THURSDAY, JULY 17, 1902.

MECHANICS OF ENGINEERING.

The Mechanics of Engineering. By Prof. A. Jay DuBois, C.E., Ph.D., Yale University. Vol. i., Kinematics, Statics, Kinetics, Statics of Rigid Bodies and of Elastic Solids. Pp. xxxiv + 634. Price 31*s.* 6*d.* Vol. ii. Stresses in Framed Structures and Designing. Pp. xxiii + 609. Price £2 2*s.* (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1902.)

THIS manual forms one of a number of publications which are being prepared by professors and instructors of Yale University and issued in connection with the Bicentennial Anniversary.

Dealing first with vol. i., the first 400 pages of the book, about two-thirds of the whole, are devoted to what may be considered as the preliminary work of developing the principles of the mechanics of solids. In substance this part corresponds with the author's treatise on the "Elementary Principles of Mechanics," published in three volumes, entitled "Kinematics," "Statics" and "Kinetics." The treatment is mainly analytical, graphical methods being reserved for the later chapters, in which the practical application of the principles is dealt with, and for the second volume.

In the section dealing with the fundamental and derived units of measurement, the author rightly insists on the importance of constantly keeping in mind the dimensions of the various quantities, and of checking equations from time to time by inserting the dimensions and applying the principle of homogeneity.

The old difficulty as to the use of the same word *pound* to denote both mass and force is partially overcome by writing lb. when mass is referred to, and pound when force is meant. There is thus a distinction to the eye if not to the ear. This convention, however, is not adhered to in the latter parts of the work.

In the development of the subject the reader is constantly reminded of the very useful fact that the various directed quantities which appear are vectors, and follow the vector law. But we think it would have tended to increased clearness of view if the author had brought into greater prominence the distinction between vectors the representative lines of which have different degrees of freedom, or, as they have been named, between unlocalised vectors, vectors localised in lines, and vectors which are localised at points.

The author's fundamental definition of a vector as a directed quantity merely, with the frequent inference that any quantity which has magnitude and direction is a vector and therefore obeys the vector laws, is open to criticism. The reader will find that its application to the resolution and composition of angular displacements on pp. 58 to 60 is not very clear or convincing. Stated in this form it is liable to lead to slips like the one we notice on p. 186:—

"If a rigid body has angular acceleration about an axis through its centre of mass, the resultant is a force couple in a plane at right angles to this axis. And conversely," &c.

In the chapter on central forces the author touches on planetary motions and on harmonic motion. The latter might with advantage be treated more fully in any subsequent edition, considered from the vector point of view, and with some reference to Fourier's theorem.

In treating of friction, only the simple approximate laws of solid friction are considered. Academic calculations are made as to the action and efficiencies of machines like the wheel and axle, the different systems of pulleys, the screw, &c. Some useful lessons, not revealed in the treatise under review, would be learnt by any student who had the opportunity of putting the results of these calculations to the test by actual experiments in a laboratory.

In the chapter on impact there are some practical observations on pile driving and on the limiting pressures which may be put on pile and earth foundations.

The section on the development of principles is brought to a close by a discussion of the action of the gyroscope and spinning top, and the statement of the equations of motion of a rigid body in their general form.

In the part dealing with the practical applications of principles, the subject-matter treats mainly of questions specially interesting to the civil engineer. This is naturally to be expected, having regard to the position and qualifications of the author.

There are two short chapters relating to framed structures and bending moments, evidently curtailed in anticipation of vol. ii. Then follows an interesting discussion on masonry structures, dealing with earth and water pressures, and including the design of masonry dams and retaining walls.

The closing section of the volume, comprising about 150 pages, relates to the "Statics of Elastic Solids," and deals with the design of such details as ties, riveted joints, pins and eye-bars, shafts, beams, springs and long columns; and the first volume concludes with an application of the principle of least work to the swing bridge, the metal arch, the stone arch and the suspension bridge.

The discussion of the theory of elasticity is meagre and disappointing. The various formulæ are established without giving the reader any clear insight with regard to the assumptions made and to the consequent limitations to the practical applications of the formulæ that are obtained. Consequently there is a tendency to interpret the results of the calculations as if they had the same certainty as demonstrations in geometry, and sometimes the proof given is quite illusory. For instance, the investigations on pp. 509 to 511 on the strengths of shafts need thorough revision. The work of St. Venant in regard to the torsion of shafts of other than circular section is entirely ignored. The formula $\frac{M}{I} = \frac{f}{r}$, applicable to circular shafts only, is taken as if it were true for all forms of section, and is actually applied to square and rectangular shafts. As another example of misleading theory, we think the working of example 3, p. 491, relating to a plate girder, should be entirely recast.

In other portions of the subject the author is more happy. He applies the method of strain energy and the principle of least work to framed metal arches, in a manner readily lending itself to cases of travelling loads. He also investigates temperature stresses in the two-hinged and the continuous arch. We think he is right

in also applying the same methods and principles to stone arches and to stiffened suspension bridges, and that the results so obtained are probably more to be depended on than corresponding results by older writers based on other assumptions. However, in structures of this class, liable to be self-strained, and with important factors necessarily omitted or only roughly guessed at in any estimate of the straining actions, we should not be inclined to set the same value on the results of the calculations that the author seems to attach to them. The remarks made on p. 519, in reference to calculations for a four-leg table, probably apply largely to this case, and indicate the more appropriate attitude of mind in regard to the value to be assigned to the results.

Whilst pointing out that much of vol. i. will seem inadequate to an English engineer, we are glad to draw attention to the large number of practical examples scattered throughout its pages, and in many cases fully worked out. In fact, many students might refer to these with advantage, although they will have to look elsewhere for a more thorough discussion of the principles involved.

The second volume consists of the author's well-known treatise on "Stresses in Framed Structures," eleven editions of which have already appeared, the present revised edition being the first under the new title. Some of the subject-matter of vol. i. is repeated in vol. ii., so as to make the latter complete in itself.

Students and engineers on this side of the Atlantic who are interested in bridge building will wish to possess this volume, in which modern American practice is very fully dealt with. In developing the subject, the author gives numerous examples of the design and construction of details, worked out numerically and profusely illustrated by diagrams and drawings. Towards the end, the author quotes a standard specification for bridge work, in compliance with which he works out in detail a complete design of a typical structure, giving all the calculations, and accompanying the discussion by plates comprising a full set of working drawings.

The volume concludes wish special chapters by experts on shop drawings, office work and inspection; on the erection of bridges; and on lofty commercial buildings, in th construction of which steel enters largely.

SURFACE-FEEDING DUCKS.

The Natural History of the British Surface-feeding Ducks. By J. G. Millais, F.Z.S. Pp. xiv + 107. With 6 Photogravures, 41 Coloured Plates, and 25 other illustrations. (London: Longmans, Green and Co., 1902.) Price 6 guineas net.

THE first feeling of a reader on closing Mr. Millais's "Natural History of the Surface-feeding Ducks" will be surprise that one individual—though naturalist, sportsman and artist in one, and blessed, as the author has been from boyhood, with exceptional opportunities—should have been able single-handed to collect direct from Nature so much new and interesting information about familiar birds.

The next will be, perhaps, a touch of regret that it should have been given to the public in a form and at a price (six guineas net) which must limit its readers to the favoured few who have broad bookshelves and substantial balances at their bankers, or who may be living within reach of rich libraries.

But the tyranny of custom has decreed that a monograph of bird or beast, if it is to take rank as a serious contribution to scientific literature, must dress up to the part, and appear in the form and type of a family Bible; and Mr. Millais, prudently no doubt, has judged it wise not to fly in the face of the conventionalities.

The result is a richly illustrated and beautifully got-up quarto volume weighing nearly nine pounds—about as much as a couple and a half of well-fed mallard—describing the life and changes of plumage of seven species of ducks more or less common in England, with pictures and shorter notices of three others which, as rare occasional visitors, have been admitted to the list of British birds. Mr. Millais has much that is interesting to tell of the courtships and varying habits of feeding of the ducks he writes about; of their contrivances for escaping the notice of birds of prey; and of their every-day life.

But it is to the wonderful plumage changes during the period of the drake's "eclipse," when at a time of helplessness he assumes the inconspicuous dress of his mate, that he has more especially devoted his attention. The conclusions he has arrived at add another to the marvels which every fresh discovery in natural history has revealed.

Birds, as everyone knows, periodically renew their feathers, some oftener than others; but all, or nearly all, probably at least once a year. As a rule—though often when undergoing the change they mope and show otherwise signs of the need of a tonic—the moult is effected without seriously incapacitating them. Geese and most kinds of ducks are an exception, and, at least in the case of the males, for a time commonly completely lose the power of flight. Why this should be so, science has never yet been able to suggest. But it is, incidentally, where the birds most congregate, of immense advantage to human beings. It is during the moult that the Samoyedes, without much more exertion than is involved in driving sheep into a pen, lay in their most important winter stores.

The most interesting chapters in Mr. Trevor Battye's "Icebound in Kolguev" are those in which he describes the great autumn goose drives in which he took part, when the birds, unapproachable at any other time, were knocked on the head by thousands to be salted down for future consumption.

Nature has been a little more pitiful to the ducks than to the geese, and for their protection has arranged that, during the week or two that the duck is practically flightless, he shall doff his conspicuous colouring, and masquerade in the unobtrusive dress of the female. In the case of the mallard, the colour even of the legs and beak is changed.

Nature in most of her processes works economically. In the matter of the drake's "eclipse" she is reckless. The strain put on the bird's system, for no other apparent reason than to avoid startling contrasts and produce the desired results gradually, is almost incredible.

Two-thirds of the mallard's feathers (viz. those of the head, neck, breast and parts of the back and scapulars),

writes Mr. Millais, as the results of close observation, "between June 15 and October 10, undergo *a double moult*, that is to say, the feathers are actually shed twice, whilst one-third (viz. the long scapulars, wings, tail and back feathers) are renewed only once, and during all the time, both in the shedding of the old feathers and the assumption of the new, there is a process of constant sympathetic change of colour."

Mr. Millais has something even more strange to tell.

"I am convinced," he writes, "that a bird has full power to command the moult as it will, and also"—stranger still—"to infuse or withhold colouring matter as it thinks necessary."

The Lord of creation "cannot make one hair black or white."

His conclusions, startling as they may be, are those of a thoughtful and observant man who has conscientiously devoted many years to a close study of a fascinating subject.

It is not, as a rule, until the drake has completely assumed the duck's brown dress, harmonising as it does with the colour of the dying reeds, that the quills are shed. The operation is got through without an hour's waste of time. "I have known them" (Mr. Millais must speak for himself again) "all come out together in one day, the new flush starting at once."

The duck has others to think of besides herself. If she, like her mate, were to be deprived of flight-power, it would often be at the risk of her brood, and so her wing feathers are shed, like those of most birds, gradually, and she seldom, if ever, quite loses the use of her wings. If she has a second brood to look after, and is thus occupied later than usual with family cares, even this comparatively harmless wing moult is postponed for a more convenient season—as Mr. Millais believes, if we read him rightly—by a direct action of will on her part.

It is a wonderful story, but nothing in Nature is incredible merely because incomprehensible.

Mr. Millais has a very simple answer to a question which has puzzled many others than scientific naturalists. When ducks and other birds which usually nest on the ground change their habits, as they often do, and lay in trees, how do the young ones—*nidifugae* who leave the nest as soon as they are hatched—manage to get down?

At the mother's call, he says, they throw themselves down and alight unhurt. The explanation is good so far as it goes, and may, not improbably, be in most cases true. But it would be rash to accept it as of universal application.

Three young birds found dead at the foot of a tree in a park in Sussex led this spring to the discovery of a moorhen's nest at a very considerable height from the ground. The young birds were all well nourished and had been apparently killed by the fall.

Woodcocks have been more than once seen by trustworthy witnesses in the act of carrying their young, and there is no reason to suppose that ducks and other birds cannot on occasion as easily do the same.

There are many other directions in which, if space permitted, it would be pleasant to follow Mr. Millais's lead. But enough has, perhaps, been said already to show that his book is original and very interesting. The pictures are all excellent. Among the most interesting is the pencil sketch by the author, facing p. 60, of the beak of a shoveller, with its strange spoonbill tip and the hanging bristles, in which—as in a sieve, or in the great mouth-fringes of the whalebone whale, to compare small things with large—dainty morsels are trapped as the bird skims the water as he paddles about with extended neck.

"Here" (the quotation is from the note attached to the sketch) "we see a wonderful provision of Nature. The comb-like teeth or *laminae* of the surface-feeding ducks are developed in proportion to the extent to which the particular species feed on the surface or otherwise. An omnivorous and somewhat coarse feeder like the mallard only possesses them in a very rudimentary form, whereas the shoveller, which is constantly skimming the surface for fine substances, has them greatly developed in both upper and lower mandibles."

Mr. Thorburn contributes eight full-sized coloured plates. He is still, among English bird-artists, an easy first. But in some of his pictures, notably Plates xxx. and xxxvii., garganeys chasing water-beetles, and the pintails, Mr. Millais has run him close.

The only fault to be found with a beautiful book is that in choosing his subjects for illustration the author has, perhaps, ridden his hobby "Eclipse" a little too hard.

The best work, excepting in the case of the few rare visitors figured, which are, strictly speaking, scarcely British, is confined almost entirely to birds in immature or transitional plumage. In a book of natural history, destined to take a well-earned place for some years to come as the standard work on our surface-feeding ducks, a few plates might with advantage have been spared, if only as a sop to unscientific bird-lovers, for ducks and drakes at their best. T. DIGBY PIGOTT.

