, previously distinguished as a variety of *P. gutta*, was raised to specific rank by Burck. The native name in Perak for *P. oblongifolium* is given by M. Lecomte as *Taban merah*, whilst it is stated by Obach that this name really belongs to *P. gutta*, the other plant being known as *Taban sutra*. In this M. Lecomte adopts the views of Burck (Rapport Gutta-Percha, 1884), who has expressed the opinion that *P. oblongifolium* is the real *Taban merah*, since *P. gutta* was not found by him to occur in the Malay peninsula, but only in Singapore.

It is of course possible that this may turn out to represent the true state of the case, since, although differing in habitat, the two species (?) closely resemble each other; but if so it is a pity that the matter was not more fully enquired into, as the native names are of some importance in a matter of this kind. If Burck should prove to be correct in his statements, its wide geographical range, extending from Malacca to Sumatra and Borneo, would perhaps indicate that *P. oblongifolium* ought to be regarded as the parent species, *P. gutta* representing a local off-shoot which has developed in, and is confined to, a very limited area. But in any case it is clear that several questions with regard to the mutual affinities of these plants still await definitive solution.

The book is an interesting record of an endeavour to extend the cultivation of a most important series of tropical economic plants, and it is sincerely to be hoped that the efforts made in this direction will be crowned with success.

J. B. F.

*Determination of Radicles in Carbon Compounds.* By Dr. H. Meyer. Authorised translation by Dr. J. B. Tingle. Pp. x + 133. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd., 1899.)

THERE is no doubt but that the original edition of Dr. Meyer's "Anleitung zur quantitativen Bestimmung der organischen Atomgruppen" supplied a want which had been felt for some time by all who had seriously taken up the study of organic chemistry, as well as by more advanced workers engaged in original investigations. The translation, which has now been provided, is thoroughly up-to-date, and, in the author's words, "has been further improved by certain changes in arrangement which Dr. Tingle has made."

It might, perhaps, be suggested that but little distinction is drawn between methods which are purely qualitative and those which also admit of quantitative treatment, in spite of the fact that, according to the translator, one of the main objects of the book is "the introduction of some quantitative work into the college courses of organic preparations"; generally speaking, however, the arrangement is excellent, and the numerous references to the original papers is a noticeably useful feature in a work of this kind.

The statement that "considerable care has been bestowed on the proof sheets" is hardly borne out by the results.

F. S. K.

*Unités électriques absolues.* By Prof. G. Lippmann. Pp. ii + 240. (Paris: Carré and Naud, 1899.)

THIS treatise is the reproduction of professorial lectures delivered at the Sorbonne in the session of 1884–85, and consists mainly of three parts. The first part deals with the electrostatic system of units, the second with the electromagnetic system, and the third with the electromagnetic theory of light. These are preceded by an introduction, which treats of units in general and the *c.g.s.* system. At the close of the book are two supplements, dealing respectively with the conservation of electricity and Lippmann's electrodynamometer.

The treatment is chiefly mathematical, the experimental methods referred to being described in outline. The analysis is, however, simple and the text illustrated by a hundred excellent figures. Indeed, the book is on the whole so good and clear that one regrets the more that the dimensional formulæ have not been brought up to date by embodiment of the progress made in the fourteen years which have elapsed between the delivery of these lectures and their publication. In our view, the value of the book would have been much enhanced by the introduction in it of Prof. Rücker's work on the usually *suppressed* dimensions of $\mu$ and $k$ (see paper read before the Physical Society of London, November 24, 1888; NATURE, vol. xxxix. p. 165).

This, impossible in the lectures themselves delivered in 1884-85, was both possible and highly desirable in the book of 1899. E. H. B.

*Elementary Practical Physiography* (*Section II.*). By J. Thornton, M.A. Pp. viii+208. (London: Longmans, Green and Co., 1900.)

THIS is an effort to meet the requirements of candidates for the Queen's Scholarship in Section II. of the syllabus of elementary science. Its scope is best described by the sub-title "A Course of Lessons and Experiments in Elementary Science," but it is necessary to add that the only branches of science touched upon are chemistry and astronomy. In both these subjects some knowledge gained by experiment and observation is now expected; but though the author claims to have kept this in view throughout, there is little in the book to entitle it to be called practical. It is true that reference is made to seventy-four experiments in chemistry, but they are for the most part better adapted as suggestions for the teacher than for performance by the student. In the astronomical section an excellent course of reading lessons is provided, but the author has by no means taken sufficient advantage of the opportunity of directing the student's attention to the heavenly bodies themselves. Instead of the descriptions of simple apparatus for making observations which might have been expected, such, for instance, as the measurement of altitude and azimuth, half-a-dozen class-room demonstrations are alone given.

Objection may be taken to the author's statement that "most of the diagrams are new and original"; many of them seem familiar, though they may have been re-drawn for their present purpose. A. F.

*Atlas de Photomicrographie des Plantes Médicinales.* Par MM. les Drs. Braemer et Suis. Pp. vi + 230; 76 plates. (Paris: Vigot Frères, 1900.)

THIS book consists of series of plates derived from microphotographs of the ordinary medicinal plants. To the plates relevant to each plant a descriptive text is added, dealing with the morphology of the respective plant. The microscopic sections are very clear and well reproduced.

The book ought to be useful to those interested in *materia medica*; but although we know of no similar work, we are afraid it will only appeal to a relatively small circle of readers.



## LETTERS TO THE EDITOR.

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

### Effects of Lightning upon Electric Lamps.

IN a communication to NATURE (p. 391), Prof. Wood pointed out the similarity of the features exhibited in Mr. Webb's photographs to the trails of luminosities exhibited in a picture taken with a moving camera.

To this I replied (p. 413), saying I had understood that the camera was fixed, and calling attention to two features which seemed to show that the phenomenon was real.

An independent suggestion similar to that of Prof. Wood, from another quarter, accompanied by photographs purposely taken with a moving camera,[1] subsequently came before me. This helped to arouse suspicion, and it occurred to me as conceivable that though the camera was fixed, Mr. Webb might as a matter of convenience have taken it up before he capped it; and if so, trails might have been left from the short exposure between lifting and capping. I wrote to him accordingly, suggesting that he should try the effect of lifting before capping. This led him to try the effect of exposure with a moving camera, with the result that there appears to be no doubt now that such was the origin of the supposed effects. In his reply, enclosing photographs taken with a camera which was purposely moved, Mr. Webb writes: "I had made so sure that there was no shake of my camera, in spite of your frequent suggestions to the contrary, that I cannot even now understand it, placed as it was on the balcony rail, excepting in the No. 6 or five-flash exposure, when I wilfully raised or depressed the camera a little to avoid getting two of the horizontal flashes on the same plane of horizon."

I must now refer briefly to the two arguments I used (p. 413) in support of the reality of the effects. I pointed out that in Fig. 4 there was a real decrease of scale in the luminosities about the nine more distant lamps, in accordance with the increasing distance from the camera. I confess it seemed to me that the difference of scale, though real, was not as great as I should have expected, but I had no measurements of the distances of the several lamps from the camera whereby to calculate what the difference of scale should have been if the luminosities were real, and of the same size for the different lamps. A difference of scale might be produced in a moving camera if the exposed plate had a movement of rotation about the line of sight. The other argument was founded on the visibility of the discharge. It seemed to me that such a discharge as those shown for instance in Fig. 1, taken as real, might be expected to be seen directly if the eye were defended from too much glare of the lightning, and I suggested to Mr. Webb to be on the look-out if an occasion should occur. He states in his letter to NATURE (p. 343), that he actually saw such a discharge. I think it is not difficult to reconcile this with the supposition that there is no real discharge. The observer on the look-out would have his eye directed to the lamp, and when the flash came might unintentionally look in a somewhat different direction. In the rapid rotation of the eyeballs the image of the lamp would leave a trail on the retina, which might easily be mistaken for an actual luminous discharge.[2]

The beading of the discharge now presents no difficulty. Indeed, the first idea which naturally occurs to one on seeing it is that it might be connected with the rapid alternation of the current; but so long as the picture is supposed to represent a real discharge, it seems difficult to imagine how the alternation could possibly account for the beading.

Cambridge, March 23. G. G. STOKES.

### The Absorption of the Becquerel Rays by Solid and Gaseous Bodies.

I WISH in this note to give some observations recently made with regard to the absorption of the Becquerel rays. Though the experiments are not complete, it is hoped that the results

[1] [The photographs referred to were taken by Mr. J. Williamson, of Hove, the electric lamps towards which his camera was directed being those along King's-road, Brighton. The effects were produced by giving a stand exposure of from five to ten seconds, and then moving the camera about for a few seconds with the cap still off.—Editor, NATURE.]

[2] Mr. Webb has suggested to me another explanation.

already obtained may be of sufficient interest to justify preliminary publication. The experimental details will be more appropriately given with the completed experiments.

Curie has shown that the rays from active barium compounds are of two kinds. One kind is easily absorbed, and is not deflectable by the magnet. The other kind is much more penetrating, and does suffer deflection in a magnetic field. It is to the latter kind exclusively that the experiments refer.

The intensity of the radiation was measured by the electrical conductivity of air exposed to it. It was again measured after partial absorption by a plate of the material under investigation.

In the following table the first column gives the coefficients of absorption λ defined by the equation

$$r = r_0 e^{-\lambda d},$$

while $r_0$, $r$, are the initial and final intensities of the radiation, and $d$ the distance traversed.

| Material | Coefficient of absorption | Density | Coefficient of absorption / Density |
|---|---|---|---|
| Platinum ... | 157·6 | 21·5 | 7·34 |
| Lead ... ... | 62·5 | 11·4 | 5·48 |
| Silver ... ... | 65·7 | 10·6 | 6·20 |
| Copper ... | 49·2 | 8·95 | 5·50 |
| Iron ... ... | 52·2 | 7·76 | 6·74 |
| Tin ... ... | 51·2 | 7·3 | 7·01 |
| Zinc ... ... | 40·3 | 7·2 | 5·58 |
| Mica ... | 10·8 | 2·74 | 3·94 |
| Glass ... | 12·5 | 2·73 | 4·58 |
| Aluminium ... | 11·6 | 2·7 | 4·30 |
| Celluloid ... | 5·45 | 1·36 | 4·01 |
| Ebonite ... | 4·77 | 1·14 | 4·18 |
| Card ... ... | 3·84 | 1·0 | 3·84 |
| Sulphur dioxide[1] | ·0413 | ·00758 | 5·45 |

It will be seen that, although the coefficient of absorption is not accurately proportional to the density, yet the departure from this relation is not very great, if the enormous range of density be taken into account. Thus between solid platinum and the compressed sulphur dioxide used, there is a three thousand-fold difference of density. The quotients $\frac{\text{absorption}}{\text{density}}$ are respectively 7·3 and 5·45. It is interesting to compare these results with Lenard's observations on the absorption of the kathode rays (*Wied. Ann.* vol. lvi. p. 255). He found that the above relation between absorption and density held to about the same degree of approximation. The coefficients of absorption for the kathode rays are, however, some five hundred times greater than for the rays investigated in my experiments.

We may, I think, fairly consider that the approximate proportionality between absorption and density is an additional argument in favour of the view that the deflectable Becquerel rays are of the same nature as the kathode rays. To account for the enormously greater penetrating power of the latter, one must suppose either that the particles constituting them are much smaller, or that their velocity is much greater.

R. J. STRUTT.

[1] Saturated vapour at 13° C.

## Planets at their Greatest Brilliancy.

MR. DENNING'S able and lucid article upon the planet Mercury (NATURE, March 1) induces me to send a few notes. With inclined elliptical orbits it is a complicated matter to determine when an interior planet is at its greatest brilliancy. But if the orbits are assumed circular and coplanar, interesting results are easily obtained.

Theory shows that there is a certain elongation, at which the interior planet, viewed from the exterior one, has a maximum brightness. Now, for a given elongation, there are two distances, a long and a short one, between the planets. Consider only eastern elongations. It will be found that Mercury has its greatest brilliancy (for mean distances and circular orbits) when its elongation is 22° 19′, and when its distance (1·00) from the earth is the larger of the two distances possible for this elongation. The illuminated phase is 0·60. Thus Mercury is brightest *before* its maximum eastern elongation of 22° 47′.

Venus has its greatest brilliancy at elongation 39° 43′; but its distance (0·43) from the earth must be the smaller of the two possible ones. The phase is 0·27. Thus Venus is brightest *after* its maximum elongation of 46° 20′.

But, if from Venus we view Mercury, then (as in the case of the earth and Venus) we must take the shorter distance for maximum brilliancy. The elongation is 31° 36′, distance 0·54, phase 0·40. Thus Mercury, seen from Venus, is brightest after its maximum eastern elongation of 32° 21′.

That a planet should be brightest exactly at maximum elongation involves, I find, the following relationship between the radii vectores: the radius vector of the exterior planet should be just $\sqrt{5}$ times that of the interior one. When the factor exceeds $\sqrt{5}$, the interior planet is brightest before maximum elongation. When the factor falls short of $\sqrt{5}$, the interior planet is brightest after maximum elongation. Circular orbits are assumed. For the pairs, Mercury-Venus, Venus-Earth, Earth-Mars, Jupiter-Saturn, the factor is less than $\sqrt{5}$. But for Mercury-Earth it is greater; hence Mercury is brightest before maximum elongation east, a fact clearly brought out by Mr. Denning's observations. On several occasions I have seen Mercury with the unaided eye, and, generally, after greatest eastern elongation, when the conditions are less favourable than before it.

C. T. WHITMELL.

Leeds, March 5.

P.S.—The American *Ephemeris* for 1900 shows that the maxima of brightness for Mercury occur very irregularly. One maximum occurs 6 days before greatest east elongation, another only 1½ days after superior conjunction. Eccentricity accounts for these irregularities.

## The Use of Silica in Thermometry.

I HAVE just learnt from your last number (p. 521) that Mons. A. Dufour has recently exhibited two silica thermometers in Paris, and that he proposes to study the suitability of silica for use in thermometers.

As I had the honour of exhibiting silica tubes of various sizes last June at the soirée of the Royal Society, and also then exhibited, in conjunction with Mr. Evans, our process for making such tubes, I am anxious at once to state that I have continued to study the applications of silica in conjunction with Mr. H. G. Lacell, and that we have at this moment the bulbs and stems of four delicate silica thermometers ready to be joined and filled as soon as their scales and some fittings are delivered. In February last we filled one of these ungraduated thermometers and tested it. It was shown to our colleague, Mr. J. E. Pearson, but was afterwards cut in two in order to alter the length of the degrees (20 mm.), as they were not quite as long as we then wished them to be.

I may add that the scales for these thermometers have been ordered, through the Cambridge Instrument Company, of Messrs. Zeiss, and that a special glass thermometer has been constructed for use in studying their zero points, which has now been in the hands of the Superintendent at Kew for some days.

Clifton, April 2, 1900. W. A. SHENSTONE.

## The Natural History Museum—A Correction.

IN a paper of mine on *Ilyopsyllus coriaceus*, which appeared recently in the *Natural History Transactions of Northumberland and Durham*, I referred to certain dissections—which had been described by Mr. Thomas Scott, and are now in the Natural History Museum at South Kensington—as having "deteriorated so as to be useless," at the same time ascribing this statement to Prof. T. Jeffrey Bell, who had kindly examined the dissections at my request. The statement, so far as Prof. Bell's authority is concerned, is not quite accurate, and at his request I wish to be allowed to correct it in your columns. What Prof. Bell told me was that the dissections consist of "nothing but unrecognisable fragments," and that "Mr. Pocock, who had charge of the Crustacea in 1893, says the tube came there in the state it is in now."

I think I need scarcely add that my words, as quoted above, were not meant in any way to impute negligence or want of care to the officials of the Museum.