A FRENCH TEXT-BOOK OF ZOOLOGY.

Traité de Zoologie Concrète. Par Yves Delage et Edgard Hérouard. Tome ii., 2me Partie, Les Cœlentérés. Pp. x + 848. (Paris: Libraire C. Reinwald, 1901.)

THE volumes of the "Traité de Zoologie Concrète" already published are so well known and have been so acceptable to zoologists that the present volume, dealing with the Cœlenterata, scarcely requires any recommendation. While it leaves little to be desired in such important matters as abundance and excellence of illustrations, bibliography, index and glossary, the chief merit of the "Traité de Zoologie Concrète" must be attributed to the logical and systematic method of exposition adopted by its authors. The majority of zoological text-books, following the German model, give a brief and insufficient definition of each class or order of the animal kingdom, and this is succeeded by a discussion of the organology and embryology of the class or order that is generally so diffuse as to leave the student in a state of hopeless uncertainty as to what are the characteristic structural features of the group in question. Recognising the importance of fixing clear and definite ideas of structural relations in the student's mind, MM. Yves Delage and Hérouard have adopted the time-honoured plan of illustrating the anatomy of each important group of animals by a description of a morphological type, which

serves as a standard to which all the other members of the group may be referred. The method is familiar enough, but has fallen into discredit because previous authors have made too little use of it and have confined themselves to the description of one or two animals as examples of a large class, whence it has resulted that students have too frequently formed narrow conceptions of animal structure and have underestimated the wide range of variation of which animals belonging to the same class are capable. The "Traité de Zoologie Concrète" has the merit of having avoided this error by describing a morphological type, not only for each class or subclass, but also for each order, suborder, and even for each tribe. Thus a general description is given of the morphological type of the order Octanthida (Alcyonaria); Kophobelemnon is taken as a type of the suborder Pennatulidæ; Renilla, Umbellula, Kophobelemnon, Pennatula and Gœndul are taken as the morphological types of the five tribes into which the Pennatulidæ are divided, and a sufficient description of the families and genera included in the tribe follows the description of each type. This system is consistently adopted throughout the work, and as the types are illustrated by well-designed schematic drawings, the essential characters of all the subgroups are brought in the clearest possible manner before the mind.

The book gives evidence of a minute acquaintance with zoological literature, and the numerous illustrations are largely copied from treatises of a recent date. In the latter respect, the volume on the Cœlenterata is considerably in advance of other text-books, for it is only too frequently the case that old and sometimes obsolete illustrations are copied from book to book, while more recent work is ignored.

The classification adopted does not depart widely from accepted lines. The Cœlenterata are divided into two branches, Cnidarea and Ctenarea, the latter being co-extensive with the Ctenophora. Though some authors would separate the Ctenophora from the Cœlenterata on the ground that they have an embryonic mesoblast, MM. Delage and Hérouard give sufficient reasons for retaining them in the phylum in which they have so long been classed.

The Cnidarea are divided into two classes, Hydrozoaria and Scyphozoaria, the former including all the forms usually classed under Hydrozoa, except the Scyphozoa, which have been placed along with the Anthozoa in the class Scyphozoaria. The union of these two groups is a step in advance, abundantly justified by recent anatomical and embryological researches. In the class Hydrozoa it is noticeable that the Siphonophora are raised to the rank of a subclass, the other subclass, Hydrophora, including the Hydridæ, the Hydromedusæ, the Trachymedusæ and Narcomedusæ. The grounds for this distinction are probably sufficient, but it is open to question whether the classification of the Siphonophora adopted in this work is an improvement on that of Hæckel, and one cannot but regret that the authors' love of symmetry or their anxiety to satisfy the claims of priority should have led them to abandon well-known and generally accepted names for others which are unfamiliar. For example, the order Chondrophorida sounds strange to most ears; the name is due to Chamisso, but has never come into general use, and that of Disconectæ is preferable because better known. Again, in the Scyphozoaria the name Octanthidæ, derived from the Octactinia of Ehrenberg, is preferred to Alcyonaria, though the latter is in general use and there is no good reason for abandoning it. The name Actinanthidæ, again, is substituted for Zoantharia, without sufficient reason, and the classification of the order is open to many objections. It scarcely seems consistent to class Edwardsia and Tealia under the Hexactinidæ, though the authors justify the inclusion of the former genus because of Faurot's discovery of micromesenteries completing the first cycle of six pairs in certain species. The division of madreporarian corals into Hexacorallidæ and Tetracorallidæ is quite unjustifiable in the present state of our knowledge, and in spite of their sharp criticism of Miss Ogilvie's work on the microscopic characters of the corallum (p. 602), the authors might have given her the credit of having demonstrated the unity of structure in recent and so-called rugose or tetracorallid corals. Indeed, they are open to the charge of inconsistency in this respect, for they have borrowed largely from her figures and adopted her possibly erroneous views on the mode of formation of the corallum, but have refused to accept some of her most important and well-grounded conclusions. It is scarcely possible, at the present time, to retain the groups Aporina and Porina (Aporosa and Perforata of Milne-Edwards), though it must be confessed that no acceptable alternative has been offered, and MM. Delage and Hérouard, while retaining a discredited classification, give a very good summary of the various schemes that have been proposed by different authors.

Knowing the previous writings of M. Delage, one is not surprised to find that, in discussing the origin of atolls and barrier-reefs, he takes the opportunity of making a double attack on the Darwinian theories of the formation of coral reefs and natural selection. It is to be regretted that he allows himself to write so dogmatically on these subjects, for it is by no means the case that the theory of natural selection has been abandoned by zoologists in general as a "hypothèse séduisante," attractive but inadmissible. He would seem to have overlooked the school of statistical zoologists, whose work, so far as it has gone, has done much to strengthen the opinion that natural selection is by far the most potent factor in the evolution of species. Finally, when the complete results of the boring at Funafuti are published, M. Delage will probably be obliged to admit that the great English naturalist was not far wrong also in his speculations on the origin of atolls and barrier reefs.

G. C. BOURNE.

WAVES AND SOUND.

Wellenlehre und Schall. Von W. C. L. van Schaik. Translated into German by Dr. Hugo Fenkner. Pp. xi+358. (Brunswick: F. Vieweg and Sohn, 1902.) Price Mk. 8.

NO portion of physics is more difficult to treat in an elementary way than that of sound; the consequence is that though advanced treatises of magnificent quality exist, an elementary text-book in English which

is less severe than these, but which is something more than a mere description of acoustic phenomena, is still a desideratum. Where attempts have been made to supply the want the result is not successful, owing chiefly to the clumsy methods employed in "getting round" the calculus. We are not upholders of the doctrine that the calculus should be "got round"; it is much better, we think, to "get through" it. Experience in teaching others has taught us that pupils find no difficulty in grasping its elements, and this is the case whether they are taught analytically or geometrically. Why then should we seek to devise elaborate methods of eluding the calculus—methods which in most cases we would never think of employing ourselves, and which, moreover, are usually only adapted to the particular problem for which they are devised—when a straightforward introduction to the methods we use ourselves would clear the ground and render the student's progress easy, and enable him the sooner to be his own path-finder instead of needing to rely on the guidance of others?

The book under review cannot supply this want in England, for it is a translation into German (from the Dutch); the substance of the book is in the above respect, however, entirely to our mind.

No calculus is employed in name; but the notion of it is everywhere. Velocity is the limiting value of a ratio and so is acceleration, and their values are found by the usual direct methods employed in proving the initial theorems of the calculus. We would have gone a step further and given the process a name, in order to suggest to the student to what branch of mathematics these and similar theorems belong. But the notion is the main thing. There is nothing here which a man will discard at a future time, having learnt a better way; though he will, of course, learn to abbreviate the logical statements of the process into the mere symbols dx/dt and d^2x/dt^2.

Without making a full analysis, the following subjects dealt with may be briefly stated:—In the mathematical treatment: simple harmonic motion—waves and their composition, with a proof of all the simple theorems.

Fourier's theorem is given, but not proved; it is illustrated, however. The dynamical equation to simple harmonic motion is given, and the motion deduced by showing that it satisfies the equation. Even the case of a restoring force involving second as well as first power of displacement is given, on account of its importance in connection with the Helmholtz theory of the production of combination tones. The equation to damped motion is treated as an article for faith; its properties, however, are lucidly described.

Although the experimental phenomena are mainly collected together, the mathematical portion is not wholly free from experimental illustration. For example, we specially note a device which should be found useful for illustrating the behaviour of forced oscillations with different degrees of damping.

Perhaps the most interesting section is that dealing with the interference and diffraction of waves. This might be amplified by an account of recent experiments imitative of Lloyd's mirror and diffraction from two apertures (Young's experiment); and, in particular, an account of Rayleigh's brilliant application of the principles of diffraction in *restricting* the spreading of sound to one plane by suitably shaping the aperture of the fog horns employed in coast signals would form an excellent additional illustration.

The last chapter is concerned with movements of air in pipes, concluding with an account of the secondary motions usually developed, such as the small striations in the cork figures in a Kundt's tube, which were investigated by Walther König and others (König is mentioned without being discriminated from R. König). These are highly interesting, though many will no doubt consider them rather out of place in an elementary book.

There is no mention of Rücker's important experiments in connection with combination tones.

OUR BOOK SHELF.

Malarial Fever, its Cause, Prevention and Treatment. Containing full Details for the use of Travellers, Sportsmen, Soldiers, and Residents in Malarious Places. By Ronald Ross, F.R.S., Walter Myers Lecturer in the Liverpool School of Tropical Medicine. Ninth edition, revised and enlarged. Pp. 68. (London: Published for the University Press of Liverpool by Longmans, Green and Co., 1902.) Price 2*s.* 6*d.*

THIS little book is an enlargement of a previous work by the same author, and should prove of the utmost use to those for whom it is written. The exact knowledge concerning the epidemiology of malaria which has been attained during the last six or seven years has made clear the principles upon which the disease may be prevented in the individual and perhaps exterminated in the locality. The wide dissemination of these principles and of the facts upon which they are based is the next obvious step in the campaign against malaria, and the Liverpool School of Tropical Medicine has done good service in the publication of this work. Within the short compass of some seventy pages we find a lucid and succinct account of the nature and life-history of the malarial parasite, of the habits and life-histories of the gnats which serve as its definitive hosts, of the precautions to be taken to avoid infection, and of the elementary treatment of the disease should it be acquired. In short, nothing is wanting that should enable an intelligent man, even if devoid of any scientific training, to escape malaria, even where it is most virulently endemic. The writer's wide experience, and the important share which he has taken in building up our knowledge of the disease and its propagation, are a sufficient guarantee of the accuracy of his information and of the practical value of his rules for guidance. There is a consensus of practical experience that, by attention to the rules here set forth, a man may safely pass through countries where malaria of the most dangerous type prevails. We recommend the book heartily to all who have occasion to sojourn in such lands.

Velocity Diagrams. Their Construction and Uses. Intended for all who are interested in Mechanical Movements. By Prof. C. W. MacCord, A.M., Sc.D. Pp. iii + 116; 83 figures. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1902.) Price 1.50 dollars.

IN this book some examples of plane motions of machines are worked out. The title well describes the scope and contents of the work and the very modest aims of the author.

The main problem to which the discussion is directed is:—Given a skeleton drawing of a mechanism and the speed of the driving point, to find graphically the corresponding speed of the driven point, and to show the latter all throughout the cycle by means of a rectangular

curve of speed plotted on a time base. The author believes that this curve exhibits the kinematic action of the machine more clearly and directly than any other form of diagram.

Beginning with the composition and resolution of velocities, it is shown how the constraints of slides, pivots and rigidly connected points affect the ordinary rules for vectors, and one or two simple special rules are established. These are applied systematically to selected mechanisms such as pruning shears, quick return motions, direct-acting and oscillating cylinder engines, epicyclic trains of wheels, the pilgrim-step motion, &c., until the reader becomes quite familiar with the process.

No attempt is made to give more than a cursory and very limited account of the plane motions of mechanisms, consequently many important theorems and constructions of a general nature find no place. Simple harmonic motions, and harmonic analysis, often so useful, are not considered. Acceleration is only incidentally referred to in showing how an acceleration-time curve can be determined graphically from a velocity-time curve. The author has evidently imposed severe restrictions as to the amount of ground to be covered. But so far as the subject is dealt with, the methods and demonstrations are very clear and convincing, and the diagrams are well drawn and beautifully printed.

Spiderland. By Rose Haig Thomas. Pp. viii + 227. (London: Grant Richards, 1902.) Price 5*s*.

THIS is a charming little book, based on the authoress's original observations on a variety of animals and plants, and cast into a poetic form likely to interest children in natural history. It is dedicated as follows:—"To my Son, whose wondering child-eyes first taught me to look deeper into the workings of Nature, and to all the Children I know and shall never know, I dedicate these simple tales." As we remarked when reviewing elsewhere the first edition, printed for the author in 1898, which comprised only the first twelve tales, whereas twelve more are added in the present edition, the book reminds us of the "Episodes of Insect Life," on the one hand, and Mrs. Gatty's "Parables from Nature" on the other. The mode of treatment resembles that of the former book, and the general style the latter. A great variety of subjects are dealt with, and only one or two of the stories relate to spiders; among others, we note such titles as "The Tree Frogs," "Pistil the Peace-maker" (a more elegant setting of the old fable of the "Stomach and the Limbs"); "Thomisa Citrina, the Robber-Mother"; "The Wedding of the Fly Ophrys"; "The Green Caterpillar" (a study somewhat resembling one of Mrs. Gatty's, but dealing with a more mournful phase of caterpillar life, an ichneumoned caterpillar); "Hymen, the Worker Ant"; "Nimble Nat, the Gay Grasshopper"; "Cocky: a London Love-Tale" (sparrows); "The Romance of the Water Beetle"; "The Lemming," &c. The remarks on the lemming are interesting, and will be new to many readers. Here and there we meet with a trifling oversight; the authoress has travelled in France and Norway, and has forgotten to note that processionary caterpillars are not British; and the auditory organs (hardly "ears") of grasshoppers are situated, not in the hind legs, but in the front legs.

Children are easily interested in natural history and insect life; and a poetical view of some of its phases, such as Mrs. Thomas has here given, is likely to prove more attractive to them than a purely didactic book, like "Uncle Philip's Conversations with Children," which was almost the first book on natural history read to the present writer in his childhood. Naturally, the stories written by Mrs. Thomas are not all of equal merit; but most of them are excellent, and we regret that our space will not allow us to give a sufficiently long quotation to afford a fair idea of the style of her book. W. F. K.

Tuberculosis as a Disease of the Masses, and How to Combat It. By S. A. Knopf, M.D., of New York. Adapted for English use by J. M. Barbour, M.D. Pp. 76; 25 figures. (London: Rebman, Ltd., 1902.) Price 1*s*. net.

IN plain, simple language, devoid of technicalities, Dr. Knopf presents an accurate account of the causes of tuberculosis, some details of the symptoms of a few of its many phases, and indicates the chief hygienic principles which underlie the present-day methods of treatment.

He emphasises the fact that tuberculosis is a contagious and therefore a preventable disease, that the child of a tuberculous mother is not itself necessarily tuberculous, although it frequently acquires the disease—the maternal kisses often being the channel of infection—that man may derive the infection from animals and that he may in turn transmit the disease to them, and above all that *tuberculosis is a curable disease.*

The author fully explains the duty of the consumptive to himself and to his fellows, and points out in no uncertain manner the real danger attendant upon the habit of spitting elsewhere than in a proper receptacle by the subjects of this disease. He also gives much excellent and useful advice with regard to the practice of calisthenics by, and the inculcation of habits of cleanliness in, the young, and the value of fresh air and sunshine as factors in the prevention and cure of tuberculosis, as well as many suggestive hints on the home care of consumptives.

We are not surprised to learn that this essay was awarded the first prize (200*l*.) offered by the "International Congress for the Study of the Best Way to Combat Tuberculosis as a Disease of the Masses," which met at Berlin, and that it has already been published in five languages besides English. It is an excellent treatise, and should be in the hands of every individual, sick or well, who has at heart the physical welfare of his fellow mortals.

The Teacher's Manual of Object Lessons in Geography. By Vincent T. Murché. Pp. xvi + 334. (London: Macmillan and Co., Ltd.) Price 3*s*. 6*d*.

HOW great has been the improvement in methods of teaching during recent years can be measured to some extent by a comparison of newly published books intended for use in public elementary schools with those in circulation twenty years ago. The old implicit reliance on the child's faculty for memorising is fortunately giving place to an appeal to his observation and incipient reasoning powers. Mr. Murché's latest addition to his already extensive series of books on elementary science is marked by his usual clearness of exposition and by that helpfulness for which he is justly highly esteemed by teachers in elementary schools. But the bewildering miscellany of type, with its frequent transitions from Roman to italics and from these to Clarendon and capitals, makes the volume a trying one to read and raises the question of the possibility of such over-emphasis defeating the object in view. It is unfortunate that in explaining volcanic activity the author speaks of "dense volumes of flame and smoke" which "burst out from the crater," and that he instructs the teacher to explain "that ages ago this earth on which we live was a burning mass like the sun." This seems to indicate a want of clearness as to the nature of smoke and burning; it will certainly give the child a wrong idea. But the book should do a great deal to improve the teaching of geography.

William Gilbert of Colchester: a Sketch of his Magnetic Philosophy. By Charles E. Benham. Pp. 96. (Colchester: Benham and Co., 1902.) Price 2*s*. net.

THE immediate occasion of the appearance of this little book is the issue to the subscribers of the Gilbert Club of the English translation of "De Magnete." The author

has attempted, and with real success, to show what manner of man Gilbert was, wherein lay his genius, what were his merits, and what also were his faults and failings. Mr. Benham dwells on the circumstance that, although Gilbert's actual discoveries were few and crude, he must be judged rather by the spirit of his work. "He was not the builder of sciences, but the architect of a truly scientific spirit; and his life-work consisted in the doctrine, new to England, that all scientific knowledge must be founded on practical experiment and observation alone, instead of upon speculations and theories evolved out of inner consciousness." The successive chapters of the book deal with the old magnetic philosophies, magnetic motions and electric force, the magnet's "directive virtue," the variation of the compass, the dip and "orbes of virtue" of the magnet, the life of the Universe (in which Gilbert, although no Manichean, was clearly a believer) and the Copernican theory. The author is particularly happy in his treatment of this last topic; but throughout the analysis of Gilbert's work is accurate and discriminating. The book is illustrated with a picture of Gilbert's terrella, and another of his tombstone in the church of Holy Trinity, Colchester. S. P. T.

The Vocal System based on the Fundamental Laws of Language. By G. Lionel Wright. Pp. 20. (Published by the Author, Upper Belgrave Road, Clifton, Bristol.) Price 1*s.* net.

IT is now recognised that teaching to read is not the simple matter which it was once thought to be. In recent years one system has followed another in rapid succession, and each has claimed in turn that by its introduction the time taken by the child to learn to read the mother tongue was much reduced. There seems to be a chance that these experiments may eventually reduce the difficulty of this first step in human education to a minimum. Mr. Wright proposes to make extensive use of the blackboard and of *vivâ voce* methods of instruction, and to start teaching the child to read by making him learn the five vowels. When this has been accomplished, the learner is introduced, by carefully graduated steps, to certain combinations of vowels and consonants, which are clearly indicated in this brochure, and by following which Mr. Wright claims that children may read at the age of six. A somewhat minute examination of the contents of the pamphlet leads us to think that Mr. Wright would be well advised in making his instructions to the teacher much more detailed and explicit if he is anxious that his system should become widely adopted, for at present the teacher will be, at several points, at a loss to know the next step in the course of work.

The Lake Counties. By W. G. Collingwood. (Dent's County Guides.) Pp. xii + 392; illustrated. (London: J. M. Dent and Co.) Price 4*s.* 6*d.* net.

THIS little volume—the fourth of the series to which it belongs—will be found invaluable to all who visit the Lake District. In addition to being an excellent guide, with a number of itineraries and many maps, it contains four chapters on the natural history of the district, the birds being described by Miss Armitt, the butterflies and moths by Canon Crewdson, the flora by Mr. S. L. Petty, and the geology by Prof. Hull. In the chapters on fox-hunting, angling and shooting, the sportsman will find abundant matter for interest, according to his particular taste. This volume fully maintains the high reputation of its predecessors, and is, in fact, all that a guide should be. Those tourists who wish to go more deeply into the natural history of one of the most interesting and beautiful districts in England will find all they want in the more pretentious volume by the late Mr. Macpherson entitled "Lakeland." R. L.

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.*]

Symbol for Partial Differentiation.

PROF. PERRY'S difficulty (NATURE, May 15, p. 53) is without doubt a real one, and is deserving of serious consideration. In connection therewith the following extract from a paper at present passing through the press may be found interesting, at least on the historical side. It is in reference to a memoir of Jacobi's published in the year 1841 in the twenty-second volume of *Crelle's Journal*:—

"The subject of the notation of differential-quotients is then entered on at some length (pp. 320-323), and the decision made to use ∂ in the manner which soon afterwards came to be familiar. The insufficiency of this notation is not forgotten, however, although its advantages over the different devices of Euler and Lagrange are recognised, his illustrative example being the case of $\partial z/\partial x$ where z is a function of x and u, and u is a function of x and y. He puts the whole matter in a nutshell when he says that it is not enough to specify the function to be operated on and the particular independent variable with respect to which the differentiation is to be performed, but that it is equally necessary to indicate the involved quantities which are to be viewed as constants during the operation."

To this the following footnote is added:—

"I may state in passing that in 1869 when lecturing on the subject I found it very useful to write

$$\phi x, y, z \ , \ \overline{fs, t, u, v} \ , \ \ldots .$$

in place of

$$\phi(x, y, z) \ , \ f(s, t, u, v) \ , \ \ldots .$$

and then indicate the number of times the function had to be differentiated with respect to any one of the variables by writing that number on the opposite side of the vinculum from the said variable; thus

$$\overset{1}{\phi x}, \overset{3}{y}, \overset{2}{z}$$

meant the result of differentiating once with respect to x, thrice with respect to y, and twice with respect to z.

"Using this notation to illustrate Jacobi's example, we see that if it were given that

$$z = \overline{\phi x, u}$$

we should have

$$\partial z/\partial x = \overset{1}{\overline{\phi x, u}} ;$$

but that if it were given that

$$z = \overline{\phi x, u} \quad \text{and} \quad u = \overline{\psi x, y}$$

then we should not be certain as to the meaning of $\partial z/\partial x$, as it would stand for

$$\overset{1}{\overline{\phi x, u}} \text{ or } \overset{1}{\overline{\phi x, u}} + \overset{1}{\overline{\phi x, u}} \cdot \overset{1}{\overline{\psi x, y}}$$

according as u or y was to be considered constant."

Cape Town, S.A., June 5. THOMAS MUIR.

I AM glad to think that a pure mathematician sees the difficulty met with by users of mathematics. I wish that men who write to me privately would publish their remarks. One correspondent says: "I think 'the mathematicians' made a rather stupid blunder when they introduced ∂ for partial differentiation. This way: nearly all differential coefficients *are* partial; even a complete one (assumed complete) may become partial by extension of the field of operation. So an old investigation of Kelvin's, for example, using d throughout, is, by 'the mathematicians,' replaced by the same using ∂ throughout, except one or two here and there! What is the use? It gives a lot of trouble, and as printers haven't always ∂'s, or proper sized ∂'s, it makes bad work. It should have been ∂ itself that was introduced for the exceptional use, thus making next to no alteration in the classical investigations." These are, indeed, my own views, but as my pupils go forward to University examinations I

advise them to adopt the fashion which is likely to please the examiners.

In thermodynamics we cannot easily adopt Mr. Muir's suggestion. Take the simplest case of unit quantity of mere fluid. v, p, t, E and ϕ are such that they are all known if any two (except in certain cases) are known. Any one *may* be expressed as a function of any other two. My symbol $\left(\frac{dE}{dv}\right)_p$ is quite definite. But to adopt Mr. Muir's suggestion I must say:—

Let $E = f(v, p)$ then $f^1(v, p)$ is what my symbol means. Inasmuch as my letters stand for the same quantities irrespective of the letters of which they are functions, I use one letter E where on Mr. Muir's suggestion I must use E as $f(v, p)$ or $F(v, t)$ or $\psi(v, \phi)$ or $\chi(p, t)$ or $\theta(p, \phi)$ or $\xi(t, \phi)$ or six distinct symbols if I have to express any differential coefficient of E, and if I have to express all the differential coefficients of v I must use other six symbols; altogether I must use thirty of these curious symbols instead of five common letters, and, furthermore, I must keep them all in my head. JOHN PERRY.

The First Magnetician.

WHILE thanking you and "R. T. G." for the exceedingly kind appreciation of the Gilbert Club's English translation of "De Magnete" (p. 249), I write to express the wish that the notice had mentioned the names of those who have collaborated in the production of this version. They are the late Mr. Latimer Clark, the late Sir B. W. Richardson, Rev. A. W. Howard, Prof. R. A. Sampson, Dr. Joseph Larmor, Sec. R.S., Prof. Meldola, F.R.S., Mr. Edward Little, Mr. G. T. Dickin and Rev. W. C. Howell. To the last-named a special recognition is due for indefatigable and critical care during the long final revision and press correction.

July 14. SILVANUS P. THOMPSON.

"Fox-shark" or "Thrasher" (Alopecias vulpes) in the English Channel.

ON July 2 a fine specimen of this shark was captured several miles south of the Eddystone Lighthouse by fishermen in search of mackerel. The fish was taken at a depth of about 40 fathoms, and did a large amount of damage to the mackerel nets before it could be hauled on board and killed. The shark was brought to the Plymouth Museum and purchased for the collection.

It may be worth while to state that the spiracles, which Couch says he was unable to detect, are distinctly visible in this specimen. It is scarcely surprising that they should be sometimes overlooked, for though our fish is 13 ft. (thirteen feet) 7 in. (seven inches) long (of which the tail occupies seven feet), the spiracles are only 1/12th (one-twelfth) of an inch long by 1/16th (one-sixteenth) of an inch wide. Each is situated exactly 2½ (two and a half) inches behind the eye, and a line from the spiracle to the tip of the snout passes just above the centre of the pupil. E. ERNEST LOWE.

Plymouth Museum, Plymouth.

THE TRAMWAYS EXHIBITION AT THE AGRICULTURAL HALL.

THE International Tramways and Light Railways Exhibition which came to an end on Saturday last must be regarded as having been very successful from all points of view. The opening ceremony was performed by Mr. Gerald Balfour on July 1, and was accompanied by the usual luncheon and speeches. Mr. Gerald Balfour alluded, as might have been expected, to the recent deputation to his Department on the subject of electrical legislation, but he did not evince any sign of having become convinced of the necessity for speedy reform. In other respects the speeches were not of much interest; the same may be said to be true to a certain extent of the proceedings of the International Tramways and Light Railways Congress, which held its meetings on July 1 and 2. The Congress, which was the twelfth held by the Union internationale permanente de Tramways, was the first to be held in London; the papers read and discussed dealt with the management and technical details of tramway schemes, and were most of them contributed by the engineers or managers of continental tramways. Many of them were very valuable, especially as they were based on the results of wide practical experience, but we doubt if they would prove of great interest to the readers of NATURE.