G. S. BRADY.

The Durham College of Science, Newcastle-upon-Tyne, March 29.

### New Mode of Using the Concave Diffraction Grating.

I GREATLY regret that in a note of mine on a "new mode of using the concave diffraction grating," in the "Astronomical Column" of March 22 (p. 501), I wrongly interpreted a sentence of Prof Rizzo's article, which led me to think it was inconvenient for him to use the instrument in the usual way. The words "Dr Rizzo investigated this disposition on account of being unable to use the instrument as usually set up," should therefore not have been included THE WRITER OF THE NOTE

### Internal Stresses in Iron and Steel.

CAN you kindly inform me where I may obtain a copy of the researches of General Kalakoutsky on the "Internal Stresses in Cast Iron and Steel," translated by the late Sir William Anderson, F.R.S., Director-General, Royal Ordnance Factories. THOS. ANDREWS.

Sheffield, March 27.

THE work in question—"Investigations into the Internal Stresses in Cast Iron and Steel," by General Nicholas Kalakoutsky—was published by George Reveirs, 4 and 5 Graystoke Place, Fetter Lane, E.C., in 1888.

Second-hand copies can occasionally be procured from dealers in technical books. B. H. B.

## *ELECTRICITY IN WAR.*

UNDER the Presidency of the late Dr. Hopkinson, the Institution of Electrical Engineers established an Electrical Engineer Volunteer Corps affiliated to the Royal Engineers. Lord Kelvin is now its Honorary Colonel; the well-known electrical and mechanical engineer, Mr. R. E. Crompton (formerly Captain in the Rifle Brigade) is its Major. It is a corps consisting of 350 young men, most of whom have had a scientific education; they are all engaged every day in practical electrical engineering work; many of them are constantly engaged in inventing new apparatus and improving old apparatus; all of them are athletic, and enjoy such exercise as the volunteer drill affords; many of them are experienced bicyclists; all of them are curious as to the existing applications of electricity in warfare, and in consequence of their unfamiliarity with existing apparatus are very likely to quickly notice methods of improving it.

Hitherto many of these men have had a yearly drill in the management of the electrical apparatus in use for submarine mining and home defence.

I would point out that the ordinary volunteer drill of these men is only a part of their preparation for the nervous tension of an enemy's presence. There is no more trying experience than that of a young engineer in a central electric light station when the "peak" of the evening load is coming on, and every appliance is worked to its highest capacity; when the stoker cannot get enough draught for his boilers, and a short-circuit suddenly takes place. It is interesting to note how the man who was nervously afraid of himself beforehand, braces himself up to meet the emergency, and to his own wonder afterwards, manages to do exactly the right thing at the critical moment. A man who has proved his coolness in this sort of way is not likely to be flurried in the field, even when a rain of those most dangerous of all missiles, the 37 mm. Vickers-Maxim shells, are exploding about his search-light.

A few years ago, when Major Crompton vainly urged the necessity for the provision of new apparatus, practice in the use of existing field search-lights, &c., such as might lead to better designs, and money to enable such better apparatus to be constructed and tested, some of us felt very strongly that the War Office was wasting an invaluable opportunity.

A committee of the Institution of Electrical Engineers was able to assure Major Crompton of considerable pecuniary help in case the War Office gave facilities, and it was proposed that the corps should take up some one problem at a time, and work it out to a thoroughly good practical result. For example, the production of a really good field search-light was proposed. To work awhile with the existing things, which were like ship search-lights carried upon ordinary waggons, and to expend all the ingenuity of the corps upon the creation of a piece of apparatus perfect for military purposes. This involves also the best design of mobile steam engine and dynamo plant; the best kind of cable, and the best ways of paying

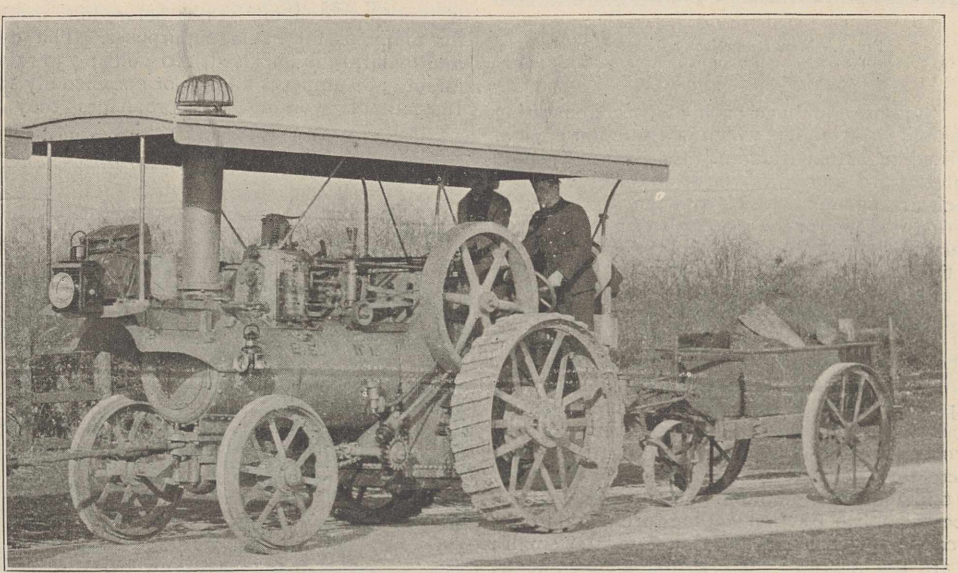

FIG. 1.—Traction engine.

it out and reeling it in. It also involves the design of the best arrangement of telephonic communication between the generating plant, the lights, and the officers in command and the general officer, possibly miles apart.

Again, is there anything of greater practical importance than this? Suppose we have such electric generating plant in the field; the engine, which is a traction engine, may be utilised in actual traction. Or a spare dynamo may be sent forward across a river or up a kopje with a simple winch arrangement, which may quickly be set in position, so that waggons or the materials of a bridge may be hauled across the river, or the heaviest guns may be hauled up the hills, or ammunition hoists or pumps may be set in motion. Electricity gives us the means of transmitting power in great or small quantities to any distance for all sorts of purposes; and Major Crompton imagined the gradual working out of all such problems, one at a time, by this corps of men, whose qualifications were just perfect for such purposes. It is to be remembered that in such work the requirements of war service introduce special conditions such as never have to be taken into account by the ordinary engineer. Everybody understands something about traction engines. Now the best English traction engines are made to run on good roads; their wheels are, therefore, too small; their tires are too narrow; their spring arrangements, and therefore their gearing, are quite unsuited for motion on a South African veldt. Not only so, but they are designed for places where the supply of water is plentiful everywhere. A traction engine, using up at least a ton of water every five hours, is not quite what is wanted in a dry country.

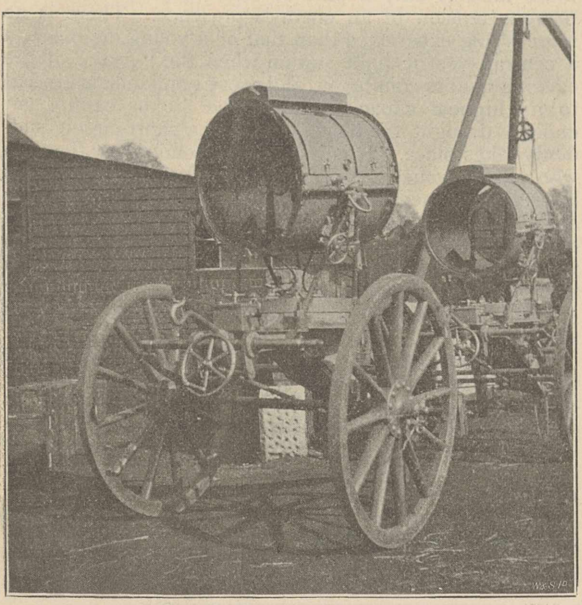

FIG. 2.—Mounted projector

I wonder if the War Office officials dream of the number of ways in which the scientific engineer might be made useful. A few really experienced practical electrical engineers will sometimes get together and unbend and talk of the things that might so easily be done, if instead of appointing third class men to important posts, the Government would really try to utilise the services of good engineers.

I shall not here refer to the fact that temptations are dangled before the eyes of third class men by unscrupulous contractors; about this side of the subject I do not care to speak. I think merely of the importance of the services of clever experienced men.

Even a good man would perhaps have but little chance of doing much service under existing arrangements. A Government prefers to spend ten millions of pounds in building ships that are something like existing ships, slight improvements on existing models, than to waste, as they would call it, a hundredth part of the sum in making experiments which would teach how ships may really be improved. And so it is in all branches of applied science. Bring forward a cut and dried scheme, perfect; be prepared to spend your own money in showing that it is good; if you have sufficient influence your scheme will be tried and may be adopted. But even a powerful clever head of a Government department must show a finished working thing to represent expended money. As this is so generally the case in all Government departments, it is probably not very fair to blame the War Department for not utilising the inventive and experimental talent of the Corps of Electrical Engineer Volunteers. Even if it could justly be blamed, there is now no desire to criticise the past inaction of the War Office. There is no inaction now; Major Crompton has been given a free hand in the equipment of active service contingents. He has worked night and day for two months, and his success has been marvellous. One of these contingents, consisting of fifty-eight men and six officers, started for South Africa a few days ago. Under Captain Lloyd, R.E., it took with it a complete equipment of two search-lights, including four waggons, each carrying 4 tons, and two traction engines, each with its dynamo as well as one spare dynamo, and I am greatly mistaken if this spare dynamo be not before long used as a motor for many useful haulage purposes. The dynamos are multipolar, semi-enclosed, 110 volts; 750 revolutions per minute; 80 amperes all day, or occasionally 100 amperes. Instead of working the projectors they may work ordinary arc and incandescent lights for use with night working parties (24 arc lights with portable lanterns, as well as 200 incandescent lamps have been sent out). Future dynamos will have spare armatures wound for

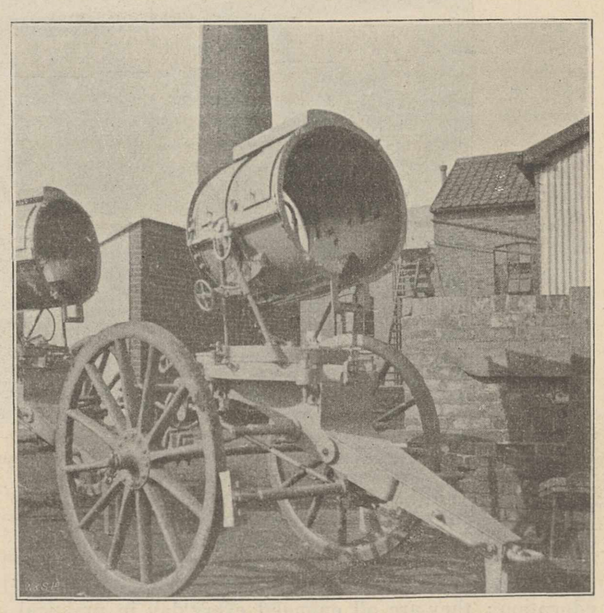

FIG. 3.—Mounted projector.

much higher voltages; also they will be driven from smaller fly wheels by chains instead of belts. The detachment takes with it twenty-five khaki-coloured, long-crank, specially strong bicycles. Fig. 1 shows the engine, but I am sorry to say that its dynamo has been removed from its front end and replaced by luggage. Special spring arrangements at the front end of the engine prevent hurt to the dynamo from jolts. I know of no other compound traction engine whose weight is only 8 tons. I am told that in practice it consumes about 32 pounds of water per hour per electrical horse-power developed—a wonderfully good result for so small an engine (maximum electrical power, probably 13). With a little experience this expenditure may be cut down to 28 pounds. It will be part of the regular drill of the men to run a search-light for a specified time, there being competition as to the expenditure of coal and water. When we consider that these very economical engines need about 400 pounds of water (they need also about 45 or 50 pounds of coal) per hour, we see the defect of the ordinary traction engine for army transport purposes. A third engine which is going out with Major Crompton and a second contingent this week will have partial condensation of its steam, so that the water will not all be wasted. It is to be hoped that so easily designed a thing as a traction engine with light surface condensing plant condensing all its steam will be in use before long. Major Crompton has had a considerable experience of engines in general, and of traction engines in particular, having carried out experiments on traction for the Indian Government long before he became identified with electrical engineering. I understand that the War Office is now considering his scheme for working the transport service of an entire division of the army, independently of all railways.

This is the first time that projectors have been fitted to special trails like gun-carriages. The carriages of riveted best cast steel are strong and light, as may be seen in Figs. 2, 3 and 4. The wheels are from the Royal Arsenal, and may be replaced if hurt in the field. The limbers are shown in Fig. 5. Poles and harness equipments for ten span of mules have been provided. The projectors may be hauled either by the engines, or by the mules, or by the men. The projectors are novel in design; almost the only feature of existing projectors embodied in them is the barrel. Their mirrors, glasses and divergers are mounted in aluminium. They have gun-metal bases moving in ball run turntables. They may be detached from their carriages and stand on the ground on their four feet. The Coles reflectors are of deposited copper faced with silver, and a thin coat of palladium to prevent tarnishing. The lamp mechanism is new, the pattern service lamp being far too heavy and clumsy; moreover, the usual arc-striking arrangement would be hammered to pieces by the vibration of the moving carbon when the lamp is travelling about. The new lamp locks the moveable carbon holder in position after the arc is struck, and the feeding movement is carried out by the shunt coil acting on the other carbon. These search-lights may be stationed a mile or more away from each traction engine, as there may be a fall of 52 volts between dynamo and arc. The main cables are of quite a novel kind. They are concentric cables with an insulated core, one-tenth of a square inch in cross section; they are armoured on the outside by a copper braiding, which forms the return conductor, but there are other forms of cable and uninsulated copper ropes for returns. The telephone arrangements are novel. Major Crompton has adopted the Swedish cavalry pattern of instrument, which can be used as a telephone, or the signals may consist of the "buzz" through a high resistance or through a very leaky circuit. On trial, he finds that there is very good speech through the telephones and two miles of bare wire on the wet grass. Of course there will be audible speech for, possibly, six miles, on dry grass. This fine (No. 22) copper wire may be laid from reels fixed on bicycles when the bicycles are going at ten miles an hour; and it may be picked up at a speed of four miles an hour. There is also a supply of the more usual concentric telephone cable, and twelve sets of combined telephones and buzz telegraph instruments have been sent out.

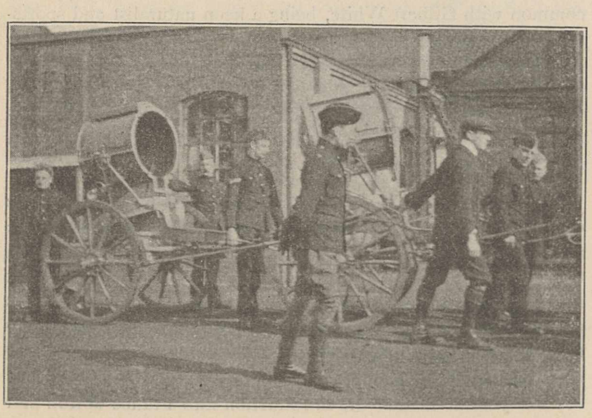

FIG. 4.—Projectors hauled by men.