The exhibition itself contained a number of very attractive exhibits. Although primarily a general exhibition of all things pertaining to tramways, there was much on view which was of the greatest interest to those having nothing to do with traction. It was also very noticeable that the exhibition resolved itself practically into one of electric tramways. Of course, there was much that was not electrical—such, for example, as rails, points, &c.—but these are all part of the equipment of an electrical system. And perhaps the general impression with which one left the hall, that a "tramway" was necessarily the same thing as an "electric tramway," was of more interest, as a sign of the times, than were any of the individual exhibits.

Several different types of car were on view; the one which, not unnaturally, attracted the most attention was that constructed by Messrs. Dick, Kerr and Co. for the London County Council. This is the first of one hundred cars being built for the Council's South London Tramways. The car is double-decked, and has a total seating capacity of sixty-six (twenty-eight inside and thirty-eight outside), and is equipped for the conduit system to be used on the South London lines. The Westinghouse Company exhibited a car which ran over a fully equipped trolley line laid along the total length of the hall, a distance of more than 300 feet. Power was obtained for running this from a 75 kw. direct-current generator (500 volts), driven by a Westinghouse three-cylinder gas engine. The car was fitted with the Westinghouse magnetic brake. This brake has a triple action, acting as a wheel-brake, a track-brake and an axle-brake; it is energised by current derived from the car motors, which work as generators whilst the car slows down, the necessary energy being derived from the momentum of the car. The action of the brake is therefore independent of the main current supply.

A notable feature of the exhibition was the Bremer arc lamp, exhibited by the Westinghouse Company. This lamp was used for part of the lighting at the Natural History Museum on the occasion of the Institution of Electrical Engineers' conversazione. Unfortunately, it did not create a very favourable impression there, as the lamps kept flickering; those at the Agricultural Hall seemed to be burning much better. The carbons used in the Bremer lamp are saturated with certain minerals which volatilise and become incandescent in the arc; they are, moreover, arranged nearly parallel to one another instead of vertically one above the other; the ends project a little below a protecting hood, meeting at an angle of about 20°, and the arc is kept at the tips by means of a magnetic deflecting device. The position of the arc, the materials used in the composition of the carbons, and the reflecting power of the conical hood, combine to produce a highly efficient light. It is said that the lamp is three times as efficient as an ordinary arc. The colour of the light is also much pleasanter and warmer than that of the ordinary arc, and the light appears to fill the globe much better, with the result that it produces somewhat the effect of a golden ball of light.

Another similar arc lamp exhibited was that of the Union Electric Company. This, which is called the "Flame" arc lamp, has vertical carbons like an ordinary lamp; the carbons are, however, cored with a mixture of certain fluorides, and the upper one passes through a

dome-shaped hood, which is fixed a little above the arc itself. A rather long arc is burnt, and the effect is very similar to that produced by the Bremer lamp, only the light is of a slightly different colour. This lamp is also said to be three times as efficient as an ordinary arc.

We have not space at our disposal to describe the exhibits fully. There is one other, however, which deserves special comment on account of its ingeniousness and possibly great importance. This is the Partridge "Sparklet" fuse, exhibited by Messrs. Elliott Brothers. This fuse is designed more especially for high-tension circuits carrying heavy currents. When the fuse in such a circuit goes an arc forms, and in order to prevent this burning, either a very long fuse or some form of oil fuse is used. In Mr. Partridge's "Sparklet" fuse a short length only is used, and the terminals of the fuse wire are connected to an ordinary sparklet such as is now a familiar article for making soda-water. The arc when it forms burns between the two sparklets, and in a very few seconds one or other of these is burnt through; the carbon dioxide immediately rushes out through the hole and blows out the arc. It will readily be understood that the more current the circuit is carrying, and the more power there is in the arc, the sooner will the sparklet burn through, and also the hole being larger the more certain it will be in its action. At the Agricultural Hall a model fuse was shown working a circuit of 2500 volts. The current was small, only about 6 amperes, the power being therefore about 15 kilowatts; yet the arc was blown out in less than three seconds. Two sparklets are used, one at each end of the fuse, in case one should be defective; but this precaution has never been found necessary during all the experiments and trials that have been carried out. For the past eighteen months the apparatus has been in practical use, and has proved, it is said, thoroughly satisfactory. Mr. Partridge is certainly to be congratulated on a very ingenious idea; it remains to be seen whether it will prove a sufficient cure for all the troubles that are likely to be met with now that large-power high-tension circuits are becoming common. M. S.

THE ASTROGRAPHIC CHART.

IT is probably well known, even to those who are not astronomers, that an astronomical enterprise of considerable magnitude was initiated fifteen years ago, and is steadily, although somewhat slowly, progressing towards completion. In the year 1887 a conference of astronomers met at Paris to consider the best means of cooperating to make a complete map of the heavens on a large scale, and with all possible attention to accuracy, by photography. As the outcome of this conference, eighteen observatories of various nationalities undertook the work, the whole sky being divided up into eighteen zones; a zone assigned to each observatory with due regard to its geographical position. A standard pattern of photographic telescope was chosen, and all the eighteen observatories obtained instruments of the required type and set to work. The enterprise being in several respects entirely new, it has been necessary to guide the procedure in the light of experience acquired; and conferences assembled at Paris in the years 1889, 1891, 1896 and 1900 to report progress and compare notes. At the last of these conferences a second enterprise was undertaken. The small planet Eros, discovered in 1898, was to make a particularly close approach to the earth in the winter of 1900–1, thus affording an opportunity, the like of which would not recur for thirty years, of determining the solar parallax; it was felt that, although the main object of the association of observatories (viz. the formation of the Astrographic Chart) was not yet attained, still the advantages to astronomy which would result from utilising this exceptional opportunity were too great to be neglected, and it was resolved that the cooperating observatories should add to their programme the photographic observation of the little planet during the months October 1900 to February or March 1901. In connection with this second enterprise it has been found necessary to circulate a large amount of statistical material, such as approximate positions of the planet on different dates and of all the well-known stars lying near his path in the heavens, lists of the observations made at the different observatories, so that one might know how to match plates with another, and so on. The energy of the director of the Paris Observatory (who has from the first acted as director of the whole work) in printing and circulating this material has been most noteworthy. We have recently received the *ninth* circular relating to Eros, which is itself a pamphlet of 200 pages quarto, and represents a vast amount of work. In the first place, M. Lœwy discusses, in two long memoirs (supplementing a former one already published), what accuracy is obtainable from measures of photographic plates and what precautions are necessary to obtain that accuracy. The discussion is concerned with a number of minute details, and involves the adjustment of conflicting advantages, so that there is room for difference of opinion in the conclusions; but there can be but one opinion of the value of the material patiently collected and tabulated by M. Lœwy, which can be examined in the light of any hypothesis preferred. The second part of the ninth circular gives, among other useful information, ephemerides of the planet Eros and of the sun, calculated to eight significant figures for every six hours—almost a new departure in such work, the only precedent being afforded by the investigations of Sir David Gill on the planets Victoria, Iris and Sappho, whereby he clearly showed that eight figures were necessary to represent the accuracy of heliometer measures. To advance one decimal place is of course a step of the gravest importance, and to Mr. Hinks, of the Cambridge Observatory, belongs the credit of being the first to show that an accuracy can be obtained from photographic measures of the Eros plates of the same order as that which led Sir David Gill to ask for an eight-figure ephemeris.

The appearance of so much important literature in connection with this second enterprise, the photographic observation of the planet Eros, naturally suggests a glance at the state of affairs with regard to the main work, the Astrographic Chart itself. It is, as remarked in the first sentence of this article, some fifteen years since the work was initiated, and it should by this time be possible to form an estimate of the probable outcome and the approximate date of completion. It must be confessed that the original estimate of the time required has already been seriously exceeded. In the letter which summoned the conference of 1887 it is stated that:—

"Ce grand travail . . . pourrait être facilement exécuté en quelques années si dix ou douze observatoires bien répartis sur le globe pouvaient se partager convenablement la tâche."

The phrase "quelques années" is somewhat indefinite, but it may be assumed that those who assembled in 1887 would have been shocked to learn that after a lapse of a dozen years scarcely one-fifth of the work projected had been accomplished. Indeed, many who are tolerably familiar with the general course of events may be startled to hear this statement made; and yet a glance at the last comprehensive report available (see R.A.S. *Monthly Notices*, vol. lxi. p. 280) shows it to be only too true. It was decided to work on such a scale that 11,000 plates would be required to cover the sky, and this number was to be repeated four times, twice with short exposures (of 6 minutes, 3 minutes and 20 seconds), and twice with long exposures (40 minutes). The plates of the first series (catalogue plates) were to be measured, and the measures printed and published; those of the second series

(chart plates proper) to be reproduced in facsimile. In June, 1900, the state of affairs was as follows:—15,000 of the 22,000 catalogue plates had been *taken*, but only 4000 had been measured; and the measurement is of course by far the most serious part of the work. Of the 22,000 chart plates required, less than 4000 had been taken, and only a small portion of these had been reproduced and published. So that the fraction of the whole programme accomplished in a dozen years can certainly not be put higher than one-fifth.

Does this mean, then, that it will take sixty years to finish the whole? It is earnestly to be hoped that this would not be a legitimate inference, and fortunately there are good sound reasons why it should not be. The years immediately succeeding 1887 were naturally devoted to experimental work, of which a large amount has been necessary. This was foreseen at the outset; witness, for instance, the words of the veteran Otto Struve in his opening address:—

"En effet, l'Astronomie pratique possède aujourd'hui, dans la Photographie, un instrument de la plus haute valeur et qui, probablement avec le temps, facilitera énormément nos études épineuses. Mais restons sobres dans nos prévisions. Pour le moment, nous ne devons regarder la Photographie que comme un instrument très précieux, *mais dont l'étude reste encore à compléter*."

But it will probably be agreed that the amount of work necessary to "complete the study" has exceeded expectation.

Beyond the preliminary experiments which might have been foreseen by an individual worker, much time has been spent in a well-meant endeavour to secure uniformity in the work, which has, after all, not been very successful. Thus a large part of one year was lost in attempts to devise an obscuring screen which should diminish the light received from the stars in a known ratio, and ultimately secure uniformity in the limiting brightness (or rather faintness) of the stars charted; but this attempt was at last abandoned in favour of the simpler method of fixing a definite time of exposure, which might have been adopted from the first. Or going further back in the history, it must be remembered that although a standard pattern of telescope was adopted in 1887, it took a considerable time, not only to make the eighteen instruments required, but for the makers to find out how to make them. Thus it would be fair to estimate that in 1900 the work had been in actual progress, not for a dozen years, but for less than half that period; so we need not fear that the completion of the work is still half a century off. Nevertheless, he would be sanguine who should reduce this prospective limit below twenty years, unless some very drastic measure is adopted in the near future. Some of the cooperating observatories are well advanced with their work, but others are far behind. In 1900 there were actually three which had not started at all, and these have been struck off the list and replaced by three new ones. We have good reason for anticipating energetic action from these new comers, but it must be remembered that they start a dozen years at least behind their colleagues.

This great delay in the execution of the work has been prominently mentioned because it demands most serious attention if the original scheme is to be carried out in any real manner. Even without the addition of the Eros work there was sufficient cause for anxiety; with that important and unforeseen addition there is reason for alarm. It is to be hoped that the dangers may be realised and obviated within the next few years.

But when we turn to the contemplation of what has been accomplished, there is good reason for satisfaction. To take first the series of catalogue plates, with short exposures of a few minutes only. Each observatory has to take about 1200 of these, and the area of the sky covered by each is a square of two degrees in the side, so that sixteen full moons arranged in solid square formation would just about cover this area. On each plate there are some 300 or 400 star-images on the average; but this is an average from which the deviations are large. A plate exposed near the Milky Way, even for a few minutes only, shows thousands of stars, whereas if the telescope be pointed to a region distant from the Milky Way, the number may fall below 100. Taking the average as 350, there are on the 1200 plates which form the share of one observatory some 400,000 star-images; and it is the business of that observatory, after taking the plates, to measure carefully the relative positions of all these images and publish the results. Moreover, it has been found advisable to make these measures at least twice over, so that we may put the total number at something like a million. It will readily be conceded that this is a gigantic piece of work for a single observatory to carry out, and it is a great thing to be able to say that some of the observatories are already in sight of its accomplishment. Others, as has been admitted, have not yet commenced the work, but they will enter upon it with all the advantages of following an example already set, and we may consider that the greatest difficulties have been overcome.

This portion of the work affords another reason for satisfaction. Mention has been made of some preliminary experimental work which produced no positive result, but other such investigations have had more fortunate issues, especially the research on the best method of measuring the plates. In 1887 there were at least three different methods which might be adopted, and corresponding to each of these there was a choice of patterns for the instrument to carry it out. The proper method for measuring stellar photographs has now been practically settled, and though there is diversity of opinion as to the best actual instrument, the relative advantages of the different forms are becoming tolerably well known. It will be realised how definite an advance has here been made when it is remembered that an eminent astronomer, in reviewing the possibilities in 1887, dismissed the method which has since been universally adopted as obviously inferior to the others and not worthy of consideration. The test of experience had, in fact, not been applied, and the result of its application may be regarded as a valuable scientific asset.