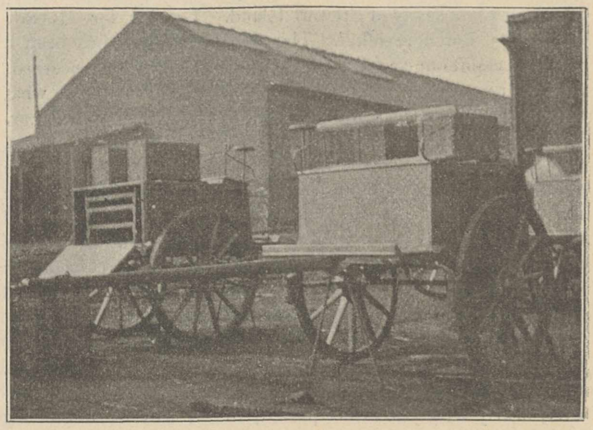

FIG. 5.—Limbers.

I am not at liberty to publish an account of the novel ideas as to the best use of search-lights which Major Crompton hopes to illustrate when in front of the enemy's position. I think that the whole experiment is a hopeful one. Everybody knows the sort of athletic, energetic young men who are chosen for mountain battery work; they are as resourceful and cat-like as sailor men. Imagine such young men, with, in addition, the qualifications which I have enumerated, and you have some idea of these young electrical engineer volunteers. With Captain Lloyd and Major Crompton in command, it is to be expected that there will be a good return for the expense incurred. The money paid for equipment is only a very small part of the total expense of this experiment.

JOHN PERRY.

## NOTES.

The Antarctic expedition equipped and sent out by Sir George Newnes in August 1898, under the direction of Mr. Borchgrevink, has safely returned. The following cablegram, sent from the Bluff, Campbelltown, which is one of the southernmost ports on the south coast of the South Island of New Zealand, has been received by Sir George Newnes from Mr. Borchgrevink:—"Object of Expedition carried out. Furthest south with sledge; record, 78·50. Present position of South Magnetic Pole located. Zoologist Nicolai Hanson dead. *Southern Cross* safely at Stewart Island. Leaving for Hobart. All well. Borchgrevink." The expedition has thus been a very successful one so far as geographical results are concerned, and we trust that its success may be taken as an earnest of what will be accomplished by the expeditions which depart next year. The highest latitude reached by Ross, in 1842, was 78° 10′ S., this being the latitude at which his ships met with the great ice barrier. Mr. Borchgrevink has gone further than this, and he must have made a long journey by land to have reached lat. 78° 50′ S. It will be interesting to know the position of the magnetic pole located during the expedition. From the observations made during Ross's expedition it has been inferred that a magnetic pole is situated in lat. 73° 5′ S., and long. 147° 5′ E. This places the real southern magnetic pole not far from the position assigned to it by the calculations of Gauss, viz. lat. 72° 35′ S. and 152° 30′ E. Since Ross's expedition, however, nearly sixty years have passed, and it will be interesting to compare Mr. Borchgrevink's determination of the present position of the magnetic pole with that deduced by Ross, and that predicted from theoretical considerations. While upon the subject of Antarctic exploration, it is noteworthy that Prof. J. W. Gregory, who has succeeded the late Sir Frederick M'Coy as professor of geology at Melbourne, has been appointed director of the scientific staff of the British Antarctic expedition to start next year. The Scottish expedition referred to last week (p. 518) is to be a private expedition organised by Mr. W. S. Bruce, and will not be officially connected with the Royal Scottish Geographical Society.

The Paris correspondent of the *Times* announces the death, after a long illness, of M. Joseph Bertrand, the eminent mathematician.

We regret to record that Dr. St. George Mivart, F.R.S., the distinguished biologist, died on April 1, at the age of seventy-three.

At yesterday's meeting of the Institution of Naval Architects, the gold medal of the Institution was presented to Mr. J. Bruhn, and the premium to Prof. W. E. Dalby.

At a recent meeting of the American Academy of Arts and Sciences, the Rumford medal was presented to Mr. C. F. Brush for his electrical work.

Prof. P. Tacchini has resigned the directorship of the Royal Italian Bureau of Meteorology and Geodesy after forty years of service. Prof. Luigi Palazzo has been appointed temporary director.

Sir William T. Gairdner, F.R.S., professor of medicine in the University of Glasgow, has resigned his chair because he feels unequal to the task of the enormous amount of reading necessitated by the professorship in order to keep in touch with the developments of medical science, and also because he wished to give way to "a younger pair of eyes, and perhaps a younger brain as well."

A Pasteur institute was opened at Antananarivo, the capital of Madagascar, on Friday last.

The Actonian Prize of 100 guineas has been awarded by the Royal Institution to Sir William and Lady Huggins for their work, "An Atlas of Representative Stellar Spectra."

The celebration of the jubilee of the Royal Meteorological Society began on Tuesday with an afternoon meeting, held in the Institution of Civil Engineers, with Dr. C. Theodore Williams, the president, in the chair. The president read an interesting paper on the history of the society, written by the late Mr. G. J. Symons. In the evening the Fellows and their friends attended a conversazione held in the galleries of the Royal Institute of Painters in Water Colours.

Prof. H. G. Seeley, F.R.S., sends the following particulars from a communication received by him from Dr. Corstorphine. While Messrs. Rogers and Schwarz, of the Geological Survey of Cape Colony, were examining the Uitenhage or Sundays River beds, which are of Middle or Lower Jurassic age, Mr. Schwarz came upon the skeleton of a small Plesiosaurian about four feet long. The remains include the head showing the snout and palate, and the lower jaw. The teeth are in sockets, as usual, with fluted conical crowns and a cylindrical base. The largest teeth are in front. Thirty-eight vertebræ were collected, and one of the limb-girdles, regarded as that of the fore limb. The greater part of the flat, paddle-shaped hand is preserved. With this fossil were found *Astarte browni*, large Trigonias and *Olcostephanus atherstoni*.

We regret to see in *Science* the announcement of the death, at her home in New York City, of Miss Catherine Wolfe Bruce, who made generous gifts for the advancement of astronomy to Harvard University, Columbia University and other institutions.

Many naturalists and archæologists will regret to see the announcement of the death of Canon J. C. Atkinson, on March 31, within a few weeks of completing his 86th year. His well-known volume, "Forty Years in a Moorland Parish," published in 1891, was at once recognised as a work of permanent value, worthy of a place beside the immortal "Natural History of Selborne." Indeed, Canon Atkinson had many points in common with Gilbert White, being a keen naturalist and sportsman, as well as a highly-trained antiquary and philologist. Many generations of school-boys have derived their first interest in country matters from his still popular book on "British Birds and their Nests" and the contemporary volumes, "Walks and Talks" and "Play-hours and Half-Holidays," all of which are still in circulation.

A few particulars of the career of M. Samson Jordan, the distinguished French engineer and metallurgist, whose death we referred to last week, are given in the *Times*. He was born in Geneva in 1831. In 1855 he constructed the Saint-Louis blast furnaces, near Marseilles, of which works he was for some years engineer and afterwards a director. These blast furnaces were the first in France built for the purpose of smelting the pure, rich iron ores from Elba, Spain and Algeria, with coke as a fuel. To M. Jordan is due the introduction into France of iron and manganese ores from Spain and from the Mediterranean coast, as is also the manufacture of a special quality of cast iron. In 1862 M. Jordan removed to Paris, where he continued his professional work, and in 1865 he was appointed professor of metallurgy at the École Centrale des Arts et Manufactures, of which he was a former pupil. This appointment he held at the time of his death. M. Jordan in numerous ways promoted the advancement of the iron and steel industries in France. He was the author of several valuable metallurgical treatises. In 1874 he was elected President of the Société des Ingénieurs Civils de France, and an honorary member of the Society of

Engineers in England. He was also a member of the Iron and Steel Institute of Great Britain, of the Imperial Institute, and of the leading technical societies of France.

WE have to record with regret the death of Dr. Wilhelm Waagen, professor of palæontology at the University of Vienna. In 1865 he published at Munich an important essay on the classification of the Upper Jurassic strata, and subsequently gave much attention to the study of ammonites. On the death of Ferdinand Stoliczka in 1874, Dr. Waagen was appointed palæontologist to the Geological Survey of India. This post he was unfortunately compelled to resign at the end of three years, on account of his inability to resist the effects of a tropical climate. He, however, continued to labour at the Indian fossils, and after he had published his important memoir on the Jurassic Cephalopoda of Kach (1873–76), he devoted his attention to the remarkable series of fossils, ranging from the Lower Cambrian to the Trias, which had been obtained from the Salt Range. As remarked by Dr. W. T. Blanford, "his masterly summary of the geological results" thoroughly justified the award of the Lyell medal, which was made to Dr. Waagen by the Council of the Geological Society in 1898. He died at Vienna, on March 24, in the fifty-ninth year of his age.

THE announcement of the death of Prof. Pepper, formerly honorary director of the Polytechnic, Regent-street, and the inventor of the celebrated "Pepper's Ghost" effect and other illusions, came as a surprise to most men of science, for it was not generally known that until a few days ago he was still living. He assisted to popularise science in various ways, and was one of the founders of evening science classes in London. He lectured also for many years, making tours through America, Canada, and Australia, where he met with enthusiastic receptions. He was an honorary life member of the Institution of Civil Engineers, and a Fellow of the Chemical Society, and the author of the "Boy's Playbook of Science" and the "Boy's Playbook of Metals."

IT is officially notified that all applications for space at the Glasgow International Exhibition, which is to be opened in May 1901, must be lodged not later than June 1 with the General Manager, Mr. H. A. Hedley. There are in all eight classes, embracing agriculture, mining, industrial design and manufactures, machinery and labour-saving appliances in motion, locomotion and transport, marine engineering and shipbuilding, lighting and heating, science, education, music, sports and sporting appliances. Separate sections will be devoted to women's exhibits, archæology and fine art.

A REMARKABLE instance of the destruction of a species of bird by a hurricane is related by Mr. T. Digby Pigott in a recent issue of the *Times*. Before the West Indian hurricane of September 1898, one of the tamest and commonest birds on the island of St. Vincent was a small bronze-green humming-bird. It appears, however, that since the hurricane the bird has entirely disappeared. A friend of Mr. Pigott's, who was familiar with the bird, lately made a seven weeks' stay on the island, but did not see a single specimen; and upon inquiry he found that none of the birds had been seen since September 1898. The disappearance is the more remarkable as other humming-birds formerly less common than the one now missing are still to be seen in St. Vincent, though in diminished numbers. A possible explanation lies in the fact that the humming-bird which has apparently been extirpated was the smallest of the three species known upon the island, and therefore the most easily killed. Mr. Pigott has been unable to find the name of the bird that has disappeared; but his friend describes it as easily to be recognised by its habit of sitting with its crest erect.

AT the recent annual meeting of the Association of Chambers of Commerce, the following resolutions referring to the metric system were carried unanimously:—(1) That steps be taken by this Association to again urge Her Majesty's Government: (*a*) to introduce into and endeavour to carry through Parliament, as speedily as possible, a Bill providing that the use of the metric system of weights and measures shall be compulsory in this country within a period of not more than two years from the passing of the Bill; and (*b*) to adopt the system with as little delay as possible in all specifications for Government contracts. (2) That in the opinion of this Association it is necessary, in order to promote knowledge of the metric system of weights, measures and money among the people, that the Education Department should require Her Majesty's Inspectors to hold a real and effective examination of scholars in this system in the public elementary schools, and that a deputation of this Association do wait upon the vice-president of the Committee of Council on Education, and call his attention to the necessity of such examinations by Her Majesty's Inspectors.

THE Assistant Secretary to the Treasury Department of Washington, before whom a petition was recently brought by a number of persons in Buffalo as to the expediency of levying a tariff duty on electricity generated in Canada, and transmitted to the United States, has decided not to recommend such a proposal. The decision of the former Assistant Secretary Tichener has thus been upheld, and as a consequence it is agreed that no tariff will be collected on electricity.

THE post of Technical Assistant to the Imperial Department of Agriculture for the West Indies has been offered to and accepted by Mr. Wm. G. Freeman, B.Sc. Educated at St. Olave's Grammar School, Mr. Freeman obtained a National Scholarship in Biology, and spent three years at the Royal College of Science, making botany his special subject. He obtained the Associateship of the College, with a first class in botany, and was awarded the Edward Forbes medal and prize for biology. In February 1896, he went out to assist the late Dr. Tremen at the Botanic Gardens, Ceylon, and afterwards, Mr. Willis, the present director. In October 1897, he was appointed Demonstrator in Botany, under Prof. Farmer, at the Royal College of Science.

THE second number of the *West Indian Bulletin*, just published, is devoted to a report of the proceedings at the Agricultural Conference held at Barbados in January last. It contains the address of the President, Dr. Morris, and the various papers, and discussions on them, which were recently described in NATURE by Prof. D'Albuquerque (pp. 392, 398).

DR. W. BUSSE, of Berlin, intends starting early in April for German East Africa, to investigate the flora of the steppes, for the purpose of discovering any plants of technical or medicinal value. He proposes to remain nine months.

FROM a summary of the mineral production of Canada in 1899, by Mr. E. D. Ingall, just published by the Canadian Geological Survey, it appears that the increase which has been so marked a feature during the past few years was sustained. Compared with the corrected total for 1898, the preliminary figures for 1899 show an increase of over 22·2 per cent., the increases for 1898 and 1897 having been nearly 35 per cent. and nearly 27 per cent. respectively. Of the increase of 22·2 per cent., 15·52 per cent. is credited to the increased output of gold from the Yukon placers, 2·92 per cent. to the increases in the other metallic products, and 3·84 per cent. to the growth of the non-metallic mineral industries.

REFERENCES to the work done at the Astrophysical Observatory of the Smithsonian Institution are made by Prof. S. P. Langley in his report upon the operations of the Institution for the year ending June 30, 1899. It has been shown that rock-salt prisms, whether obtained from mineral mined in Russia or Bavaria, have exactly the same refractive indices. It appears, therefore, that this interesting crystal, which from the time of Melloni to Prof. Langley himself has been chiefly used on account of its qualitative properties as regards the transmission of radiations, can now be used quantitatively as a standard of refraction to which all wave-lengths may be referred with the same order of precision as to the diffraction grating. Prof. Langley's measures of 1897–98, which determined the exact positions of 700 Fraunhofer lines in the infra-red spectrum of rock-salt, may thus be regarded as fixing constants of nature. As the wave-lengths of the lines were determined with an average probable error of three parts in 10,000, we are led to the surprising fact that, by working automatically in the dark, with the bolometer, it has been possible to analyse the infra-red solar spectrum with an accuracy comparable with that attained with much more pains through the eye itself.

ALL artificial lights, even the best, are extravagantly wasteful of energy, in that they lavish it in the infra-red, and not in the visible spectrum. Mr. C. G. Abbot, who has charge of the Astrophysical Observatory of the Smithsonian Institution, has examined the light emitted by the Welsbach mantle (which consists of impure thorium oxide) and other incandescent mantles, by means of the bolometer, with a view to comparing their efficiencies. Though the illuminating powers differ considerably, the distribution of energy is much less diversified than would be supposed, and shows clearly the wastefulness even of the Welsbach light as a source of illumination. The infra-red in each case includes by far the greater portion of the energy, and not the visible spectrum, as is the case with the sun, and still more, with phosphorescent substances. Excluding the infra-red radiation, the Welsbach mantle was found to be superior in light to the others experimented with, especially in the red, orange and yellow parts of the visible spectrum.

IN a paper published in the *Geological Magazine* for March and April, Dr. C. Davison describes some of the less important British earthquakes felt during the years 1893–1899. The total number of shocks recorded in these seven years is forty-two, of which twenty-eight occurred in England and Wales, and fourteen in Scotland. In England, earthquakes were most numerous in the counties of Pembroke, Hereford and Cornwall; and in Scotland, in Annandale and Glen Garry, and near Comrie and Fort William. The earthquakes at the two last places are interesting from their connection with the two great faults which bound the Highland district; and the study of the shocks shows that the southern boundary fault near Comrie hades to the north-west, and the northern fault near Fort William probably to the south-east. A list of doubtful and spurious earthquakes is given, and among these are several which have been referred to by correspondents in NATURE. Several local earth-shakes in mining districts are described, and Dr. Davison suggests another cause of some of these shocks besides rock-falls in old workings, namely, small fault-slips in those places where the coal has been worked right up to the fault, and so withdrawn support from the rock above.

HERR R. PARKINSON has a unique knowledge of several districts of Melanesia, and he has recently contributed a very valuable paper on the ethnography of the North-western Solomon Islands to the *Abhandl. u. Berichte d. K. Zool. u. Anthrop. Mus, Dresden*, Bd. vii. 1899. He brings forward some fresh information on that evergreen topic of totemism. In Buka there are two clans which are called after their respective totems, the Fowl and the Frigate-bird, and members of the one clan must marry into the other. In North Bougainville the same clans exist, but in South Bougainville and in the neighbouring islands there are a number of bird clans; here also no one may marry into his own clan, though he may marry into any other. In all cases the children belong to the mother's clan. The lads are initiated into the *Rukruk* society in a tabooed clearing in the bush; as in Australia and elsewhere, a bull-roarer is whirled, and the women believe that the unearthly noise produced by this mystical instrument is the conversation between the initiates and the male and female spirit. After this ceremony the lad may marry. As Parkinson deals with other customs, music, houses, clothing, ornaments, money, utensils, weapons and the like, it will be apparent that this memoir is of considerable importance, especially as the author has peculiar facilities for gaining trustworthy information.

IN the *Report* of the Rugby School Natural History Society for 1899 will be found an excellent plate of the skeleton of *Ichthyosaurus platyodon* disinterred at Stockton in 1898.

FROM the *Report* just to hand, the Ghizeh Zoological Gardens, under the direction of Mr. S. S. Flower, seem to be in a flourishing condition. By far the most interesting animals acquired during the year are the Proboscis Monkeys presented by the Netherlands Government.

AS the result of an examination of the specimens brought back by the Harriman expedition, Dr. C. H. Merriam (*Proc.* Washington Academy, ii. pp. 13–30) describes no less than twenty-six mammals from Alaska and British North America as new. Although the majority of them are described as species, many naturalists will probably relegate at least a percentage to the rank of local races.

THE *Sitzungsberichte* of the Royal Scientific Society of Bohemia for 1899 is a bulky volume containing a large number of papers on various subjects, many of which, from being written in Czech, are unfortunately a sealed book to the majority of Englishmen. Among interesting or important biological papers, we may call attention to one, by Herr Ryba, on a new *Megaphytum* from the Coal-measures; to a second, by Herr Smyčka, on the occurrence of the European Pond-tortoise in Silesia; and to a third, by Dr. Rohon, on the morphology of the Devonian fishes in one of the Petersburg museums.

DR. O. Z. BIANCO has sent us a copy of an interesting communication made to the Royal Academy of Sciences at Turin on February 11. The paper is intended to be a contribution to the history of meteorology, and contains an account of some recent investigations of Italian men of science upon the physical constitution of the atmosphere, founded upon the famous balloon ascents of Mr. James Glaisher in the years 1862–6, which still hold their place as the best and most extensive series that we at present possess. The principal object of the paper is the construction of improved barometric formulæ for the determination of heights.

WE have received from Prof. G. Schwalbe an excerpt paper from the *Annalen der Physik* (iv. series, 1900), giving an account of his recent experiments upon Exner's theory of atmospheric electricity. The experiments, like those made some years ago (*Wied. Ann.* vol. lviii. p. 500, 1896), were carried on at the physical laboratory of the Agricultural High School at Berlin with the view of investigating the electrical behaviour of the vapours rising from electrified fluids. The author finds that such vapours carry no kind of electricity with them, and that consequently the experiments do not support Exner's theory, which explains the phenomena of atmospheric electricity by the transfer of the electric charge of the earth to the air by means of the evaporation going on from masses of water.

RECENT numbers of the *Communications* from the Physical Laboratory of the University of Leyden are occupied with work carried out in the cryogenic laboratory, which has been reopened after completing certain safety arrangements required by the Privy Council. Dr. H. Kamerlingh Onnes gives an account of certain methods and apparatus, including (1) a cryostat or boiling-glass and boiling case, for measurements with liquefied gases, especially oxygen; (2) the arrangement of a Brotherhood air compressor for the compression of gases to be kept free from admixture with air; (3) methods of pouring out little quantities of liquid nitrous oxide; and (4) boiling nitrous oxide in large quantities. In another issue, Dr. E. van Everdingen, jun., describes a continuation of his experiments on the Hall effect at the low temperatures now available, and has found no indication of a maximum value to this effect down to the boiling point of liquid oxygen. Dr. Fritz Hasenoehrl investigates the dielectric constants of liquid nitrous oxide and nitrogen, a branch of investigation previously carried out by Dewar and Fleming. The results are for nitrous oxide 1·933, and for oxygen 1·465, as compared with Dewar's 1·491, while the Clausius Menotti formula is at any rate not negatived by the experiments.

MESSRS. WATKINS AND DONCASTER have sent us their catalogue of natural history apparatus, books, birds, eggs, lepidoptera and other requisites of the field naturalist.

A SECOND edition of Part ii. of Prof. Chrystal's "Algebra" has just been published by Messrs. A. and C. Black. The principal changes occur in the sections on the Theory of Series, which have been rendered more useful to students proceeding to study the Theory of Functions. In the interests of the same class of readers, a sketch of the modern theory of irrational quantity has been added to the chapter. The first edition of Part ii. of Prof. Chrystal's work has already been noticed in NATURE (vol. xli. p. 338), and the merits of the work are so well known that it is unnecessary to do more now than announce the publication of the new edition.

THE London Geological Field Class, conducted by Prof. H. G. Seeley, F.R.S., offers exceptional opportunities of obtaining observational knowledge of the physical geography and geology of the London district. Visits are made to selected places on Saturday afternoons between the end of April and the beginning of July, and short addresses are given upon the characteristics of the rock structures and the development of the land forms seen during the excursions. The places to be visited this year have been selected with the view to illustrate the geological structure of the London basin by an examination of Cretaceous rocks at Godalming, Oxted, Gomshall and elsewhere, and of the Oolite of Bedford. The first excursion will be made on April 28.

SEVERAL parts of elaborate scientific memoirs in course of publication by Mr. W. Engelmann, of Leipzig, have been received from Messrs. Williams and Norgate. Included among these recent works are:—"Monsunia: Beiträge zur Kenntniss der Vegetation des süd- und ostasiatischen Monsungebietes" (Band i.), by O. Warburg; "Monographieen afrikanischer Pflanzen-Familien und Gattungen: IV. Combretaccæ excl. Combretum," by A. Engler and L. Diels; "Genera Siphonogamarum ad Systema Englerianum Conscripta" (Fasciculus i.), by Drs. C. G. de Dalla Torre and H. Harms; and "Conspectus florae graecae" (Fasciculus i.), by E. de Halacsy. In addition to these publications of the house of Engelmann, we have received from the firm of Gebrüder Borntraeger, Berlin, the first part of the first volume of "Die mikroskopische Analyse der Drogenpulver," an atlas for chemists and druggists, by Dr. Ludwig Koch. We propose to review these works when they have been completed.

THE question as to the origin of the energy possessed by the Becquerel rays is one of considerable interest. The existence of substances capable of emitting radiations possessing energy, without any appreciable loss of weight or introduction of work from external sources, would appear to be impossible from the view of conservation of energy. The measurements of M. Henri Becquerel upon the deviation of the radium rays in an electric field, taken in conjunction with those of M. and Mme. Curie of the charges carried by these rays, lead to results which show a way out of this difficulty, on account of the extreme minuteness of the quantities of energy in question. The calculations of M. Becquerel show that the energy radiated per square centimetre is of the order of one ten-millionth of a watt per second. Hence a loss of weight of about a milligram in a thousand million years would suffice to account for the observed effects, assuming the energy of the radium to be derived from an actual loss of material.

THE detailed study of the hydrocarbon indene has hitherto been hindered by the difficulty of obtaining it in large quantities in a pure state. In the March number of the *Journal* of the Chemical Society, Messrs. Kipping and Hall describe two new syntheses of indene, in which the yields are practically theoretical. Cinnamic acid is the starting point, from which $\alpha$-hydrindone is prepared by methods previously described; the oxime from this is then reduced to $\alpha$-hydrindamine, from which indene can be obtained either by heating the hydrochloride at 250° C., or by preparing the iodide of trimethyl-hydrindamine and submitting this to dry distillation. The indene thus prepared was shown to be identical with that synthesised by Perkin and Révay, and also with indene from coal-tar.

IT is now very generally agreed that the true constitution of the sulphites is represented by the unsymmetrical formula $R.SO_2.OR$, as opposed to the symmetrical $SO.(OR)_2$. One interesting outcome of the former view is that there should be isomeric double sulphites, the one $R.SO_2.OR'$, and the other $R'.SO_2.OR$, and Schwicker and Barth have indicated the existence of such isomers in the case of sodium potassium sulphite. Dr. Fraps, however, in the March number of the *American Chemical Journal*, after carefully repeating these experiments, has been driven to the conclusion that no such isomerism exists in this case. This coincides with the views of Hantzsch, who holds that structural isomerism is unknown in inorganic bodies.

THE additions to the Zoological Society's Gardens during the past week include a Secretary Vulture (*Serpentarius reptilivorus*) from South Africa, presented by Mr. James D. Logan, jun.; a Spanish Blue Magpie (*Cyanopolius cooki*) from Spain, presented by Mr. E. G. B. Meade-Waldo; a Greater Black-backed Gull (*Larus marinus*), European, presented by Mr. H. Clinton Baker; four Marbled Newts (*Molge marmorata*) from Bordeaux, presented by Mr. G. A. Boulenger, F.R.S.

## OUR ASTRONOMICAL COLUMN.

NEW VARIABLE IN ANDROMEDA.—Dr. T. D. Anderson, of Edinburgh, has communicated to the *Astronomische Nachrichten* (Bd. 152, No. 3632) his observations of the variability of a new variable star in the constellation of Andromeda. The coordinates of the star's position are:—

$$\left.\begin{array}{ll} \text{R.A.} = & \text{0h. } 8\cdot5\text{m} \\ \text{Decl.} = & +46^\circ\ 12' \end{array}\right\}(1855.)$$

lying almost exactly on the boundary between Cassiopeia and Andromeda. It is not mentioned in the Bonn *Durchmusterung*, As measured from the comparison stars B.D. +46°·38 (8·5), 40

(9·6) and 48 (9·1), the following are the observed magnitudes of the variable :—

| | | | |
|---|---|---|---|
| 1900. | Jan. 16 | ... | 8·8 |
| | 19 | ... | 8·7 |
| | Feb. 20 | ... | 9·0 |
| | March 14 | ... | 9·5 |

SOLAR ECLIPSES OF THE 20TH CENTURY.—In a reprint from the *Bulletin de la Société Astronomique de France* for November, M. Camille Flammarion brings together the local particulars for the eclipses of the sun which will be visible in Paris during the 20th century. Forty-three eclipses will be visible, but only thirty-three under good observing conditions. Special attention is drawn to the eclipses of April 17, 1912, and August 11, 1999, as although Paris is not included in the path of totality, in each case the central line of eclipse is only a short distance away from the capital. Maps are given of the paths of the shadow for both dates. These are also reproduced in the last number of the *Bulletin* (March).

A BRILLIANT FIREBALL.—On March 28, 8h. 31m., a very large meteor, giving several flashes like vivid lightning, was observed from the south-eastern parts of England. At Bishops Stortford, Herts, the light was so great that it illuminated the country, and three distinct explosions were observed. A sound like that of the roar of a distant cannon followed the disappearance of the meteor, and would indicate that it was 24 miles distant, but this is probably much underestimated. The meteor descended from the constellation Leo in the south. In Berkshire it was seen falling in Virgo, and it flashed out very brilliantly just prior to its disruption. The head of the meteor was very much brighter than Venus, and it travelled rather swiftly. Two vivid flashes were observed here as at Reading, where the terminal point of the flight was noted as being near $\epsilon$ Virginis. At the latter place the phenomenon ended in a cloud of sparks, and for a moment the sky and landscape were flooded in light. At Blackheath the meteor was seen by Mr. Crommelin, of the Greenwich Observatory. He estimated it as three times as brilliant as Venus at her brightest, and describes the terminal point as 1° N. of $\beta$ Leonis. Many reports of this brilliant object are available for discussion, and it will be possible to determine its real path satisfactorily. Many large fireballs are directed in very slow flights from westerly radiants, but in this case the object moved swiftly, and probably had a radiant not far from the star $\epsilon$ in Ursa Major. Its position was over the east coast of Kent, and its height, when it finally burst and disappeared, about 52 miles.

## MODERN EXPLOSIVES.[1]

THE subject of explosives is one which never fails to excite interest even under the most ordinary conditions, doubtless owing to the enormous potentiality of these substances, whilst at the present time more than usual attention is directed to them, it being scarcely possible to read a daily paper without finding some reference to the behaviour of various modern explosives in the theatre of war.

Explosion may be defined as chemical action causing extremely rapid formation of a very great volume of highly expanded gas, this large volume of gas being generally due to the direct liberation by chemical action and the further enormous expansion by the heat generated. Explosion itself may therefore be regarded as extremely rapid combustion, whilst the effect is obtained by the enormous pressure produced owing to the products of combustion occupying probably many thousand times the volume of the original body. The effect of high temperature is seen in the well-known case of explosion of a mixture of hydrogen and oxygen, where if the original mixture and the products of explosion are each measured at the same temperature above the boiling point of water, a less volume of gas (water vapour) is actually found. The explosion can only have been produced by the enormous expansion of this vapour in the first place by the heat of the reaction. Such an explosion when carried out in a closed bomb with the mixed gases under ordinary conditions of measurement produces a pressure of about 240 lbs. to the square inch. A more practical illustration is seen with nitroglycerine, which Nobel found yielded about 1200 times its own volume of gas calculated at ordinary temperatures and pressures, whilst the heat liberated expands the gas to nearly eight times this volume.

Clearly, then, a substance for use as an explosive must be capable of undergoing rapid decomposition or combination with the production of large volumes of gas, and further produce sufficient heat to greatly expand these gases; the ratio of the volume of gases at the moment of explosion to the volume of the original body largely determining the efficiency of the explosive.

Explosives may be divided into two great classes—mechanical mixtures and chemical compounds. In the former the combustible substances are intimately mixed with some oxygen-supplying material, as in the case of gunpowder, where carbon and sulphur are intimately mixed with potassium nitrate; while gun-cotton and nitroglycerine are examples of the latter class, where each molecule of the substance contains the necessary oxygen for the oxidation of the carbon and hydrogen present, the oxygen being in feeble combination with nitrogen. Many explosives are, however, mechanical mixtures of compounds which are themselves explosive, *e.g.* cordite, which is mainly composed of gun-cotton and nitroglycerine.

Two methods are in common use for bringing about explosions—ignition by heat, thus bringing about ordinary but rapid combustion, molecule after molecule undergoing decomposition; and detonation, where the effect is infinitely more rapid than in the first case; in fact, it may be regarded as practically instantaneous. The result may be looked upon as brought about by an initial shock imparted to the explosive by a substance—the detonating material—which is capable of starting decomposition in the adjacent layers of the explosive, thus causing a shock to the next layer and so on with infinite rapidity. That the results are not entirely due to the mechanical energy of the liberated gas particles is shown by the fact that the most powerful explosive is not the most powerful detonator; neither is it entirely due to heat, since wet substances undergo detonation. The probability is that the result is brought about by vibrations of particular velocity which vary for different substances, the decomposition being caused by the conversion of the mechanical force into heat in the explosive, thus bringing about a change in the atomic arrangement of the molecule. According to Sir Frederick Abel's theory of detonation, the vibrations caused by the firing of the detonator are capable of setting up similar vibrations in the explosive, thus determining its almost instantaneous decomposition.