Let us turn now to the other set of plates, the chart plates as they are called, similar in every way to the catalogue plates, except that they are exposed to the sky for a much longer time (forty minutes at least, instead of three or six), and hence contain thousands of stars instead of hundreds. It is proposed that these plates shall be reproduced on paper by some process which depends on the automatic action of light only, and is thus free from the imperfections incidental to human agency. The exact process has not been formally specified, and it is open to any observatory to circulate ordinary contact prints, for instance, if such can be made without losing too many of the fainter star-images. Up to the present time, however, the only reproductions of chart plates which have been published are in heliogravure. The French observatories (Paris, Algiers, Toulouse, Bordeaux) and the Observatory of San Fernando, in Spain, have produced and circulated most beautiful enlargements (twice the linear dimensions) of some of their chart plates made by heliogravure, and there are many reasons why we may hope that their example will be universally followed. To begin with, the charts are really beautiful to look at—as might be expected from the French, they have produced something æsthetically satisfactory. Secondly—a matter of infinitely more importance astronomically—the charts

are wonderfully accurate. It has been shown that the places of stars can be measured from them with an accuracy almost equal to that obtainable from the original glass negatives. Finally, they are presumably permanent—far more so than the glass negatives, unless the toning process recently suggested by Sir William Crookes is adopted and found as successful as is expected. Against these manifest advantages is, unfortunately, to be set the costliness of the process. It is estimated that to reproduce its 1200 plates in this way each observatory must have a sum of about 10,000*l.* at command, independently of the actual time spent in the work. This sum is large, but not prohibitive. Five observatories are apparently already provided with it; in the interests of uniformity in a magnificent piece of work, may it be hoped that in some way or other the remaining shares will be taken up? If the paper reproductions were (as it was at one time supposed they would be) mere playthings of no scientific value, such expenditure might have been deprecated. But it has been demonstrated that they are accurate beyond expectation, that, in fact, an observatory provided with copies of this kind for the whole sky could in a few minutes obtain the place of any star down to the 14th magnitude with an accuracy equal to that with which the best meridian observations can be made. It seems probable that the outlay is as good a one as can be made with our present imperfect knowledge of the requirements of the future.

The consideration of what this means in actual weight of paper brings home to us in a striking manner the magnitude of the whole enterprise. If the 22,000 maps are completed in the style adopted by the French, the sheets when piled one on the other would form a column thirty feet high and weighing nearly two tons! The most elaborate star atlas which has been produced up to the present time can be bound as a single, though rather large, volume, which could be added to any library without sensible disturbance. But not so with a copy of the Astrographic Chart; it is a matter for the serious consideration of each fortunate possessor where and how he shall store the sheets and ensure their preservation. There is not likely, of course, to be any real difficulty in doing this, the point is only mentioned here to illustrate the novelty of the departure rendered possible by photography.

As there is an obvious danger of not being able to carry out this vast programme (for which, it will be remarked, not only scientific labour, but much hard cash is required, and the latter may not be easy to extract from reluctant Governments), it is reassuring to know that there is at least one good alternative. We might carry out the work much more economically with a different type of instrument, though at the cost of some obvious advantages. The type selected in 1887, a refracting telescope of 11½ feet focal length, allows us to photograph an area of the sky at one exposure limited to two degrees square, and 11,000 plates are required to cover the whole sky. Two other types were considered and rejected. The first was the reflecting telescope, with a concave mirror in place of a lens. The area satisfactorily photographed at one exposure with a reflector is even smaller, and the number of plates required for the whole sky consequently greater. Though the reflector has distinct advantages in cheapness and in light-grasping power which have recommended it for other classes of work, there is no doubt that it was rightly rejected for the Astrographic Chart; all our experience subsequent to 1887 has tended to confirm this view. The third possibility open to the conference of 1887 was the use of a doublet lens, such as is familiar in an ordinary camera. The lens of a camera is made up of two lenses (each of which is itself double) separated by a definite interval, where a "stop" may be inserted. A photograph could be taken with one of these lenses alone, but only a comparatively small portion of the picture near the centre would be in good focus; the combination is made to give a larger "field." If such a doublet lens is used to photograph the sky, we get a much larger field at one exposure, and can cover the sky with fewer plates. The claim has recently been made that twenty or thirty plates would suffice to cover the sky instead of 11,000! Of course the results would be on a correspondingly smaller scale, and this extreme procedure is not to be contemplated as an alternative to the large and accurate charts with which a start has already been made. But if we could reduce the 10,000*l.* required to (say) 1000*l.*, we are in the region of the possible or even the probable, and this only means reducing the number of plates required in the ratio of one to ten, or increasing the area covered by each in the same ratio. We may take it as fairly well established that a doublet will satisfactorily cover a field at least ten times as large, in area of the sky, as the single lenses at present in use for the work of the chart.

The question naturally arises whether these facts were realised in 1887, and if so, how the single lens came to be preferred to the doublet. The discussion on the type of instrument to select took place on April 18, 1887, and the *procès-verbaux* are given on pp. 36–43 of the official account of the conference. Twenty-six distinguished astronomers were present, and eighteen of them took part in the debate. *The photographic doublet was not even mentioned.* At the present time this circumstance is almost bewildering. At the end of the volume a letter is printed from Prof. E. C. Pickering (who most unfortunately was not able to attend the conference) advocating the use of the doublet, and giving detailed suggestions for the whole work which commend themselves, in the light of subsequent experience, as admirable. But his views received no attention; the debate was confined almost entirely to the relative advantages of reflectors and refractors, and the proper size to be adopted for the latter, and it must be confessed that an opportunity was lost. Since that time Prof. Pickering, using doublets, has charted the whole sky himself many times over, while the associated observatories have not yet accomplished a third of their programme. It must not be forgotten that their programme includes much more than the mere charting of the sky, viz. the measurement of some plates and the reproduction of others; but even making this allowance, the discrepancy between what he has done single-handed and what has been done on the plan preferred at Paris in 1887 is sufficiently serious.

The fact is that astronomers generally were afraid of the doublet in 1887, and some of them have not yet lost their mistrust. They were afraid that so fair a promise was too specious; that, in fact, the gain in extent of field over the refractor must be accompanied by a corresponding loss in accuracy. At the time no definite information was forthcoming on this point, and it must be admitted that even now our knowledge is far from complete. It is not so easy as it might seem to test pictures of the stars for the minute accuracy necessary to an astronomer, and it may still be proved that the choice of the refractor in 1887 was, from the point of view of getting the greatest attainable accuracy, a wise one. But, on the other hand, it has been shown that the mistrust of the doublet was largely unjustifiable; its accuracy is of a high, if not of the very highest, order. It is not even now too late to follow the excellent advice which was offered in 1887 only to be ignored. By adopting the doublet the chart plates might be completed in a reasonable time and at a reasonable cost, though on a smaller scale.

H. H. TURNER.

SOME NEW FORMS OF GEODETICAL INSTRUMENTS.

THE optical principles involved in gun-sighting apparatus, described in the issue of NATURE for January 9, 1902 (p. 226, vol. lxv.), have been further developed by Sir Howard Grubb, F.R.S., and applied to some new forms of geodetical instruments. In the gun-sighting apparatus alluded to, a virtual image of an illuminated cross is optically projected on to the object aimed at, and both the cross and the object are easily seen without any refocussing or straining of the eyes. In the case of the gun sights and also the present instruments, light traverses a plate of glass coated with a very thin film of galena; by this means reflection of light from the surface of the glass is greatly increased, while but little transmitted light is shut off. The process of depositing galena is due in the first instance to Prof. J. Emerson Reynolds, F.R.S.; it is described in the *Proc. Chem. Soc.* for 1884, under the heading "The Synthesis of Galena by means of Thiocarbamide."

The process has been modified by Mr. G. Rudolf Grubb and applied with great success to some new forms of surveying instruments. These instruments have not

FIG. 1.

been designed to take the place of the standard instruments of the engineer, namely the level and the theodolite, but to place in the hands of comparatively inexperienced observers, a ready means of making a rapid survey with an accuracy as great as can be attained in plotting a survey on paper. In the case of ordinary surveying, for example, in road making and in the conveyancing of property, the accuracy of the survey is limited by the degree of precision with which it can be actually plotted on paper with a pencil giving fine lines. When the theodolite is used, the readings are first entered in the field book and then afterwards plotted on paper, the angles being set off with a protractor. By means of the new instrument, the survey is continuously plotted as the instrument is being used. In Fig. 1 the new form of plane table is shown. The central pillar, through which the successive bearings are taken, is shown in section in Fig. 2; it is mounted on a triangular base, or set square, which can be rotated about a point situated in the centre of the paper on the plane table. The instrument is used thus. The sight tube is rotated until its fixed line coincides with a given object, a line is then ruled, it is again moved through some angle till the line coincides with a second fixed object, and another line is ruled along the edge of the set square, the process being repeated until the position of the last fixed object is recorded. Then the whole plane table is moved to a fresh station at a measured distance from the first station, and similar observations are made on the same fixed objects; the intersections of the two sets of bearings give the points

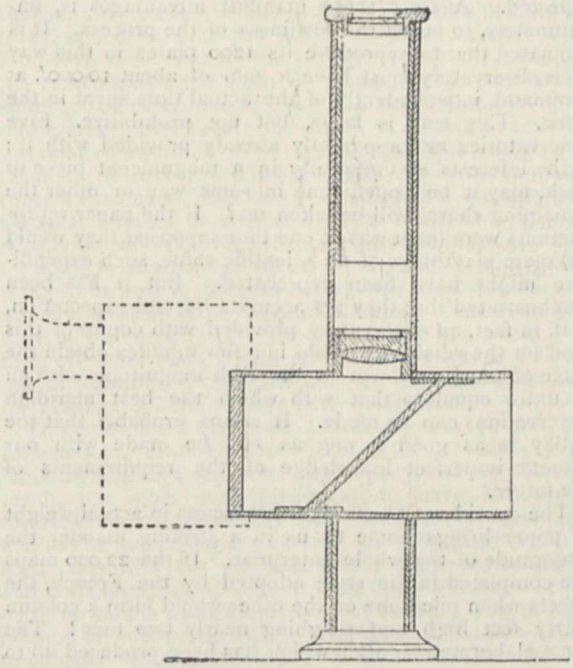

FIG. 2.

required for the survey. In the case of the survey of a small area, the instrument is not shifted to a new station, but the distances corresponding to the ruled lines are determined by reading the number of divisions which appear in the field of the instrument between two marks

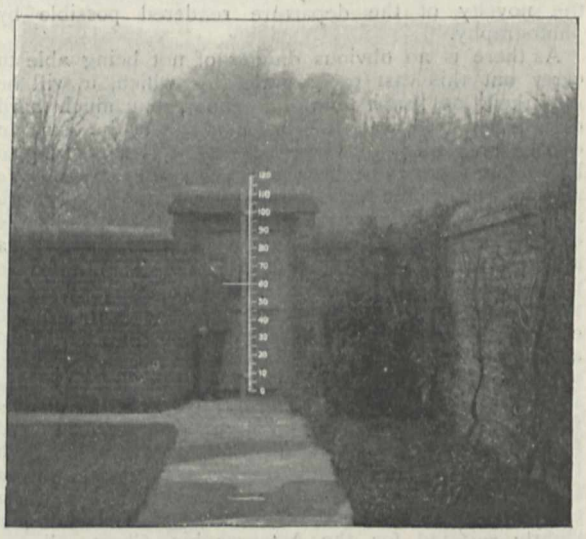

FIG. 3.

of known distance apart on a staff held at a fixed point. The instrument thus becomes a telemeter, and by means of a suitable scale the distance along any given direction is found and marked on the paper. The actual method of using the instrument is as follows:—The staff man

walks round a field and successively plants his staff upright where a change in the directions of the boundary occurs; at each point the observer at the plane table rules the direction line and marks the distance, repeating the operation for each successive point, so that the survey of the field is made during the time taken by the staff man in walking round the field and making the necessary halts at each point for the observation to be recorded. The scale and view photographed through the plane table instrument is shown in Fig. 3.

The same optical principle has also been employed by Sir Howard Grubb in the construction of a level to be used in making rapid estimates of gradients in road making and laying out property.

The observer sees at the same instant a fiducial mark, the bubble of the level, and an arc marked with degrees projected on to the field of view.

The excellent optical device has also been utilised in the construction of a prismatic compass and a clinometer.

M. HERVÉ FAYE.

ALL who have taken any interest in the advance of science, more particularly in the direction of astronomy and meteorology, will hear with regret of the death of M. Hervé Faye, which sad event was announced last week. A long course of scientific industry has marked his career, and a great distance seems to separate the workers of to-day from the epoch when Faye and many others, whose names are now but a matter of history, laboured strenuously and successfully to make the paths for their successors more easy and of more rapid attainment. Nearly sixty years have passed since M. Faye first came prominently before the world as the discoverer of a comet, to which his name has always been attached, and it will serve to make us appreciate the advance accomplished in one lifetime if we recall the fact that this was the first elliptic comet the period of which was determined by calculation alone, without any assistance drawn from observations made at previous returns. Faye, at that time an assistant in the Paris Observatory, recognised the necessity of computing an elliptic orbit, but the credit of determining the first orbit of considerable eccentricity from a few days' observations belongs to Goldschmidt, who was stimulated to the task by Gauss. Then the information and the methods of the *Theoria Motus* had not filtered through a score of text-books and come into the hands of numberless computers, whose deftness of calculation had been whetted by the discovery of hundreds of asteroids, the orbits of which stood in need of determination.