The most common and familiar of explosives is undoubtedly gunpowder, and although for military purposes it has been largely superseded by smokeless powders, yet it has played such an important part in the history of the world during the last few centuries that apart from military uses it is even now of sufficient importance to demand more than a passing notice.

Its origin, although somewhat obscure, was in all probability with the Chinese. Roger Bacon and Berthold Schwartz appear to have rediscovered it in the latter years of the thirteenth and earlier part of the fourteenth centuries. It was undoubtedly used at the battle of Crecy. The mixture then adopted appears to have consisted of equal parts of the three ingredients—sulphur, charcoal and nitre; but some time later the proportions, even now taken for all ordinary purposes, were introduced, namely—

| | |
|---|---|
| Potassium nitrate ... ... ... ... | 75 parts |
| Charcoal ... ... ... ... ... | 15 ,, |
| Sulphur ... ... ... ... ... | 10 ,, |
| | 100 ,, |

Since gunpowder is a mechanical mixture, it is clear that the first aim of the maker must be to obtain perfect incorporation, and necessarily in order to obtain this, the materials must be in a very finely divided state. Moreover, in order that uniformity of effect may be obtained, purity of the original substances, the percentage of moisture present, and the density of the finished powder are of importance.

The weighed quantities of the ingredients are first mixed in gun-metal or copper drums, having blades in the interior capable of working in the opposite direction to that in which the drum itself is travelling. After passing through a sieve, the mixture (green charge) is passed on to the incorporating mills, where it is thoroughly ground under heavy metal rollers, a small quantity of water being added to prevent dust and facilitating incorporation, and during this process the risk of explosion is greater possibly

[1] A lecture delivered at the London Institution on February 12, by Mr. J. S. S. Brame.

than at any other stage in the manufacture. There are usually six mills working in the same building, with partitions between. Over the bed of each mill is a horizontal board, the "flash board," which is connected with a tank of water overhead, the arrangement being such that the upsetting of one tank discharges the contents of the other tanks on to the corresponding mill beds below, so that in the event of an accident the charge is drowned in each case. The "mill-cake" is now broken down between rollers, the "meal" produced being placed in strong oak boxes and subjected to hydraulic pressure, thus increasing its density and hardness, at the same time bringing the ingredients into more intimate contact. After once more breaking down the material (press-cake), the powder only requires special treatment to adapt it for the various purposes for which it is intended.

Within the last half-century an enormous alteration has taken place in artillery, the old smooth-bore cannon, firing a round shot, having gradually given place to heavy rifled cannon, firing cylindrical projectiles and requiring very large powder charges. This has naturally had its influence on the powder used, and modifications have been introduced in two directions—first, alteration in the form of powder, and second, in the proportions of the ingredients. As the heavier guns were introduced, a large grain powder which burned more slowly was adopted, but further increase in the size of the guns led to the introduction of pebble powders, which in some cases consisted of cubes of over an inch side. Such cubes having large available surface evolved the usual gases in greater quantity at the start of the combustion than towards the finish, since the surface became gradually smaller, thus causing extra strain on the gun as the projectile was only just beginning to move. General Rodman, an American officer, introduced prism powder to overcome this difficulty, the charges being built up of perforated hexagonal prisms in which combustion started in the perforations and proceeding, exposed more surface, the prisms finally breaking down into what was virtually a pebble powder.

In order to secure still further control over the pressure, modifications in the proportions of the ingredients became necessary; the diminution of the sulphur and increase of the charcoal causing slower combustion, and moreover the use of charcoal prepared at a low temperature giving the so-called "cocoa-powders."

The products of the combustion of powder and its manner of burning are largely influenced by the pressure, a property well illustrated by the failure of a red-hot platinum wire to ignite a mass of powder in a vacuum, only a few grains actually in contact with the platinum undergoing combustion. The gaseous products obtained are carbon dioxide, carbon monoxide and nitrogen, other products being potassium carbonate, sulphate and sulphide. The calculated gas yield at 0° C. and 760 mm. pressure is 264·6 c.c., whilst Noble and Abel actually obtained by experiment 263·74 c.c., numbers agreeing very closely. At the temperature of explosion this volume is enormously increased.

In 1832, Braconnot found that starch, ligneous fibre and similar substances when treated with strong nitric acid yielded exceedingly combustible substances, and Pelouze in 1838 extended the investigation to cotton and paper. Schönbein announced in 1845 his ability to make an explosive which he termed gun-cotton, and a year later Böttger made a similar announcement, and on a conference being held between these chemists their methods were found to be identical. The method was not disclosed at the time, since it was hoped that the German Government would purchase the secret, but in a very short time several investigators solved the problem, and attempts to make the new explosive commercially were common. Unfortunately the earlier product was unstable, and several disastrous accidents occurred which led to the abandonment of the experiments except in Austria. General von Lenk, who continued experimenting in that country, showed that if sufficient care was taken to ensure complete nitration and to remove all traces of free acid from the finished material, the substance was stable. He introduced a method of manufacture which was improved by Sir Frederick Abel in 1865. The physical character of the cotton fibre is such that it presents every obstacle to the removal of free acid, since it is built up of capillaries, but by reducing these tubes to the shortest possible length, as in Abel's process, the removal of acid is facilitated.

Since water is a product of the reaction of nitric acid on cellulose, the nitric acid would become diluted, forming "collodion cotton" instead of the more highly nitrated gun-cotton, and therefore sulphuric acid is used with the nitric acid to absorb this water, the usual proportions being three parts by weight of sulphuric acid (1·84) to one part by weight of nitric acid (1·52). Cotton waste, which has been picked, cleaned, cut into short lengths and dried, is dipped in 1¼ lb. charges in the acid, removed after five or six minutes, the excess of acid squeezed out, and the cotton placed in cooled earthenware pots for some twenty-four hours for nitration to be completed. The gun-cotton now goes through the lengthy process for removal of all traces of acid, starting with the removal of the greater portion of the acid by a centrifugal extractor, washing in water till no acid taste can be detected, boiling in water till free from action on litmus, reducing to pulp in a hollander, and, finally, the thorough washing of the pulp by more water. If the product now satisfies the tests for purity, sufficient alkali—lime-water, whiting and caustic soda—is added to leave from one to two per cent. in the finished gun-cotton. The pulp is drawn up into a vessel from which it can be run off in measured quantities into moulds fitted with perforated bottoms, the water being drawn off by suction from below, and, finally, a low hydraulic pressure is brought to bear on the semi-solid mass. The blocks are taken to the press-house and submitted to a pressure of some five tons per square inch, after which the finished block will contain from twelve to sixteen per cent of water.

From its chemical reactions gun-cotton must be regarded as an ether of nitric acid, a view first suggested by Béchamp. The point of ignition of the substance has been found to vary considerably, ranging from 136° to 223° C., this difference being probably due to variations in composition. Good gun-cotton usually ignites between 180° and 184°C. The combustion is extremely rapid when fired in loose unconfined masses, so rapid, in fact, that it may be ignited on a heap of gunpowder without affecting the latter. When struck between hard surfaces gun-cotton detonates, but usually only in that portion which is subjected to the blow. The volume of permanent gases evolved by the explosion of gun-cotton, as stated by different observers, has varied greatly. Macnab and Ristori give for nitrocellulose —13·30 per cent. nitrogen—673 c.c. per gram, calculated at 0°C. and 760 mm. Berthelot estimates the pressure developed by the detonation of gun-cotton—sp. gr. 1·1—under constant volume as 24,000 atmospheres or 160 tons per square inch.

Various attempts have been made to adapt gun-cotton for use in guns, but the tendency to create undue pressure led to its abandonment. In 1868, Mr. E. O. Brown, of Woolwich, showed that wet gun-cotton could be detonated by the use of a small charge of dry gun-cotton with a fulminate detonator, and since it can be stored and used in the moist state, it becomes one of the safest explosives for use in submarine mines, torpedoes, &c.

Nitroglycerine is a substance of a similar chemical nature to nitrocellulose, the principles of its formation and purification being very similar, only in this case the materials and product are liquids, this rendering the operations of manufacture and washing much less difficult. The glycerine is sprayed into the acid mixture by compressed air injectors, care being taken that the temperature during nitration does not rise above 30° C. The nitroglycerine formed readily separates from the mixed acids, and being insoluble in cold water, the washing is comparatively simple.

This explosive was discovered by Sobrero in 1847. Nitroglycerine is an oily liquid readily soluble in most organic solvants, but becomes solid at three or four degrees above the freezing point of water, and in this condition is less sensitive. It detonates when heated to 257° C., or by a sudden blow, yielding carbon dioxide, oxygen, nitrogen and water. Being a fluid under ordinary conditions, its uses as an explosive were limited, and Nobel conceived the idea of mixing it with other substances which would act as absorbents, first using charcoal and afterwards an infusorial earth, "kieselguhr," and obtaining what he termed "dynamite."

In 1875, Mr. Alfred Nobel found that "collodion cotton"—soluble gun-cotton—could be converted by treatment with nitroglycerine into a jelly-like mass which was more trustworthy in action than the components alone, and from its nature the substance was christened "blasting gelatine." The discovery is of importance, for it was undoubtedly the stepping-stone from which the well-known explosives ballistite, filite and cordite were reached. In 1888, Nobel took out a patent for a smokeless powder for use in guns, in which these ingredients were adopted with or without the use of retarding agents. The powders of this class are ballistite and filite, the former being in sheets, the latter in threads. Originally camphor was introduced, but its use has been abandoned, a small quantity of aniline taking its place.

Sir Frederick Abel and Prof. Dewar patented in 1889 the use of trinitrocellulose and nitroglycerine, for although, as is well-known, this form of nitrocellulose is not soluble in nitroglycerine, yet by dissolving the bodies in a mutual solvent, perfect incorporation can be attained. Acetone is the solvent used in the preparation of "cordite," and for all ammunition except blank charges a certain proportion of vaseline is also added. The combustion of the powder without vaseline gives products so free from solid or liquid substances that excessive friction of the projectile in the gun causes rapid wearing of the rifling, and it is chiefly to overcome this that the vaseline is introduced, for on explosion a thin film of solid matter is deposited in the gun, and acts as a lubricant.

The proportion of the ingredients are :—

| | |
|---|---|
| Nitroglycerine ... ... ... ... ... | 58 parts. |
| Gun-cotton ... ... ... ... ... | 37 ,, |
| Vaseline ... .. ... ... ... | 5 ,, |

Gun-cotton to be used for cordite is prepared as previously described, but the alkali is omitted, and the mass is not submitted to great pressure, to avoid making it so dense that ready absorption of nitroglycerine would not take place. The nitroglycerine is poured over the dried gun-cotton and first well mixed by hand, afterwards in a kneading machine with the requisite quantity of acetone for 3½ hours. A water jacket is provided, since on mixing the temperature rises. The vaseline is now added, and the kneading continued for a similar period. The cordite paste is first subjected to a preliminary pressing, and is finally forced through a hole of the proper size in a plate either by hand or by hydraulic pressure. The smaller sizes are wound on drums, whilst the larger cordite is cut off in suitable lengths, the drums and cut material being dried at 100° F., thus driving off the remainder of the acetone.

Cordite varies from yellow to dark brown in colour according to its thickness. When ignited it burns with a strong flame, which may be extinguished by a vigorous puff of air. Macnab and Ristori give the yield of permanent gases from English cordite as 647 c.c., containing a much higher per cent. of carbon monoxide than the gases evolved from the old form of powder. Sir Andrew Noble failed in attempts to detonate the substance, and a rifle bullet fired into the mass only caused it to burn quietly.

Lyddite is probably the explosive which has received most notice during the past few months. In 1873, Sprengel, in a paper read before the Chemical Society, stated that "picric acid alone contains a sufficient amount of oxygen to render it, without the help of foreign oxidisers, a powerful explosive when fired with a detonator. Its explosion is almost unaccompanied by smoke."

Picric acid was first prepared by Hausmann in 1878, by treating indigo with nitric acid. It may be made by the direct nitration of phenol (carbolic acid), but a better result is obtained by first dissolving the phenol in sulphuric acid, forming phenol sulphonic acid, which is dissolved in water, and nitrating this compound with nitric acid (1·4). On cooling, the picric acid separates out, and is purified by recrystallisation from hot water, the yellow crystalline product being dried at a temperature not exceeding 100° C.

Picric acid containing as much as 17 per cent. of water can be detonated by a charge of dry picric powder; a thin layer may also be exploded by a blow between metal surfaces, its sensitiveness to shock being greatly increased by warming, for at a temperature just below its melting point a pound weight falling from a height of 14 inches will explode it.

The sensitiveness of picric acid can be reduced by converting the powder into larger masses, this being accomplished either by granulating it with a solution of collodion cotton in ether-alcohol, as in the earlier forms of mélinite, or by fusion, which takes place some twenty degrees above the boiling point of water, and casting directly into the shell, as in lyddite and possibly the mélinite of the present day. In any condition perfect detonation would yield only colourless gaseous products rich in carbon monoxide, but the bursting of a lyddite shell is frequently accompanied by a yellow smoke, probably formed by undecomposed acid in the form of vapour. The shells appear to burst in two distinct ways, in one case giving a sharp powerful explosion with enormous concussion and no yellow smoke, and the other a dull heavy report with the yellow smoke, the two results appearing to be due to perfect decomposition in the first instance, whilst in the second partial decomposition only probably occurs.

Various mixtures of picric acid or its salts, together with some oxidising agent, have been used from time to time, Abel's powder consisting of ammonium picrate, potassium nitrate, and a small quantity of charcoal.

It is impossible to deal with the numerous other explosives which are largely in use in such a survey as this, and therefore attention has been confined to those which play the most active part in modern warfare.

## ANTI-PLAGUE INOCULATIONS.

THE final proof of Chapter iv. of the Indian Plague Commission Report, dealing with Haffkine's anti-plague inoculations, has already been briefly referred to (p. 422); the following are further notes upon its contents :—

The first paragraphs contain a brief review of the history of preventive inoculation, the Commissioners trace it up to Haffkine's anti-cholera inoculations, in which a measured quantity of bacteria of known virulence was used. The next practical extension is stated to be the anti-typhoid inoculations introduced by one of the Commissioners (Prof. Wright), in which dead cultures were used; the first of these inoculations were done in July and August 1896. Next, they say, come in chronological order the experiments of Yersin, Calmette and Borrel, conjointly in 1895, which showed it was possible to confer a certain amount of immunity against plague by injection of dead cultures of plague bacilli. Mr. Haffkine's anti-plague inoculations, the Commissioners say, represent an extension of this system of preventive inoculation to men. That Mr. Haffkine was not indebted to Yersin, Calmette and Borrel, nor to the system of anti-typhoid inoculation, for the suggestion to use dead cultures in his plague prophylactic, is evident from the words used by Mr. Haffkine in his lecture on "Anti-Cholera Inoculation" reported in the *British Medical Journal*, February 11, 1893: "The microbes introduced under the skin do not propagate, but after a certain time they die and disappear. It is the substances which they contain, and which are set free when they die, that act upon the animal organism and confer immunity upon it. It is found that the same result can be obtained if the microbes be killed before inoculation, and if their dead bodies only be injected." Prof. Wright recognises this, for, in his account of the first anti-typhoid inoculations, *Lancet*, September 19, 1896, he says: "I need hardly point out that these anti-cholera inoculations have served as a pattern for the typhoid vaccinations detailed above."