But it will be rather on his philosophical writings than his scientific observations that the reputation of Faye will rest and be honoured by his countrymen. It may be that to some of his theories a general assent has not been given, and that in some cases later discoveries have modified the views the distinguished physicist expressed, but no doubt will be entertained concerning the clearness and ability with which those views have been uttered, or of the influence they have had on French thought. Ever since the time that Laplace in a few pregnant sentences sketched the plan on which the solar system might have been constructed, the subject has been a favourite speculation among French physicists. M. Faye has not been able to resist the temptation to attack this subject, and though, like all attempts at universe construction, the scheme of M. Faye fails to meet all the difficulties which beset the problem, yet it is a most suggestive contribution to the subject, and should prove an incentive to further inquiry. In some respects this cosmogonic theory contrasts very favourably with that of Laplace, and in others, as was natural, it falls behind that of his great predecessor; but this is not the place to enter into any details or criticisms of the argument developed. In recalling, however, the services which M. Faye rendered, one would not willingly forget this finished essay ("Sur l'Origine du Monde"), in which is given, with much that is suggestive, a lucid explanation of the state of our knowledge of the solar and stellar systems.

Similarly, it would be out of place to discuss here the views he expressed on the constitution of the sun, the causes of sun-spots, the behaviour of solar prominences or the chemistry of the sun generally. All these are subjects that fell under Faye's notice and which he treated broadly and philosophically, but necessarily without the facts and knowledge that later observations have brought to light. In cosmical physics and chemistry he was to a great extent a pioneer, and if his theories are in some cases for this reason insufficiently supported by exact observation, they are generally characterised by a breadth of view and thoroughness of conception that contrasts favourably with contemporary opinion. In the discussion of problems connected with cosmical meteorology, or with the motions of our own atmosphere, he was, perhaps not so happy, and his writings on cyclonic motions, the laws of storms, the behaviour of tornadoes, and the exceptional phenomena which we occasionally experience will probably be soon forgotten. Not so, however, with such works as the "Cours d'Astronomie nautique" and other mathematical books with which he has enriched French literature, and which are models of arrangement and of clearness of expression.

One could with difficulty recall the numerous services which M. Faye rendered to his Government or the acknowledgments that he received from foreign scientific bodies. He was, of course, Membre de l'Institut and besides a seat at the Bureau des Longitudes which he had occupied since 1862, in succession to Biot, he was called by Marshal MacMahon to fill in his Cabinet the office of Minister of Instruction, at a time when it was thought not impossible that M. Faye might have become Director of the Paris Observatory in succession to Le Verrier. He was elected a Foreign Associate of the Royal Astronomical Society so long ago as 1848, while Belgium, Venice, the United States of America enrolled him among the members of their scientific societies. Full of years and distinction he is removed from us, and with him another link that connects the science of to-day with the science of the past.

W. E. P.

NOTES.

THE new botanical laboratories of the Chelsea Physic Garden are to be opened by Earl Cadogan at a garden party there on Friday, July 25.

A REUTER telegram from Kronstadt in yesterday's *Times* reports that on July 14 the Italian cruiser *Carlo Alberto* received, for the first time, messages by wireless telegraphy from the Poldhu station in Cornwall. These are the first experiments in wireless telegraphy over a distance of 1600 English miles in a straight line by land, and the results are said to have been most successful, the messages received having been very distinct.

AMONG the Civil List Pensions announced in a Parliamentary Paper just issued are the following:—Mr. W. H. Hudson, in recognition of the originality of his writings on natural history, 150*l.*; the Rev. Dr. John Kerr, F.R.S., in recognition of his valuable discoveries in physical science, 100*l.*; Mrs. S. C. Jones, in recognition of the services rendered by her late husband, Principal John Viriamu Jones, to the cause of higher education in Wales, 75*l.*; and Mr. H. Ling Roth in consideration of his services to anthropology, 70*l.*

THOUGH the damage done in Salonica by the earthquake which occurred there on the afternoon of July 5 (see p. 254) was not great, some of the surrounding villages suffered considerably. At Guvezno 150 houses were wrecked and at Karajere fifty houses were destroyed. A new spring burst out at the mineral baths of Langaza. The shock was recorded at the observatory of Laibach, which is about 560 miles north-west of Salonica, and also in Birmingham, about 1440 miles in the same direction.

THE current number of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* contains the programme of prizes proposed by the Society for the present year. Among these may be noticed a prize of 2000 francs for the invention of a cement capable of agglomerating diamond dust for mechanical purposes, another of 3000 francs for a steam superheater fulfilling certain conditions, and one of 2000 francs for any important progress in the mechanical transmission of work. In chemistry a prize of 1000 francs is offered for the utilisation of a bye-product, and medals for publications useful to chemical industry or metallurgy. A prize of 2000 francs is offered for an apparatus suitable for domestic use capable of sterilising drinking water by boiling, one of 2000 francs for a study of the alcoholic ferments and diastases, and one of 1000 francs for freeing the vine from an insect parasite. In political economy, a prize of 3000 francs is offered for a study of the effects of trusts and industrial syndicates generally upon production and sale.

SEVERAL eruptions of Mont Pelée occurred last week. On July 9 a disturbance began at 7.30 p.m. and continued until midnight. From the *Times* we learn that a column of black smoke streaked with lightning was first observed, and that this was apparently followed by flame, which set fire to the ruins of St. Pierre. Stones and ashes fell for 25 minutes on Morne Rouge and Fonds St. Denis. Drs. Anderson and Fledd were thought to have been overwhelmed by the ejected matter, but they arrived safely at Fort de France on July 11. They were on board a sloop which was lying off St. Pierre when the eruption occurred. A message from St. Thomas states that three loud detonations were heard from the Soufrière, St. Vincent, between 8 p.m. and 9 p.m. on July 9. Advices from Barbados state that loud detonations were also heard there on the night of July 9, in a westerly direction. A telegram from Fort de France states that about midnight on July 12 there was a third violent eruption of Mont Pelée. Large quantities of stones and ash fell on Morne Rouge, Macouba and Ajouba Bouillon. The French scientific mission, which arrived the day before from Guadeloupe, whence it had been recalled by the Governor, left on July 13 for St. Pierre.

M. F. A. FOREL describes, in the *Journal Suisse* of July 10, some brilliant sky effects observed by him at Morges on July 5 directly after sunset. A brilliant disc of light of a whitish-yellow colour appeared thirty degrees above the sunset point a quarter of an hour after the sun had set, and lasted for a quarter of an hour. Ten minutes later a purple circle sixty degrees in diameter appeared, and sunk lower and lower as the sun increased its distance below the horizon. While this circle was visible the sky was brightened by an after-glow. The red sunset effects observed at Jamaica on May 25, Madeira on June 10, and Bombay about June 25 had not been seen at Morges on July 8.

IN the July number of the *Bulletin de la Société Astronomique de France*, M. Flammarion gives the first instalment of a history of the West Indian volcanoes, with special reference to Mont Pelée and the recent eruptions. The article is illustrated by photographs and charts, and contains letters of pathetic interest written a day or two before the great eruption, which show that at least some of the inhabitants of St. Pierre, including several members of the Société Astronomique, feared the possibility of a disaster several days before the final catastrophe occurred.

MR. PIERPONT MORGAN has bought and presented to the Paris Museum of Natural History the collection of precious stones formed by Mr. Kunz, of New York, for the Buffalo Exhibition of last year. He has also sent to the American Museum of Natural History in New York a large star sapphire and a beautiful yellow sapphire. These gems will be added to the collection of precious stones previously presented by Mr. Pierpont Morgan to the Museum.

THE expedition to the Malay Peninsula undertaken by Mr. N. Annandale and Mr. H. C. Robinson with the aid of grants from the Government Grant Fund and Edinburgh University, has now concluded its field work, and it is hoped that a preliminary notice of its more important results may be presented to the British Association at Belfast. A complete series of anthropometrical measurements, representing more than 300 individuals of the various races "wild" and "civilised" inhabiting the Siamese Malay States and Perak, has been obtained, with numerous photographs and about thirty authenticated skeletons and skulls, nearly two-thirds of which belong to the primitive peoples known as "Sakais," "Semangs," and "Orang Laut" respectively. Studies have been made of the religions, burial customs, and sociology of these races, and collections of their clothing, weapons, utensils, and magical and musical implements made. The zoological results comprise extensive notes on mimicry and kindred phenomena and a series of photographs of insects and other animals in their natural surroundings as well as general collections from both high and low levels.

IT was recently reported that Dr. Doberck was retiring from the directorship of the Hong Kong Observatory; but we understand this is not the case and that he is merely home on sick leave.

A TELEGRAM from the Viceroy of India, dated July 12, reports:—"Good rain has fallen over the greater part of India, but fall light in Burma, in Southern India, Southern Punjab, in parts of Rajputana and Sind."

A BRITISH and Colonial Industrial Exhibition will be held at Cape Town for a period of four months from November 1903. All the necessary funds have been guaranteed, and a site adjoining the Botanic Gardens has been chosen. It is important that British manufacturers should participate in a scheme which offers a good opportunity of bringing their products and wares before the South African public, especially in view of the inroads made by foreign competitors in the South African market. When the exhibition is open the industries of farming, dairying, and wine growing will be busy in schemes for a fresh start. The exhibition of the latest and most up-to-date appliances, tools, mechanism and machinery should, therefore, lead to very extensive business, and the opening of new and permanent trade outlets for Imperial manufactures.

THE preliminary programme of the nineteenth congress of the Sanitary Institute, to be held in Manchester on September 9–13, has now been issued. The president of the congress is Earl Egerton of Tatton. Dr. W. N. Shaw, F.R.S., will deliver the lecture to the congress and Sir W. J. Collins will deliver the popular address. The three sections and their presidents will be:—(1) Sanitary science and preventive medicine, Sir James Crichton-Browne, F.R.S.; (2) engineering and architecture, Sir Alexander Binnie; (3) physics, chemistry and biology, Prof. A. Sheridan Delépine. There will be eight special conferences of municipal representatives,

port sanitary authorities, medical officers of health, engineers and surveyors to county and other sanitary authorities, veterinary inspectors, sanitary inspectors, domestic hygiene, and hygiene of school life. In connection with the congress, a health exhibition of apparatus and appliances relating to health and domestic use will be held, as a practical illustration of the application and carrying out of the principles and methods discussed at the meetings.

THE announcement that the meteorological observatories on Ben Nevis and in Fort-William will have to be closed at the beginning of October next, in consequence of the want of funds to keep them in operation, will be received with regret by many meteorologists and other men of science. During the last four years the liberality of Mr. Mackay Bernard, of Dunsinnan, made the continuation of the work at the observatories possible, but there is no hope, in the opinion of the directors, that the observatories can be continued as permanent institutions except by assistance from the State. From the commencement of the work, in 1883, until now, the total cost has been fully 24,000*l*. Of this sum nearly 17,000*l*. has been received by the directors in the form of subscriptions. The balance of the expenditure has been met by a payment of 100*l*. a year, since 1883, from the Meteorological Council for the Ben Nevis Observatory, and of 250*l*. a year from the same body, since 1890, for the Fort-William Observatory. These two contributions constitute all that can be regarded as State aid. The directors have received definite intimation that, whether the observatories are continued or not, the latter sum —250*l*.—is to cease to be paid at the end of this year. In connection with this subject we notice that Sir John Stirling-Maxwell has notified the Lord Advocate that he will put a question this week in the House of Commons as to whether any application has been made through the Scottish Office for assistance for the observatory from the public purse, and whether, if such application has been refused, he will state the grounds of refusal.

AT the Aëronautical Congress held recently at Berlin it was concluded that no ascent should take place at a higher level than 7 or 8 kilometres without placing the observers within a closed car, "nacelle close," as was suggested, in 1871, by Mr. Louis Tridon. At that time a motion to this effect was rejected on account of the faith it places in the life-sustaining properties of pure oxygen. The scientific committee of the Aëro Club discussed this same subject on June 30 and came to the same conclusions. Dr. Henocque, professor of physiology at the Collège de France, said that the foregoing principles will be observed in the ascents now in preparation by the French Society of Physiology. He held that the atmosphere should be divided into three zones; that in the first, up to 4 or 5 kilometres above the sea-level, life was possible without the use of additional gas. For the third zone, at a level less than 10,000 metres, it would be necessary to resort to the closed car, or to an aërial diving suit. The ascents which Dr. Henocque arranged to take place on July 15, were to be executed entirely in the first zone. Investigation was to be made of the effects of the ascents within the limits of a depression consistent with life, or not ruinous to health, and in accordance with a series of observations made at the Eiffel Tower Dr. Henocque hopes to show that in this zone the ascents may be considered as beneficial to the general health, invigorating the lungs and likely to afford a remedy against some pulmonary affections. The conditions of life are not the same as when mountaineering, owing to the greater velocity due to the elevation and the absence of all muscular fatigue when the aërial traveller is comfortably seated in the car of a balloon.

ACCORDING to the *Times*, there is likelihood of large supplies of electrical and mining machinery being required shortly for Johannesburg, where an ex ensive electric tramway system is to be built. There is a desire to place orders as far as possible with British firms, but freights are very heavy, and British machinery requires therefore to be made lighter. Prompt delivery and lower prices are also needed to meet American and German competition; it is said that several orders have recently been secured by foreign firms at very low prices in order to secure a firm footing in the market.

A NEW oxygen-acetylene burner has been devised by M. Fouche (says the *Engineer*, July 11) which not only has a much higher temperature, but also the admixture of ether vapour is prevented. The ratio of the mixture is 1 volume of acetylene to 1·8 volumes of oxygen, and the flame, which is 6 mm. long, has a greenish dart in the centre with a point at a very high temperature. Iron and steel, it is claimed, can be easily welded without either oxidising or carburising the iron.

IN an Appendix iii. to the Weekly Weather Report for the year 1901, the Meteorological Council has recently issued a very useful set of tables showing for the stations which furnish returns for that Report and the monthly summaries, (1) the average maximum, minimum and mean temperatures for each month, and for the whole year for thirty years (1871–1900); (2) the average monthly rainfall and number of rain-days for thirty-five years (1866–1900); and (3) the average number of hours of bright sunshine and percentages of possible duration for twenty years (1881–1900). These tables are in continuation of those issued in the preface to the Weekly Weather Report for 1895, and furnish at a glance valuable information on the climatology of each of the districts into which the British Islands have been divided for the purpose of weather forecasts.

MR. W. E. COOKE'S report on meteorological observations made under his direction at the Perth Observatory and other places in Western Australia during the year 1900 contains an excellent collection of monthly and yearly climate and rain maps referring to the colony. One series of the maps shows for every month the mean pressures and temperatures and the mean maximum temperatures at day and minimum temperatures at night; also the annual means of the same records. In another series the amount of rainfall for every month of the year is shown graphically in each square degree of the colony, with the average rainfall for that district; and the distribution of the rainfall for the whole year is shown in the same way in a separate map. Mr. Cooke reports that the astronomical buildings of the Perth Observatory are now finished and the instruments in adjustment. The observatory is pledged to take a share in the preparation of the International Photographic Catalogue of Stars, but owing to want of assistants, it is difficult to obtain time for the work. The meteorological observations are, however, kept up at a fair number of stations, and the results for various localities throughout the State obtained since 1875 have been examined, tabulated and discussed, and will shortly be available in a volume entitled "The Climate of Western Australia."

MR. KUMAGUSU MINAKATA sends us from Japan two specimens, mounted as microscopic slides, of a fresh-water alga which he collected in a pond at Wakayama Shi, Japan. He desired to obtain an opinion as to the species, which he believed to be *Pithophora Oedogonia*, Wittrock, var. *vaucherioides*, Wolle, of which he possessed a quantity of specimens personally collected near Jacksonville, Florida, between 1891–92, well agreeing in detail with those submitted. He also remarked:—"Since the publication of Wittrock's elaborate monograph of the Pithophoraceæ, 1877, has any species, besides *P. Kewensis*, been ever reported from any other part of the Old World?" Prof. Howes, to whom we submitted the specimens, says in reply:—"I have no doubt that the Japanese identification is

correct. Mr. Rendle, with a former pupil of mine, Mr. W. West, jun., has described as new for Britain a variety of the genus from a canal in Manchester, where it was assuredly introduced (see *Journal of Botany*, vol. xxxvii., 1899, p. 289). I take his word as final. Mr. Minakata may be referred to the above-cited paper for the answer to his second question. *P. Kewensis* must have also been introduced, as it has never been found again."

PROF. T. LEVI CIVITA has contributed to the *Annales* of the Faculty of Sciences of Toulouse a paper having an important bearing on the recent discussions as to the production of a magnetic field by moving charges. In a previous paper on that subject, Prof. Righi had examined the possible sources of error in various experiments, from those of Rowland down to the recent observations of Cremieu and Adams, and had pointed out that some uncertainty was introduced by the presence of the conductor used to shield the magnetic needle from electrostatic action. This remark has led Prof. Levi Civita to undertake a mathematical investigation of the effect of an infinite plane-conducting screen on the magnetic field produced by an electrostatic charge moving uniformly parallel to the plane. The results which are embodied in the present paper show that if a is the ratio of the velocity of translation to that of light, then up to the order of a^2, the electric and magnetic forces on the side of the screen opposite to the moving charge are derivable from a potential. The electric force is negligible, while the magnetic force is reduced to a certain fraction, less than one-half, of what it would be at the same point if the conductor were removed. The magnetic force is not, however, entirely screened by the conductor except in the limiting case when the sheet has infinite conductivity.

THE unique construction of the "Cooke" photographic lenses, made by Messrs. Taylor, Taylor and Hobson of Leicester, has given rise to possibilities of variation of their focal lengths by the user, that are both interesting and useful. The replacement of the back component by a lens of greater focal length, increasing the focal length of the objective by about 50 per cent. we referred to some time ago, the alternative back lens being known as an "extension lens." Messrs. Taylor, Taylor and Hobson have now formulated a method by which the focal length may be reduced. This is effected by unscrewing the front component. One complete turn shortens the focal distance of a five-inch lens by nearly half an inch. Such a difference is of little use with reference to the resulting alteration in the scale of the image, though it may sometimes be convenient. But when applied as an alternative to the use of rack-work and other devices for increasing the distance between the lens and the plate for focussing purposes, as in the use of hand-cameras for comparatively near objects, this range is ample. Without moving either the objective as a whole or the plate, less than half a rotation of the front component of an objective of five inches focal length will alter the distance of the object that is in focus from infinity to three yards. The makers take advantage of this fact in a new issue of their lenses, in which a scale is engraved on the mount so that objects at infinity, ten, six, four and three yards' distance may be brought into focus by this simple means. Within this range the defining power of the objective from corner to corner of a quarter plate, using the full aperture of $f/6{\cdot}5$, is so little affected that the deterioration of the image at the edges of the plate can only be detected by means of a magnifier. The advantages of this method of focussing are that it is more simple from a constructional point of view than others now in use, saving the weight of those parts hitherto necessary simply for focussing purposes, and that as the lens and plate may be rigidly fixed in their relative positions, there is less risk of instability or misplacement with the consequent deterioration of definition. The same principle is applicable when the "extension lens" is employed, thus further increasing the range of adjustment possible.

MESSRS. R. FRIEDLANDER UND SOHN, of Berlin, have issued two catalogues of floras, one of European, the other of exotic plants.

ACCORDING to the Report for 1901, the Manchester Microscopical Society continues to do excellent work, although the hon. secretary has to deplore a diminished attendance at the meetings.

Nature Notes for July contains a notice of Mr. E. N. Buxton's efforts for the re-afforestation of a large part of the old Hainault Forest, which was deforested about 1850. The cost will be about 20,000*l.* for the Lambourne and Hainault lands, and 7000*l.* for the Grange Hill Forest. It is proposed to ask the great City Corporations and the Essex County Council to bear the main cost, although much financial help is expected from private beneficence and local bodies.

IN a paper published in vol. lxxi. of the *Journal* of the Asiatic Society of Bengal Mr. F. Finn notices certain instances of what he terms "abrupt variation" in Indian birds. Among them he notices a not uncommon colour-phase in the ruff, and for the birds displaying this peculiarity he proposes the name *Pavoncella pugnax leucoprora*; this, it may be mentioned, is not in accordance with modern practice, which restricts subspecific titles to local geographical forms. The author also calls attention to a domesticated cock in the Indian Museum, described many years ago by Blyth, which has partially assumed the female plumage, and appears to be the only known example, at least in India, of such an abnormality.

THE failure of pea crops forms one of the more important items in the *Bulletin* issued this year by the authorities of the agricultural experiment station at Fort Collins, Colorado. It was discovered that the soil was permeated with the hyphæ of a Rhizoctonia, similar to, if not identical with, that which is destructive to potatoes. Peas are more resistant to the attacks of this fungus than potatoes, but under certain conditions, such as in a heavy soil which holds the water and while the plants are young, the fungus gets the better of the struggle. In the case of seeds taken from diseased potato plants, treatment with solutions of corrosive sublimate or formalin has been found to prove efficacious, and probably this will also hold good for peas. A Rhizoctonia was also found to be the cause of disease on blackberries. Injurious effects of spraying apple trees with Bordeaux mixture are reported, causing malformation of the fruit. These and other pathological effects are illustrated by excellent plates produced from photographs.

CAPTAIN STANLEY S. FLOWER has issued his Report, for 1901, on the Zoological Gardens at Ghizeh, near Cairo, which are now placed under the Public Works Department of the Government of Egypt. The Report gives an excellent account of the condition and progress of this instituton, which seems to have prospered greatly under Captain Flower's directorship. The Gardens, which extend over about 50 acres, are beautifully treed and kept up; they are situated at Ghizeh on the left bank of the Nile, and are connected with Cairo by tramway. They contain living examples of about 700 species of mammals, birds and reptiles, and a great variety of plants. The number of visitors increases every year, and was 52,711 in 1901. The latest additions to the buildings are an elephant house, a lion house and a large aviary, besides other smaller structures. It is stated that examples of forty-five different species of wild birds were observed within the Gardens in 1901.

USEFUL suggestions for laying out, planting and cultivating a garden and grounds are given by Mr. T. W. Sanders in the second number of the series of rural handbooks in course of publication by Messrs. Dawbarn and Ward. Seven plans are given for laying out plots varying in area from a quarter of an acre to ten acres; and anyone free to follow the designs set forth, and capable of waiting patiently for the trees and shrubs to develop, may act with advantage upon the concise instructions which Mr. Sanders gives.

A CHEAP edition (price 6*d.*) of Laing's "Modern Science and Modern Thought," revised and brought up to date, with a biographical note by Mr. Edward Clodd, has been issued for the Rationalist Press Association by Messrs. Watts and Co. With reference to the revision which the advance of knowledge during the last seventeen years has rendered necessary, Mr. Clodd remarks:—"The portions thus affected are those dealing with the continuity of Palæolithic and Neolithic man in Continental Europe; with the recent discovery of remains, probably of an intermediate form between man and ape, in Java; and with the remarkable discoveries in Babylonia, which appear to accord to that empire on earlier civilisation than that of Egypt."

MR. BENJAMIN KIDD is leaving England shortly for South Africa, in connection with studies on which he is engaged. Since the publication of "Principles of Western Civilisation" he has been occupied with articles of some length for the "Encyclopædia Britannica." One of these deals with the application of the doctrine of evolution to society. The article on sociology in the new edition will be contributed by Mr. Kidd.

THE question as to whether tellurium or iodine possesses the larger atomic weight has given rise to many researches since Mendeléeff pointed out that the conclusion drawn from the periodic system was opposed to the experimentally determined facts. This work has hitherto been principally devoted to tellurium, partly because as the rarer and lesser known element tellurium might possibly contain elements of higher atomic weight, but chiefly because the work of Stas in regard to iodine appeared so convincing that further determinations of this constant for iodine would be superfluous. Since all the work done on tellurium tends to show that its atomic weight is decidedly higher than that of iodine, Prof. Ladenburg has attacked the question from the other side, and has redetermined the atomic weight of iodine, using methods of purification differing from those adopted by Stas; the result is in almost absolute agreement with the usually accepted figure, so that the discrepancy between the conclusions of the periodic law and the results of experiment still remains unexplained.

THE current number of the *Berichte* contains a paper by Dr. W. Marckwald on polonium, the radioactive constituent of bismuth. The discoverers of these radioactive elements, M. and Mme. Curie, after numerous attempts to isolate this element, concluded that polonium is a species of active bismuth, and that there is as yet no proof that it contains a new element. Dr. Marckwald, after numerous fruitless experiments, has succeeded in obtaining a minute amount of polonium in a manner which would appear to exclude the possibility of its identity with bismuth. Starting with some kilograms of residues from pitchblende, about 1 per cent. of strongly radioactive bismuth oxychloride was obtained, and it was proved that this activity remained unchanged after several months. The acid solution of this was then treated with a stick of pure metallic bismuth, the metal becoming after some time coated with a black deposit. It was found that the activity of this deposit, as measured by the electroscope, far exceeded that of the original solution, the residual solution having lost its activity during the deposition. No deposit was seen when a second stick of bismuth was placed in this exhausted solution. The total weight of polonium obtained was only 5 milligrams, corresponding to an amount not exceeding 1 gram per ton of pitchblende. The author hopes to be able to obtain sufficient material to carry out an atomic weight determination.

ALTHOUGH the fact of the existence of a gaseous antimony hydride has been known for many years, it is only comparatively recently that it has been obtained in the pure state, and the accounts of the stability of the pure hydride differ considerably. Thus, according to Olszewski, who first succeeded in solidifying the gas, decomposition with separation of antimony occurs readily even at − 90° C. The current number of the *Berichte* contains a paper on this subject by A. Stock and W. Doht. In order to obtain as rich a gas as possible, they made a careful study of the composition of the gas evolved from a series of alloys of antimony with zinc, sodium, calcium and magnesium, and they found that the magnesium alloy was much the best for the purpose. Thus, whilst the zinc-antimony alloys never yielded a gas containing more than 1 per cent. of the hydride, an alloy of one part of antimony with two of magnesium gave hydrogen containing from 10·4 to 14 per cent. of the antimony hydride. From this mixture the pure gas was easily solidified out with liquid air, melting at − 88° C. and boiling at − 17° C. The solid melts to a clear liquid, and evaporates without leaving any trace of antimony, and, in fact, the gas may be kept at the ordinary temperature for some hours before decomposition sets in.