Had the Commissioners quoted Mr. Haffkine's experiments with sterilised cultures of cholera bacilli, the anti-typhoid vaccine and the anti-plague prophylactic of Yersin, Calmette and Borrel, would have been shown to be an extension of Haffkine's own anti-cholera vaccine rather than the other way about, as it would appear from the report.

The report goes on to a very stringent criticism of the method of preparing the prophylactic. A certain proportion of bottles were found to be contaminated. In dealing with large quantities of prophylactic, it is not unlikely that some bottles should become contaminated, possibly by some of the corks not being sterile, as Mr. Haffkine suggests. The fact was not brought before the notice of Mr. Haffkine, but was sprung upon the Commissioners and mentioned in the daily Press at the time, with the evident intent to detract from the value of the prophylactic. The Commissioners investigated the matter, but found no serious results could be traced to such accidental contaminations.

The comparative value of the bacterial sediment and of the supernatant fluid is discussed, and, finally, the method of standardisation.

The process of manufacture is criticised from the point of view of scientific manipulation in a properly equipped laboratory for experiments on a small scale. The Commissioners do not mention the fact that the prophylactic is made on a large scale, as much as 20,000 doses being turned out per day, and this in a laboratory with no proper equipment, and with an insufficient and partially inefficient staff. And now having adversely criticised the theory and methods of the General who is conducting the campaign against plague, one expects to find some radical alteration advised; but no, they turn round and join forces, saying, "We recognise that even though a vaccine which is insufficiently standardised, and which is occasionally contaminated, is from the scientific point of view a very imperfect vaccine, yet judged from the standpoint of practical life, such defects may very well be overlooked if the insufficient standardisation and the occasional contamination of the vaccine have not interfered in a sensible manner with its utility.

"This standpoint, which is indeed the only reasonable standpoint, is the standpoint which has been taken up by Mr. Haffkine in the statement that was handed in by him, and which is published, at his request, in our *Proceedings*."

The second part of the report criticises the statistics of anti-plague inoculations. In their summary, the Commissioners say that inoculation diminishes the number of attacks and diminishes the death-rate among those inoculated, that it does not appear to confer any degree of immunity till a few days have elapsed after inoculation, and that the protection lasts certainly for a considerable number of weeks, and possibly for some months.

They recommend that inoculations under safeguards and conditions stated in the report should be encouraged wherever possible, and in particular among disinfecting staffs and attendants of plague hospitals. C. B. S.

## *EXPERIMENTAL STUDY OF FERTILISATION.*

IN 1898 Prof. Yves Delage made a remarkable experiment.[1] He divided the unfertilised egg of a sea-urchin (*Strongylocentrotus lividus*) under the microscope into two parts—one containing the nucleus and the centrosome, the other simply cytoplasmic. Beside these he placed an intact ovum, and then supplied spermatozoa. Towards these the three objects showed equal "sexual attraction"; all three were fertilised; and all three segmented, the intact ovum most rapidly, the nucleated fragment more slowly, the non-nucleated fragment more slowly still. In one experiment, the development proceeded for three days, during which the intact ovum had become a typical gastrula, the nucleated fragment a smaller gastrula, and the non-nucleated fragment a quasi-gastrula with almost no cavity. In each case the cells showed nuclei. The conclusion was then drawn that *fertilisation and some measure of development may occur in a fragment of ovum without nucleus* or ovocentre, and it was suggested that we have in fertilisation to distinguish two processes:—(*a*) the stimulus given to the ovum by a specially energetic kinoplasm brought in by the spermatozoon, perhaps in its centrosome; and (*b*) the mingling of heritable qualities, or amphimixis. One may also note that the experiment was suggestive in furnishing experimental confirmation of what is generally assumed, that each of the sex-cells is a fully equipped potential individuality. Here we may recall the remarkable experiment of H. E. Ziegler,[2] who divided the just fertilised ovum of a sea-urchin in such a way that each half had one pronucleus, and observed that the half with the male pronucleus segmented and formed a blastula.

In 1899 Delage continued his experiments,[3] and with striking success. Non-nucleated fragments of the ova of a species of *Echinus*, of *Dentalium entale*, and of *Lanice conchilega* were effectively fertilised; they proceeded to develop, and gave rise to plutei, veligers, and trochophores respectively. The terms merogonic fertilisation and merogonic development are suggested to express the remarkable facts observed.

The segmentation of the fertilised non-nucleated fragment was practically normal in the sea-urchin, very irregular in *Dentalium*, less irregular in *Lanice* (the chief irregularity being lack of correspondence between the nuclear and the cytoplasmic divisions), but as the development proceeded some self-regulative process reduced the abnormalities to insignificance. The plutei only differed from the normal in the extreme reduction of the arms; the veligers and trochophores were almost typical. They showed no lack of vitality, and although further development did not occur, the same is usually true of normal larvæ reared in similar conditions.

1 "Embryons sans noyau maternel." *C. R. Ac. Sci. Paris*, cxxvii. (1898), pp. 528–531.
2 "Arch. Entwickelungsmechanik," iv. (1898), pp. 249–293, 2 plates, 3 figs.
3 "Études sur la mérogonie." *Arch. Zool. expér.*, vii. (1899), pp. 383–417, 11 figs. See also *C. R. Ac. Sci. Paris*, cxxix. (1899), pp. 645–648.

As to the limits of possible merogony, Delage got some results which are nothing if not striking. A quarter of a *Dentalium*-ovum was fertilised and segmented; about a fifth of a *Lanice*-ovum was successfully treated; but the *chef d'œuvre* of experimental nicety was seen when 1/37 *of a sea-urchin ovum gave rise to an agile blastula.* Delage has christened his pigmy creations—tetartogonic, pemptogonic, &c.—but he seems to hesitate in regard to that arising from the 1/37, for he puts the title "triacosthedomogonique" in a footnote. That there is a limit to merogony he is convinced, but he will not at present fix it. It seems not inappropriate to recall Marchal's description[1] of the strange behaviour of the ovum of *Encyrtus fuscicollis* (one of the parasitic Hymenoptera), which gives rise to a legion of morulæ, and forms a chain of 50–100 embyros within one elongated amniotic envelope. For practical purposes it is convenient to remember that, just as four lancelet embyros may be got by shaking apart the first four blastomeres, so Delage by cutting a sea-urchin ovum obtains three larvæ from one egg.

The issues involved in these experiments are so serious (biologically) that one is naturally led to consider possible criticisms, which Delage in his candid scientific spirit has himself suggested. It is difficult to refrain from the suspicion that there may have been some mistake somewhere. The best criticism would, of course, be to repeat the experiments; but in default of this, let us briefly consider with the author some of the possibilities of error. (*a*) It may be suggested that the eggs experimented with had been previously fertilised by stray spermatozoa; but Delage's experience has been that the spermatozoa die 24–36 hours after liberation; and the water in which the eggs were placed had stood for three or four days in a stone cistern. Moreover, only in one case was segmentation seen among the eggs from which those experimented upon were taken. (*b*) It may be suggested that the segmentation of the fertilised non-nucleated ovum-fragments was not genuine, but a pathological fragmentation such as is occasionally observed after mechanical or chemical stimulation; but it must be remembered that larvæ were reared, and there were, of course, control observations on non-fertilised fragments. (*c*) It may be suggested that the nucleus was cut in the delicate operations, so that each part had really a portion of nucleus as well as cytoplasm. But it must be remembered that the nucleus is very small and very mobile, and thus runs little chance of being cut; in the clear ova of the sea-urchin it was sometimes seen after the operation in the larger part, only once in the smaller part, never in both. In the other two cases (*Dentalium* and *Lanice*) the opacity of the egg hides the nucleus. Perhaps the best answer is, that in one experiment three embryos were got from one ovum, and that fragments representing 1/10 and 1/37 of the total volume of the egg were also seen to segment. It seems, however, possible still to retort that the operation broke the nucleus and caused a distribution of nucleoplasm into the various fragments before they were quite separated.

What are the conditions of successful merogony? Delage failed with the ova of *Ciona*, *Haliotis*, *Chiton*, *Sabellaria*, &c., and he almost failed with those of *Lanice* until he learned the particular "tour de main" in cutting them. The experiment is not practicable except with eggs which are liberated separately before fertilisation. It usually fails if there is a shell. The ova to be tried by other experimenters should be naked or with a delicate glairy envelope, not too brittle, of firm consistence, and not less than 1/10 mm. in diameter. In all Delage's experiments there was a certain percentage of failure, due perhaps to the inability of the fragments to recover from their wounds, or to a diminution in the viscous substance which surrounds the ovum and keeps its parts together. But, in spite of these failures, the number of merogonic segmentations was generally at least equal to, and sometimes greater than, the number of segmentations among intact ova in similar conditions,—a remarkable fact which leads Delage to the daring suggestion that the absence of the female pronucleus may favour fertilisation. "*The female pronucleus is perhaps useful in securing for the embryo the advantages of amphimixis, but it is not useful in fertilisation nor necessary for the development of the parts of the organism.*"

The preceding paragraphs give the gist of Delage's remarkable experiments, but there are some less secure addenda which deserve notice. He has shown the possibility of merogonic hybridisation; he observed phenomena which point to a

1 *C. R. Ac. Sci. Paris*, cxxxvi. (1898), pp. 662–664. *Ann. Nat. Hist.* ii. pp. 28–30.

distinction between cytoplasmic and nuclear maturation; he reared a merogonic sea-urchin larva whose cells had the normal number (18) of chromosomes, although the spermatozoon-nucleus (the only one in this case) imported (it is presumed) but half that number. The last fact leads him to conclude that the number of chromosomes is a specific property of the cell.

Although Delage's experiments stand at present alone as regards the method pursued, there have been of late a number of experimental studies on fertilisation, all of which present points of great interest. From among these we select those of Prof. Jacques Loeb,[1] as it seems of particular importance that his results should be collated with those of Delage.

Loeb finds that the mixture of about 50 per cent. of $\frac{10}{8}$ *n* $MgCl_2$ with about 50 per cent. of sea-water is able to bring about (in the eggs of the sea-urchin *Arbacia*) the same result as the entrance of a spermatozoon. After being subjected to this mixture for about two hours, the eggs were returned to normal sea-water, wherein many developed, forming blastulæ, gastrulæ and plutei. Fewer eggs developed than in natural conditions, and the development was slow, but otherwise the results were normal. The author believes that the only reason why the eggs of this sea-urchin and of other marine animals do not usually develop parthenogenetically is the presence or absence of ions of sodium, calcium, potassium and magnesium. The two former require to be reduced, the two latter to be increased.

"*The unfertilised egg of the sea-urchin contains all the essential elements for the production of a perfect pluteus.*" All the spermatozoon *needs* to carry into the egg for the process of fertilisation are ions to supplement the lack of favourable ions, or to counteract the effects of the other class of ions in the sea-water, or both. "The spermatozoon *may*, however, carry in addition a number of enzymes or other material. But *the ions and not the nucleins in the spermatozoon are essential to the process of fertilisation.*"

It is interesting to observe that while Delage's experiments go to show that the nucleus of the sea-urchin ovum is not essential to development, Loeb's experiments go to show that the spermatozoon may (with intact ova) be dispensed with. What is now needed is a combination of the two modes of experiment.

J. A. T.

## CHANGES OF COLOUR OF PRAWNS.

IT has long been known that the very numerous varieties of the prawn *Hippolyte* (*Virbius*) *varians* reflect, each after its kind, the colour of the weed or zoophyte to which they cling, and on which they find both food and shelter. A few naturalists, after noting this striking case of "protective resemblance," have detached some of the more brilliantly coloured specimens for the purpose of making a detailed subsequent examination. When they came to do this they found that the vivid brown and other tints had in the interval largely faded, or were replaced by others. This discovery has no doubt been made independently time after time, and has given point and emphasis to the essentially variable character of this prawn. Not only do individuals differ from each other, but any one of them is capable of altering its characteristic tint.

Thus, at the time when Keeble and Gamble began their observations,[2] *Hippolyte varians* was known to change colour, but while one author stated that a sympathetic colour-change was rapidly effected, as well in the dark as in the light, when weed of a new tint was introduced; another affirmed that even in the light the change was slow and did not always agree with the colour of the new weed. Yet a third author stated that darkness by itself has a distinct reddening effect. The only definite conclusion to be drawn from these curiously conflicting statements was that *Hippolyte* offered a fine field for research, and that though a few strollers had here and there plucked an ear or two of corn, there was a fine harvest still to be gathered.

After two years' work on the coasts of Lancashire and of Normandy, Keeble and Gamble have come to the conclusion that three kinds of colour-change may be distinguished in *Hippolyte*.

[1] On the nature of the process of fertilisation and the artificial production of normal larvæ (plutei) from the unfertilised eggs of the sea-urchin. (*Amer. Journ. Physiol.* iii. (1899), pp. 135-138.)

[2] "The Colour-Physiology of *Hippolyte varians.*" By F. W. Keeble, Caius College, Cambridge, and F. W. Gamble, Owens College, Manchester. Read before the Royal Society on November 23, 1899.

I. First, a periodic and rhythmic cycle of change composed of a diurnal and a nocturnal phase of colour. Towards evening a decided red tinge—a sunset glow—makes its appearance, and this ushers in the nocturnal change. A green tinge ensues, which spreads fore and aft from the middle of the body. Presently this green colour gives place to an azure-blue colour, which is the characteristic nocturnal tint, and is accompanied by a greatly heightened transparency in the tissues. Under natural conditions this colour-phase persists until daybreak. At the first touch of dawn it disappears, and that of the previous day is gradually reassumed.

More striking even than the distinctive colours is the periodicity of the nocturnal and diurnal phases. Thus, in constant darkness a nocturne (that is, a prawn in the nocturnal colour-phase) recovers to its diurnal colour. In constant light, a diurnal form passes over to the nightly phase. Though light often induces, and induces with marvellous rapidity, a recovery from the nocturnal colour to that of the previous day, yet it is often powerless to overcome the habit of the animal. The periodicity is only worn down in the course of two or three days.

It follows that since the colour of *Hippolyte* is a function of the time of day, that time must be taken into account in an investigation on the colours of Crustacea.

II. The second kind of colour-change is the susceptibility of *Hippolyte* to changes of light-intensity. Although the periodic habit of the prawn is the hitherto unknown and yet dominant factor, yet its force is greatest at the times of the assumption of the nocturnal phase, and the resumption of the diurnal tint. At other times external conditions may modify the colour of the animal to a large extent, and the chief agent in the production of these modified colours is the varying amount of light reflected from or scattered by, surrounding objects.

An almost black prawn changed in a few minutes, after being placed in a white porcelain, to a transparent and colourless condition. Further, a ready and almost infallible means of producing green prawns is to place them just after their capture in a white jar, and cover the mouth of the vessel with muslin. Under these circumstances the change—from brown to green, for example—takes place in from thirty seconds to one minute.

Speaking generally, exposure to a low light-intensity during the day favours an expansion of the red pigment, and so produces brown or even reddish effects. Hence, probably the red colour of these prawns at sunset; while an increase in the amount of light, especially if scattered from a white smooth surface, produces a green effect by expanding the blue and yellow pigment and causing the red to contract.

III. The third change differs chiefly from the second in its rate of progress. It is the very slow sympathetic colour-change which ensues when adult prawns, taken from a food-plant of one colour, are placed with the weed of a new colour. Thus, if green *Hippolyte* be placed with brown weed, and the light-intensity maintained unaltered, as far as possible in comparison with the light-conditions of its former habitat, the prawns will retain their green colour even for a week or more, but in the end give way and become brown. Their subsequent recovery when placed with green weed is more rapid. Keeble and Gamble have repeated such experiments time after time in the open, and under as natural conditions as possible, and found that the prawns were either quite refractory or responded in this slow manner. Yet these same specimens, as each evening drew on, underwent the colour-changes culminating in the nocturnal hue with the greatest readiness, and recovered as quickly the next morning to the tint of the previous day.

The great difficulty in ascertaining whether *Hippolyte* responds to change in the colour of its surroundings by a sympathetic change of its own bodily tints is now clear. It lies in their marvellous sensitiveness to changes of light-intensity, as apart from colour, and is increased by the dominant and periodic colour-changes which subvene night and morning. If it were possible to eliminate these two factors, then we might be able to detect the response of *Hippolyte* to colour or change of colour *per se*; in fact, Keeble and Gamble have made an attempt. By the use of colour-screens, based on the instruments used by Landolt and other workers, the prawns are subjected to red, green and blue light, and also a width of a spectrum from the red to the green. The results of these experiments are curious. They show that even when the light transmitted by the screen, and falling on the prawns, is high (the incandescent lamp and a mirror being used to effect this), yet that with red, green and blue light the colour of the animal becomes more or less rapidly of the nocturnal tint, and the tissues acquire the characteristic transparency. Further, that if these screens be employed all night the prawns do not recover so soon the next morning as do those which are simultaneously exposed to the same source of light in open white dishes. Without attempting to fully explain this effect of monochromatic light, Keeble and Gamble conclude that the prawns do not respond to light of any colour in virtue of its specific wave-length, and that in so far a colour-sense cannot be demonstrated.

Other experiments, however, show that under natural conditions *Hippolyte varians* has the power of choosing from a mixed quantity of weed that one on which it naturally occurs, and with which it agrees in colour. This power of choice is, however, very erratically exhibited. Nevertheless, it would appear to be the chief means of safety should the prawn be violently washed away from its usual habitat.

The colour-changes in *Hippolyte* are largely, if not entirely, controlled by the nervous system. That the eyes are not essential to the daily rhythmic colour-cycle is shown by the fact that blinded prawns nocturne and recover as completely as normal ones, but more slowly and somewhat more erratically. The periodicity does not reside in the eyes and optic ganglia. It is a function of the rest of the nervous system. That the eye is a most important auxiliary in modifying the control of the central system cannot be doubted; but it cannot be supposed that the light, acting through the eye, differentiates such stimuli as to cause each colour-variety to show, as in a mirror, the pattern of its weed. There must be local control, and this, under the strong central organisation, seems to be the efficient force.

The paper closes by a note on the response of the chromatophores of the *zoea*-larva of *Hippolyte.* These colour-elements develop before the time of hatching, and occur, chiefly in pairs, symmetrically throughout the body. Changes of light-intensity, such as alternately placing the larvæ on a black and then a white ground, are rapidly followed by changes in the pigments. In the former case, the yellow-green pigment expands; in the latter, it contracts and the red pigment spreads out. So far as the observations went, these larvæ did not exhibit a blue nocturnal colour phase, and further investigation, upon which the authors are engaged, will have to decide at what period in the life-history periodicity sets in; whether there is a particular phase in development during which the young prawn is specially sensitive to the colour of its surroundings; and if at that time its diurnal colour becomes relatively fixed, as the animal grows into these surroundings.

## *NATURE STUDY IN RURAL SCHOOLS.*

EVERYONE who is familiar with the work of our Education Department knows that the Inspectors are given explicit instructions to discountenance the unintelligent teaching of science, and to do everything in their power to encourage the observation and study of natural objects and phenomena. The "object lessons," which are given in the lower standards, are intended to lead the pupils to use their eyes and compare one thing with another; and though they have become in some schools of too detailed a character to develop the faculties of observation and reasoning, the fault is chiefly due to the fact that many teachers are not observers of nature themselves, and are therefore unable to describe natural things except in the language of the text-book. Every effort has, however, been made by the Education Department to show teachers that this is not the kind of teaching intended to be given as object lessons. Several circulars have been issued containing instructions as to what should be done, and the new Board of Education has shown sympathy with the work of arousing interest in nature by issuing a circular, from which the following extracts have been taken, to managers and teachers of rural elementary schools. The issue of this document by Sir G. W. Kekewich at the very commencement of the work of the Board of which he is the secretary, may, we trust, be taken as an indication that increased attention is to be given to the teaching of scientific subjects in elementary schools:—

The Board would deprecate the idea of giving in rural elementary schools any professional training in practical agriculture, but they think that teachers should lose no opportunity of giving their scholars an intelligent knowledge of the surroundings of ordinary rural life and of showing them how to observe the processes of nature for themselves. One of the main objects of the teacher should be to develop in every boy and girl that habit of inquiry and research so natural to children; they should be encouraged to ask their own questions about the simple phenomena of nature which they see around them, and themselves to search for flowers, plants, insects, and other objects to illustrate the lessons which they have learnt with their teacher.

The Board consider it, moreover, highly desirable that the natural activities of children should be turned to useful account —that their eyes, for example, should be trained to recognise plants and insects that are useful or injurious (as the case may be) to the agriculturist, that their hands should be trained to some of the practical dexterities of rural life, and not merely to the use of pen and pencil, and that they should be taught, when circumstances permit, how to handle the simpler tools that are used in the garden or on the farm, before their school life over.

The Board are of opinion that one valuable means of evoking interest in country life is to select for the object-lessons of the lower standards subjects that have a connection with the daily surroundings of the children, and that these lessons should lay the foundation of a somewhat more comprehensive teaching of a similar kind in the upper standards. But these object-lessons must not be, as is too often the case, mere repetitions of descriptions from text-books, nor a mechanical interchange of set questions and answers between teacher and class. To be of any real use in stimulating the intelligence, the object-lessons should be the practising ground for observation and inference, and they should be constantly illustrated by simple experiments and practical work in which the children can take part, and which they can repeat for themselves at home with their own hands. Specimens of such courses can be obtained on application to the Board of Education. These may be varied indefinitely to suit the needs of particular districts. They are meant to be typical and suggestive, and teachers, it is hoped, will frame others at their discretion. Further, these lessons are enhanced in value if they are connected with other subjects of study. The object-lesson, for example, and the drawing lesson may often be associated together, and the children should be taught to draw actual objects of graduated difficulty, and not merely to work from copies. In this way, they will gain a much more real knowledge of common implements, fruits, leaves, and insects than if these had been merely described by the teacher or read about in a lesson-book. Composition exercises may also be given—after the practical experiments and observations have been made—for the purpose of training the children to express in words both what they have seen and the inferences which they draw from what they have seen; and the children should be frequently required and helped to describe in their exercise books sights of familiar occurrence in the woods and in the fields. Problems in arithmetic connected with rural life may also be frequently set with advantage.

The Board of Education also attach considerable importance to the work being done by the elder scholars outside the school walls, whether such work takes the form of elementary mensuration, of making sketch plans of the playground and the district surrounding the school, of drawing common objects, ponds, farms, and other suitable places under the guidance of the teacher, or of the cultivation of a school garden.

The teacher should as occasion offers take the children out of doors for school walks at the various seasons of the year, and give simple lessons on the spot about animals in the fields and farmyards, about ploughing and sowing, about fruit trees and forest trees, about birds, insects and flowers, and other objects of interest. The lessons thus learnt out of doors can be afterwards carried forward in the schoolroom by reading, composition, pictures, and drawing.

In this way, and in various other ways that teachers will discover for themselves, children who are brought up in village schools will learn to understand what they see about them, and to take an intelligent interest in the various processes of nature. This sort of teaching will, it is hoped, directly tend to foster in the children a genuine love for the country and for country pursuits.

It is confidently expected that the child's intelligence will be so quickened by the kind of training that is here suggested that he will be able to master, with far greater ease than before, the ordinary subjects of the school curriculum.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

AN association of American Universities has been formed for the purpose of considering matters of common interest relating to graduate study. The association includes most of the leading universities of the United States.

IT has already been announced that a school of forestry is about to be established at Yale University. We now learn from *Science* that, at a meeting of the corporation on March 16, a gift of 150,000 dollars for this purpose was acknowledged. Mr. Henry S. Graves, assistant in the Division of Forestry, U.S. Department of Agriculture, has been appointed professor of forestry.

SIR GEORGE W. KEKEWICH, K.C.B., has been appointed Secretary of the Board of Education, which came into existence on April 1. A circular letter has been issued stating that in future all communications relating to elementary education should be addressed to the Secretary, Board of Education, Whitehall, London, S.W., and letters concerning science, art, and technical education should be addressed to the Secretary, Board of Education, South Kensington, London, S.W.

As the subjects which should form part of elementary education in rural districts have recently been much under discussion, it is of interest to call attention to a chapter on methods of instruction in agriculture, included in vol. ii. of the Report of the U.S. Commissioner of Education, for 1897–98. The chapter includes reprints of leaflets illustrating the educational work done at the Cornell Agricultural Experiment Station, and at Purdue University. The volume also includes reports of U.S. Consuls on school gardens and gardeners' schools in Russia.

THE Cambridge Summer Meeting will be held on August 2–15, and August 15–27. Among the lectures to be delivered in the section on scientific progress are the following: *Physical Science.*—The development of the nebular theory in the nineteenth century, by Sir Robert Ball, F.R.S.; the spectroscope in astronomy, by Mr. Arthur Berry; the wave-theory of light, by Sir George Stokes, Bart., F.R.S.; advances in the science of electricity, by Prof. J. J. Thomson, F.R.S.; the conservation of energy, by Prof. J. A. Ewing, F.R.S.; chemistry and its applications, by Mr. M. M. Pattison Muir; electro-chemical methods, by Mr. D. J. Carnegie. *Biological Science.*—The theory of evolution and its influence on thought and research, under arrangement; researches on the brain, by Dr. Alex. Hill. There will also be lectures on some aspects of advance in the following sciences:—geology, by Prof. T. McK. Hughes, F.R.S.; anthropology, by Prof. A. Macalister, F.R.S.; agriculture, by Prof. W. Somerville; bacteriology, by Prof. Sims Woodhead. Mr. H. Yule Oldham will give a lecture on geographical exploration in the nineteenth century; Prof. W. M. Davis, of Harvard, U.S.A., will give six lectures on the study of the development of land forms. The study of special points in the following departments will be undertaken in sectional meetings:—chemistry and physics, under the direction of Mr. A. W. Clayden; evolution, under the direction of Mr. F. W. Keeble, Mr. C. Warburton, and others; anthropology, under the direction of Prof. A. C. Haddon, F.R.S. There will in addition be arranged, primarily for teachers, practical courses in chemistry and geography.

THE Passmore Edwards Museum in the Romford-road, Stratford, is now approaching completion, and arrangements for the opening will shortly be made. The museum has been built and furnished by the Council of the County Borough of West Ham at a cost of about 9000*l.*, of which 4000*l.* was the gift of Mr. Passmore Edwards. The main portion of the museum will be devoted to the Essex Museum of Natural History, belonging to the Essex Field Club, which is deposited in the building under agreement between the club and the Borough Council. The remainder of the building will be used as an educational museum in connection with the adjoining Municipal Technical Institute. The scientific control of the Essex Field Club collections remains with the club, and they contribute 50*l.* a year towards the curatorial expenses, the council contributing 100*l.* a year. The club appoints the curator. At their meeting on March 27, the council resolved to set aside annually out of the Estate Duty Grant the sum of 1000*l.* for museum purposes. It is expected that from 500. to 600*l.* of this will be needed for the up-keep and maintenance charges, the balance being placed to the credit of a museum purchase fund, which will be treated as a capital fund, from which payments may be made from time to time for the purchase of objects and of the necessary cases, &c., in which to exhibit them. The Essex Field Club have appointed Mr. W. Cole as curator of their Natural History collections. The building itself and the educational collections of the council are under the charge of the principal of the Technical Institute, Mr. A. E. Briscoe.

## SCIENTIFIC SERIALS.

*Bulletin of the American Mathematical Society*, February.—The opening articles respectively give abstracts of the proceedings and papers read at the sixth annual meeting, at New York, December 28, 1899, by Prof. F. N. Cole, and at the sixth semi-annual meeting, at Chicago, December 28 and 29, 1899, by Prof. T. F. Holgate.—On cyclical quartic surfaces in space of $n$ dimensions, by Dr. V. Snyder, was read at the first of the above meetings. The method employed is a generalisation of that first employed by Darboux, using Lie's more general co-ordinates. For $n = 2$ (bicircular quartic curves) reference is made to memoirs by Casey, Darboux, Cox, Loria and others, where the curves have been discussed from a different point of view, and for $n = 3$ (cyclides) reference is again made to Casey, and to Maxwell, Cayley, Darboux, Reye, Loria, Bôcher and others. In the case of $n = 4$, the number of distinct types is 58, and of $n$ = higher numbers, the number of types has not been determined.—At the same meeting, Prof. H. Taber read a paper on the singular transformations of groups generated by infinitesimal transformations, and Prof. Dickson gave a proof of the existence of the Galois field of order $p^r$ for every integer $r$ and prime number $p$. Existence proofs have been given by Serret (*Alg. Sup.* vol. 2) and by Jordan (*Traité des Substit.* pp. 16, 17). The developments used by Serret are lengthy, and the short proof by Jordan assumes with Galois the existence of imaginary roots of an irreducible congruence modulo $p$. The present proof proceeds by induction. Assuming the existence of the GF[$p^n$], it derives that of the GF[$p^{nq}$], $q$ being an arbitrary prime number. Since the GF[$p$] exists, being the field of integers taken modulo $p$, it follows that the GF[$p^q$] exists, and by a simple induction that the GF[$p^r$] exists for $r$ arbitrary.—Dr. Lovett contributes a lengthy review of the "Leçons nouvelles sur l'analyse infinitésimale et ses applications géométriques" of Ch. Méray (1st part, 1894; 2nd part, 1895; 3rd part, 1897; and 4th part, 1898).—Varied information of interest to mathematicians occupies the "Notes" and "New Publications."

*Annalen der Physik*, No. 2.—Solubility of carbonic acid in alcohol between $-67°$ and $+45°$, by C. Bohr. The absorption of carbonic acid in alcohol increases rapidly at low temperatures. The coefficient is 1·97 at 47°, 4·46 at zero, and 39·4 at $-65°$. The coefficient of evasion at zero is 0·524, and the coefficient of invasion 2·375.—Specific heats of metals, alloys and graphite at low temperatures, by U. Behn. This paper deals with the specific heats of antimony, tin, cadmium, silver, zinc and magnesium, brass, graphite and three tin-lead alloys. Of these, only graphite and magnesium show a very considerable fall of specific heat down towards the temperature of liquid air. Many of the curves are probably parabolic, and concave towards the axis of temperatures.—Heat of sublimation of carbonic acid, and heat of evaporation of air, by U. Behn. The former is 142·4 calories, and the latter 50·8 calories.—A vacuum electroscope, by H. Pflaum. By exhausting a gold-leaf electroscope to such a degree that no vacuum discharge was able to traverse it, the author proved that an extreme vacuum is a perfect insulator, and that electrostatic forces act across it with great intensity.—The experimental basis of Exner's theory of atmospheric electricity, by G. Schwalbe. The author has made further experiments to show that a vapour arising from an electrified liquid is incapable of conveying away any of the charge. He explains the contrary results obtained by Pellat, on the ground of loose particles adhering to the vessels used. Solid particles are capable of conveying away the charge. Exner's theory of atmospheric electricity, as derived from the evaporation of natural bodies of water, is not confirmed.—Discharge of statical electricity from points, by H. Sieveking.—Negative electricity begins to be discharged from a point at a lower potential than positive electricity, and the quantity discharged is also greater. Positive electricity is chiefly discharged along the axis of the point. Gases may be arranged in accordance with their capacity of encouraging the radiation of negative electricity. Oxygen is at the top of the series, and carbonic acid at the bottom.—Reflective power of metals and glazed mirrors, by E. Hagen and H. Rubens. The authors study the reflecting powers of silver, platinum, nickel, steel, gold and copper for the various parts of the visible spectrum. They also test various speculum metals. That of Brandes and Schünemann has a reflecting power of only 50 per cent., but is eminently durable. It consists of 41 parts copper, 26 nickel, 24 tin, 8 iron and 1 antimony. Mach's aluminium-magnesium alloys have the highest reflective power.—Electrostatic effects in connection with vacuum discharges, by J. Stark. When a continuous current is sent through a vacuum tube, and matters are so regulated that the discharge is only just able to pass, the current becomes a periodic one. The kathode is set into a state of vibration, and gives a musical note. The vibrations are due to the periodical attractions of the charges on the wall of the tube.

## *SOCIETIES AND ACADEMIES.*

### LONDON.

**Royal Society**, December 7.—"*Polytremacis* and the Ancestry of Helioporidæ." By Prof. J. W. Gregory, D.Sc. Communicated by Prof. Ray Lankester, F.R.S.

The Blue Coral, *Heliopora caerulea* (Pall.) is one of the most isolated of living animals. It is the only known species of its genus, and it has recently been described as the only member of its family. Some Palæozoic corals have a very similar structure; but the view that these extinct Heliolitids are allied to the Helioporids is strongly opposed by some eminent palæontologists. If these authorities be right, then *Heliopora* is an animal with no close living relations and with no known ancestors. The only fossil that has been regarded with any probability as a possible link between *Heliopora* and the extinct Heliolitidæ is the Cretaceous coral *Polytremacis*. This genus was founded by d'Orbigny in 1849, but unfortunately its affinities and structures are still in doubt.

In preparing a description of a new species of *Heliopora* from Somaliland, the author was led to examine the material in the British Museum collection. The results seem to confirm the old view of the affinity between the Heliolitidæ and the Helioporidæ, by showing that *Polytremacis* is truly intermediate between the two families. In that case *Polytremacis* is of considerable phylogenetic interest as an ancestor of *Heliopora*.

**Linnean Society**, March 15.—Mr. G. M. Murray, F.R.S., in the chair.—Prof. Farmer exhibited (as lantern-slides) several photographs of dissections of flowers, and made remarks on the utility of such illustrations for teaching purposes.—Mr. R. A. Rolfe exhibited specimens and drawings of *Paphiopedilum*, both of species and hybrids, with their capsules, to illustrate remarks on the hybridisation of orchids —Mr. I. H. Burkill gave an abstract of a report on the botanical results of an expedition to Mount Roraima, in British Guiana, undertaken in 1898 by Messrs. F. V. McConnell and J. J. Quelch. Acknowledged authorities on plant-geography had considered it probable that the vegetation of the summit of Mount Roraima, when better known, would compare well with that on the Paramos of Venezuela; but this was not the case. The characteristics of the treeless Paramos were absent from Roraima; and *Bonnetia Roraimae*—the commonest of species on the summit—attained, where sheltered, a height of forty feet. Lower than the Paramos on the slopes of the Andes was the *Befaria* zone, and to this the upper flora of the mountain was to be ascribed, the rest of the vegetation being of a Brazilian type. Many of the plants collected were of anatomical interest; the huge mucilage-cells of the leaf of *Bonnetia Roraimae* and the quaint pitchers of some of the *Utriculariae* were especially noteworthy. The complex chain of mountains to which Roraima belongs includes other peaks of similar height, such as Duida over the Upper Orinoco; but in this direction the chain terminates with the low-lying forests of the Casiquiare, which has barred immigration from the higher Andes. The additions to botanical knowledge now made by Messrs. McConnell and Quelch might be said to emphasise the remarkable similarity which had been found to exist in the floras of Roraima and the Kaieteur Savannah.

**Zoological Society**, March 20.—Dr. W. Blanford, F.R.S., Vice-President, in the chair.—Prof. F. Jeffrey Bell exhibited a collection of Land-Planarians made by Dr. Goeldi in Brazil. This, like many other collections of Land-Planarians, had been confided to Prof. Graff for description, and some of the specimens were the types of new species described by that author in his magnificent monograph on these animals. The collection before the Society had been sent to Mr. Sclater with the request that he would deposit it in the British Museum, where it would be a valuable and welcome addition to the already good collection in that institution.—Mr. G. A. Boulenger, F.R.S., exhibited a specimen of *Polypterus lapradii*, Steindachner, with large external gills, recently brought home from the Senegal by M. P. Delhez. The fish measured 390 millimetres, and was therefore the largest on record in which this larval character had been retained. In connection with this interesting example, Mr. Boulenger also exhibited a full-grown female of the Common Newt (*Molge vulgaris*), from the environs of Vienna, bearing well-developed external gills.—Mr. S. L. Hinde read a series of field-notes on the mammals which he had met with during five years' residence in East Africa, and illustrated with lantern-slides from photographs of the animals taken in their native surroundings. Some of the points specially dwelt upon were the preservation of game-animals in East Africa, and the possibility of the acclimatisation of East African animals in the British Isles.—Mr. W. Bateson, F.R.S, exhibited a specimen of an Isopodous crustacean, *Asellus aquaticus*, in which one of the antennules was replaced by a well-formed mandible. The case was to be regarded as an instance of Homœosis, or the transformation of one organ into the likeness of another with which it is in serial homology.—A communication was read from Mr F. P. Bedford on the Echinoderms collected by himself and Mr. W. F. Lanchester in Singapore and Malacca.—Mr. F. E. Blaauw gave an account of the Zoological Garden of Berlin and of the progress which it had made under the management of the last three Directors—Dr. Bodinus, Dr. Max Schmidt and Dr. L. Heck.

**Royal Meteorological Society**, March 21.—Dr. C. Theodore Williams, President, in the chair.—Reference was made to the loss which the Society had sustained by the death of Mr. G. J. Symons, F.R.S., and a note of condolence with his relatives was passed by the meeting.—Twenty-seven new fellows were elected, as well as two honorary members, viz. M. Albert Lancaster, Director of the Belgian Meteorological Service, Brussels, and General M. A. Rykatcheff, Director of the Central Physical Observatory, St. Petersburg.—The following papers were read:—The ether sunshine recorder, by Mr. W. H. Dines.—Remarks on the weather conditions of the steamship track between Fiji and Hawaii, by Captain W. W. C. Hepworth.—Comparison by means of dots, by Mr. A. B. MacDowall.

### PARIS.

**Academy of Sciences**, March 26.—M. Maurice Lévy in the chair.—Deviation of the radiations of radium in an electric field, by M. Henri Becquerel. Previous experiments on the behaviour of that portion of the radium rays deviable in the magnetic field showed that this part of the radiation had the greatest analogy with the kathode rays. To demonstrate the complete identity of these two kinds of rays, it was necessary to establish the existence for the rays from radium either of a transport of a negative charge or a deviation in an electric field. M. and Mme. Curie have recently proved the existence of the former property, and in the present paper experimental proof is given of the latter.—On apparatus in fused quartz, by M. Armand Gautier. Remarking on the paper of M. Dufour in the last issue of the *Comptes rendus*, M. Gautier recalls that he used tubes and spirals of quartz in 1869. In conjunction with M. Moissan, the author attempted, unsuccessfully, to prepare quartz connecting tubes for the fluorine apparatus.—On the transformation of fat into glycogen in the organism, by MM. Ch. Bouchard and A. Desgrez. In previous papers, it has been shown that a person receiving no food may gain as much as 40 grams in an hour, a gain for which it is only possible to account by assuming an absorption of oxygen above that required for the formation of respiratory carbon dioxide. The hypothesis was put forward that this increase of weight is due to an incomplete oxidation of fat, probably to glycogen. The experiments now given show that it is the muscular, and not the hepatic glycogen which arises from the incomplete oxidation of fats.—M. Hittorf was elected a correspondant for the section of physics in the place of the late M. Wiedemann.—Remarks on an earthquake at Batavia on September 30, 1899, by the French Consul at Batavia.—On surfaces for which the lines of curvature of a system are equal, by M. A. Demoulin.—Remark on a note of M. A. Korn, entitled "On the method of Neumann and the problem of Dirichlet," by M. W. Stekloff.—On the liquefaction of mixtures of carbon dioxide and sulphur dioxide, by M. F. Caubet. Eight gas mixtures of varying composition were studied. The results are exhibited in the form of curves.—Limited chemical reactions in homogeneous systems. The law of moduli, by M. A. Ponsot.—On the selenide of zinc and its dimorphism, by M. Fronzes-Diacon. Since blende occurs both in hexagonal and cubical forms, and the selenide of zinc obtained by M. Margottet belonged to the cubic system, the author attempted to prepare an hexagonal form. The crystals obtained by the interaction of zinc chloride vapours and hydrogen selenide diluted with nitrogen belonged to the hexagonal system.—On the hydrated peroxides of barium, by M. de Forcrand. A thermochemical paper.—A new compound of antipyrin with mercuric chloride, by MM. J. Ville and Ch. Astre. The compounds obtained are of the type $2(C_{11}H_{12}N_2O).HgR_2.HR$, where R represents the halogen.—On the constitution of isolauronic acid, by M. G. Blanc.—On the combination of basic with acid colouring matters, by M. A. Seyewetz.—On the law of separation of hybrids, by M. Hugo de Vries. The experimental results given are wholly covered by the following law: if D be the grains of pollen or ovules having a dominant character, and R those which have a retrograde character, the number and nature of the hybrids is represented by the formula

$$(D+R)(D+R)=D^2+2DR+R^2,$$

in which D and R are equal; that is to say, there will be 25 per cent. of D, 50 per cent of DR, and 25 per cent. of R.—Concerning the contradictory results of M. Raphaël Dubois and M. Vines on the supposed digestion in Nepenthes, by M. E. Couvreur. The assumption of a proteolytic ferment in such carnivorous plants as the Nepenthes is unnecessary, and the author upholds the correctness of the views of Dubois as against those of Vines.—On the foldings of the Paris basin, by M. Munier-Chalmas.—Characteristics of a specimen of petroleum shale from the Megalong Valley, by M. Eg. Bertrand. A comparison of the microscopical appearances of the Blackheath and Megalong Valley shales.—Comparative estimation of alcohol in the blood of mother and fœtus and in the milk after the ingestion of alcohol. Remarks on the estimation of alcohol in blood and in milk, by M. Maurice Nicloux. The ingested alcohol passes from the mother to the fœtus and is also present in the milk. The proportions of alcohol in the blood of mother and fœtus are practically identical.—The absorption of iodides by the human skin, by M. F. Gallard. The arms and hands were immersed in the solution, and the iodine estimated in the urine.—On the comparison of the barometric movements (at latitude 50° of Greenwich meridian) caused by the movements in declination of the sun and moon, by M. A. Poincaré.

## DIARY OF SOCIETIES.

*THURSDAY*, APRIL 5.

ROYAL SOCIETY, at 4.30.—On the Weight of Hydrogen desiccated by Liquid Air: Lord Rayleigh, F.R.S.—Combinatorial Analysis: The Foundations of a New Theory: Major MacMahon, F.R.S.—Über Reihen auf der Convergenzgrenze: Dr. E. Lasker.—Extinct Mammalia from Madagascar. I. *Megaladapis insignis*, sp. n.: Dr. C. I. Forsyth Major.—The Kinetic Theory of Planetary Atmospheres, Part I.: Prof. Bryan, F.R.S.—Observations on the Effect of Desiccation of Albumin upon its Coagulability: Prof. J. B. Farmer.

ROYAL INSTITUTION, at 3.—Equatorial East Africa and Mount Kenya: H. J. Mackinder.

MATHEMATICAL SOCIETY, at 5.30.—The Orthoptic Loci of Curves of a Given Class: A. B. Basset, F.R.S.—On Weierstrass's Canonical Reduction of a "Scharr" of Bilinear Forms: T. J. Bromwich.—Communications by Prof. Burnside, F.R.S., and Prof. Love, F.R.S.

LINNEAN SOCIETY, at 8.—*Sphenophyllum* and its Allies, an Extinct Division of the Vascular Cryptogams: Dr. D. H. Scott, F.R.S.

CHEMICAL SOCIETY, at 8.—(1) The Liquefaction of a Gas by "Self-Cooling": A Lecture Experiment; (2) Note on Partially Miscible Aqueous Inorganic Solutions: G. S. Newth.—The Decomposition of Chlorates. II. Lead Chlorate: W. H. Sodeau.—The Interaction of Mesityl Oxide and Ethyl Sodiomethylmalonate: A. W. Crossley.—The Bromination of Benzeneazophenol: J. T. Hewitt and W. G. Aston.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

RÖNTGEN SOCIETY, at 8.—The Influence of the X Rays upon the Growth and Development of Micro organisms: Dr. Norris Wolfenden and Dr. Forbes Ross.

INSTITUTION OF NAVAL ARCHITECTS (Society of Arts), at 12.—On Large Cargo Steamers: Prof. J. H. Biles.—The Practical Results of some Innovations in Modern Shipbuilding: A. B. Wortley.—The Strength of Elliptical Sections under Fluid Pressure: Captain G. W. Hovgaard.—On Yacht Measurements, together with some Remarks on the Action of Sails: H. C. Vogt.——At 7.—On the Balancing of Steam-Engines: Herr Otto Schlick.—The Engines of the Corvette *Jeneral Baquedané*: M. Sandison.—On the Uniformity of Turning Moments of Marine Engines: Prof. Lorenz.

*FRIDAY*, APRIL 6.

ROYAL INSTITUTION, at 9.—Solid Hydrogen: Prof. J. Dewar, F.R.S.

GEOLOGISTS' ASSOCIATION, at 8.—Zonal Features of the Kentish Chalk-Pits between London and the Medway Valley: G. E. Dibley.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Experiments on Struts with and without Lateral Loading: H. E. Wimperis.

MALACOLOGICAL SOCIETY, at 8.—On the Genus *Acavus*: (*a*) from an Anatomical Standpoint: W. B. Randles; (*b*) from a Conchological Standpoint: E. R. Sykes.—Description of a New *Bulimulus* from Parana, Brazil: J. Cosmo Melvill.—Anatomical Notes on *Neptuneopsis gilchristi*, Sowerby, and *Volutilithes abyssicola*, Adams and Reeve: M. F. Woodward.

INSTITUTION OF NAVAL ARCHITECTS, at 12.—The Pressure on an Inclined Plane, with Special Reference to Balanced Rudders: Prof. H. S. Hele-Shaw, F.R.S.—On the Action of Bilge Keels: Prof. G. H. Bryan, F.R.S.—On the Influence of Depth of Water on the Resistance of Ships: Major Giuseppe Rota.——At 7.—On Mysterious Fractures of Steel Shafts: Signor Roberto Schanzer.—Corrosion and Failure of Propeller Shafts: A. Scott Younger.

*SATURDAY*, APRIL 7.

ROYAL INSTITUTION, at 3.—Polarised Light: Lord Rayleigh.

*MONDAY*, APRIL 9.

VICTORIA INSTITUTE, at 4.30.—Egyptian Chronology: Rev. Dr. F. A. Walker.

*TUESDAY*, APRIL 10.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Development of the Manufacture and Use of Rails in Great Britain: Sir Lowthian Bell, Bart., F.R.S.—The Wear of Steel Rails in Tunnels: Thomas Andrews, F.R.S.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—The Municipal Encouragement of Photography: Thomas Bedding.

*WEDNESDAY*, APRIL 11.

ROYAL ASTRONOMICAL SOCIETY, at 8.

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