THE additions to the Zoological Society's Gardens during the past week include a Brown Capuchin (*Cebus fatuellus*) from Guiana, presented by Madame Delmas; two Ocelots (*Felis pardalis*), two Common Boas (*Boa constrictor*) from South America, presented by Captain W. H. Lacy; two Giraffes (*Giraffa camelopardalis*, ♂ ♀) from Kordofan, two Cheetahs (*Cynoelurus jubatus*), three Secretary Vultures (*Serpentarius reptilivorus*) from Africa, presented by Colonel Mahon; a Green Woodpecker (*Gecinus viridis*) British, presented by Mr. J. T. Jones; a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, presented by Miss Ina King; five Lions (young) (*Felis leo*), two Grévy's Zebras (*Equus grevyi*, ♀ ♀) from Southern Abyssinia, a Campbell's Monkey (*Cercopithecus campbelli*) from West Africa, five Pratincoles (*Glareola pratincola*), European, two Lesueur's Terrapins (*Malacoclemmys lesueuri*), two prickly Trionyx (*Trionyx spinifer*), an Alligator Terrapin (*Chelydra serpentina*) from North America, two Striated Snake-head Fish (*Ophiocephalus striatus*) from India, two Egyptian Geese (*Chenalopex aegyptiacus*) from Africa, deposited; an Ourang-Outang (*Simia satyrus*) from Borneo, two Golden-backed Woodpeckers (*Brachypternus aurantius*), an Indian Roller (*Coracias indica*) from India, two White-eyebrowed Guans (*Penelope superciliaris*) from South-east Brazil, purchased; a Duke of Bedford's Deer (*Cervus xanthopygius*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

BRIGHT METEOR OF JULY 13.—Several correspondents send particulars of a brilliant meteor observed over a wide area last Sunday evening, July 13, about 10.30. According to charts sent by Prof. F. J. Allen from Cambridge, and Mr. A. Macrae from Crouch End, the meteor, which was probably sporadic, first appeared at an altitude of about 40°, and travelling in a N.E.–S.W. direction crossed a line joining Jupiter and Markab at right angles, at about 25° from the former. The meteor travelled very quickly and was intensely bright. Prof. Allen says:—"It illuminated the landscape like a considerable flash of lightning, though the moon shone and incandescent lights were near." Its colour is given as "violet-white." Mr. C. Waterer, of Margate, also remarks:—"It lighted up the whole

landscape in a remarkable manner, and seemed to glow with a peculiarly steady light." Mr. C. G. Osborne, who saw the meteor at Godalming, says that the light was so brilliant that people in a large hall thought a flash of lightning had occurred.

The trail, which was about 10° long and lasted for 15–20 seconds, is described as being of a violet and blue colour, and before extinction it became quite sinuous.

The Rev. F. J. Jervis-Smith, who observed the meteor at Iffley, near Oxford, sends the following notes of his observation:—"Time, 10.30 p.m., July 13. Approximate angle subtended by total length of luminous path about 15°. Line of flight downwards and nearly vertical. Bearing E.S.E. Angle between its highest point and the horizon about 45°. Time of duration about 2½ seconds."

Mr. Walter E. Besley, director of the meteoric section of the British Astronomical Association, states in the *Times* that the course of the meteor was from R.A. 311° and north declination 21° to R.A. 310½° and north declination 16½°.

DISCOVERER OF NOVA PERSEI.—At a meeting of the Société Astronomique held on July 4, M. Flammarion informed the members that it was one of their number, M. A. de Borissiak, a student at Kieff, who first observed Nova Persei. This observer recorded the Nova as being equal in magnitude to β Geminorum at 8 p.m. February 21, 1901 (Pulkowa time), and, taking into account the difference of longitude, this was about 8h. 40m. before Mr. Anderson discovered it.

The Russian Government has presented M. Borissiak with a special medal for this discovery (*Bulletin de la Société Astronomique de France*, July).

NOVA PERSEI.—The fourth report (June 1902) of the Variable Star Section of the British Astronomical Association, is devoted to a memoir in which Colonel Markwick has gathered together all the observations of the members on the magnitude, colour, light curve and spectrum of Nova Persei. The memoir contains several maps and charts of the region about the Nova, some very good light curves compiled, from many observations, by Mr. J. E. Gore and a series of excellent photographs of the Nova itself obtained by Mr. Alex. Smith at Dalbeattie, using a 5¼-inch doublet at various foci, sometimes with full aperture and sometimes with only half (*i.e.* a semicircular) aperture.

HONG KONG DOUBLE STAR OBSERVATIONS.—Nos. 3798–99 of the *Astronomische Nachrichten* are mainly devoted to the observations of 200 double stars made by Mr. W. Doberck at Hong Kong.

Mr. Doberck describes his instrument, which seems to be an ancient one, and shows how the somewhat necessarily large errors have been eliminated. He insists that observations of the same double star should be separated by fairly long intervals in order to render them quite independent of each other, and contends that stellar objects should always be designated by the initial and number of the discoverer, and not by any reference to a general catalogue.

OBSERVATIONS OF THE VARIABLE STAR χ^2 CYGNI DURING 1899.—M. Blum publishes in the *Bulletin de la Société Astronomique de France* an account of the observations of this star made during 1899 by MM. Ed. de Perrot and P. Sella.

The two sets of results and the curves plotted therefrom show very fair agreement, and M. Sella deduces the following conclusions from them:—

(1) The star is visible to the naked eye 3 days before and 30 *days after* the theoretical times.

(2) It increases to maximum (4·7) very rapidly, viz. in 17 days, but decreases very slowly.

(3) There exists a second maximum (4·8) about 28 days after the first, a third maximum (5·0) 16 days later than the second, and a fourth maximum about 18 or 19 days later than the third. The respective dates of observation were May 10, June 7, June 23 and July 11–12.

The complete range of variability of this star is about 8 magnitudes.

ROTATION OF THE BRIGHTER FIXED STARS, AS A WHOLE, WITH RESPECT TO THE FAINTER STARS.—In No. 3800 of the *Astronomische Nachrichten*, Sir David Gill communicates a preliminary note on the apparent rotation of the brighter fixed stars, taken as a whole, in regard to the fainter fixed stars, taken as a whole.

After comparing the common data given in the Cape Catalogues of 1880 and 1900, Newcomb's Fundamental Catalogue for 1900, Taylor's and other catalogues, and carefully correlating and eliminating the personal errors therein, the author arrives at the conclusion that the remaining discrepancies can only be accounted for by supposing the above-mentioned rotation.

The author urges that the greatest care should be taken to eliminate all the errors in reducing plates for the Astrographic Chart, and suggests that the Repsold-Struve method for magnitude correction, described by Cohn in the *Astronomische Nachrichten*, No. 3766, should be used.

PHOTOGRAPHIC MAGNITUDE OF STARS.—In a note to the Paris Académie des Sciences, M. Prosper Henry points out the effect of the influence of magnitude in causing errors, small but effective, in the reduction of stellar negatives.

Dissatisfied with the final utility of the method proposed by Sir David Gill in the *Bulletin du Comité de la Carte du Ciel*, he proposes a method where duplicate images of the same region are obtained very near together on the same negative, the one with a very short exposure, the other with a long exposure, and then by means of a formula in which the only variables are n, g' and g, he finds the quantity $\frac{n}{g'-g}$, which is the variation of the scale for a difference of one magnitude in the scale of magnitudes adopted, $g'-g$ being the difference in magnitude between the images obtained by the two different exposures. One advantage of this method is that it is not necessary to reduce the coordinates of the plate to right ascension and declination, neither is it necessary to correct for refraction unless the two exposures were made very far apart, and at some distance from the meridian.

MARINE BIOLOGY IN WALES.

AS announced last week, Mr. G. W. Duff Assheton-Smith, of Vaynol Park, Bangor, who has for many years taken a warm interest in the zoological department of the University College of North Wales, has offered a site to the College for a marine zoological station, on condition that the maintenance of the station when erected is assured. The fine zoological collection at the College bears ample testimony to Mr. Assheton-Smith's interest, as he has frequently enriched it with valuable specimens from his menagerie at Vaynol. The site spoken of is on the Menai Straits, about midway between Bangor and the suspension bridge. Sheltered and beautifully situated, it is from every point of view the best site in the locality on which to place such an institution. Besides giving the site with his rights to the foreshore, Mr. Assheton-Smith will also give the necessary facilities of access through his property. In the laboratory, aquarium and enclosures, which will be features of the station, investigations and experiments in connection with our fisheries will be instituted and carried out. The Menai Straits possess a peculiarly rich fauna, and material is always available for investigation and experimental purposes.

A brief note on the steps which have led up to this development may not be out of place. When, in 1892, the Liverpool Marine Biological Committee decided to vacate the station on Puffin Island and to take up its headquarters at Port Erin, Prof. Herdman offered, on behalf of his committee, to dispose of the Puffin Island station to Prof. White. Being unwilling to allow an institution of this nature so near to his college to lapse, and at the same time being desirous of continuing the work of the station as far as possible, Prof. White, with the cooperation of some of his colleagues, provided the money to acquire it. With the assistance of friends he also raised a small income for the maintenance of the building, for carrying on the work and for the publication of reports. A committee for investigating the fauna and flora of the coast of North Wales, and for promoting the sea fisheries, was formed and the work began. An account of the work accomplished is given in the various reports which have been issued.

The inaccessibility of the island, and other obvious difficulties connected with an isolated position, frequently presented themselves, and these led Prof. White to cast round for a more suitable situation, with the result as noted.

In addition to the promise of a site, the College obtains the professional services of an accomplished architect—Mr. Harold Hughes, of Bangor—free. Mr. Hughes took much interest in the Puffin Island station, and both he and Prof. White made some interesting excavations to elucidate the past history

of the island. A start has been made in raising the building fund, and Mr. Henry R. Davis, of Treborth, who acted as hon. treasurer of the Puffin Island station since 1892, has made a handsome contribution. It is hoped that his example will be largely followed.

With regard to maintenance, hopes are entertained that some money from Government sources will be available. A year ago the College approached the Board of Trade with a view of obtaining a grant to enable it to undertake systematic investigations in connection with fisheries, and recently the College put forward its claims for support before the Ichthyological Committee of the Board.

FORESTRY.

THE opening paper in the *Transactions* of the Royal Scottish Arboricultural Society, 1901 (vol. xvi. part iii.) is by Mr. J. S. Gamble, C.I.E., F.R.S., and gives a full account of the Forestry Exhibition in Paris in 1900, in the "Palais de Forêts, de la Chasse et des Cueillettes," the latter term practically meaning productions of various kinds, from baskets and fishing-rods to sponges and Russian caviare. The chief exhibit by the French Government was a series of models, photographs, pamphlets, &c., on the reclamation of mountain sides, including a large diorama representing a hill-side before—and several years after—reclamation. All these illustrate the magnificent work done by France in the last forty years, during which nearly 640 square miles of country have been reafforested at a cost of about two and a half million pounds. Mr. Gamble refers to the necessity of such work being undertaken in the Himalayas, where landslips due to forest denudation have wrought wholesale destruction. He instances hill-slopes which he once knew as covered with fine forests, but which are now bare and scored with landslips, while their gentle streams have been converted into torrents. The "sufficient for the day" policy of Indian administrators constantly neglects the work of preserving mountain forests, which is done seriously and systematically and with the best results in France, Austria and Hungary. The possession of a world-wide empire should induce us also to undertake such an obvious duty. More has been done in India to fix shifting sands, chiefly by means of casuarina plantations along the Coromandel coast, here also following the great French work in Gascony, where 260 square miles have been reclaimed and planted with maritime pine. The Germans have also afforested nearly the whole North German coast with *Pinus sylvestris*.

A great feature of the International Sylvicultural Congress held at Paris during the progress of the Exhibition was M. Mélard's paper on the world's annual excess of imports over exports of timber, which he estimated at 3,437,115*l*. in 1898, the chief importing countries being Britain, showing an annual excess of imports over exports of 20,523,758*l*., and Germany, 13,741,240*l*., and the chief exporting ones Austria-Hungary, having an excess of exports over imports of 7,941,422*l*., Sweden, 7,927,080*l*., Russia, 5,361,285*l*., and Canada, 5,077,756*l*. Alluding to the enormous imports of timber into the British Isles, M. Mélard notes that we have annually to build houses, factories and workshops for an increased population of 300,000, more than equal to that of Bordeaux, the third town in France. The large imports of timber into Germany, where 26 per cent. of the country is forest, much of which is scientifically managed, is a remarkable proof of the recent great economic development of that country.

The second paper in the *Transactions* is a reprint of Dr. Schlich's lecture at the Society of Arts, London, on February 27, 1901, on the world's timber supply, which gives more recent figures than M. Mélard's. Dr. Schlich had broken ground on this subject in March, 1897, in a lecture at the Imperial Institute; in the present paper he gives very full statistics, and sums up with the statement that plenty of hard-wood is still available, but that coniferous wood (soft-wood), which forms 85 per cent. of the total demand, can be continuously provided only by Sweden, Russia and Canada. Sweden, where the forests are well managed, may be able to increase its yield to 1,500,000 tons, out of a total demand of about 9,000,000 tons of coniferous timber, but the Russian supply is precarious; the great stand-by for coniferous timber will be Canada, if the Dominion Government does not lose time in introducing a rational management of the Canadian forests.

There are two useful papers by Mr. R. C. Munro Ferguson, M.P., the first on the arboricultural adornment of towns, with a list, by Prof. Bayley Balfour, of the shrubs and trees flourishing in the Royal Botanic Garden, Edinburgh. It is not, says Prof. Balfour, the low temperature of Edinburgh that retards the growth of woody plants, but winds blowing during cold weather deprive the plants of their water, so that, given shelter, a large number of trees and shrubs may be grown. Mr. Ferguson's second paper is entitled "Hints on the Training of Foresters." The advice given is excellent, and should be read by all young woodmen. Schools for woodmen might with advantage be established in the Crown woodlands adjoining the Forest of Dean and the New Forest, as well as near Edinburgh, but the great requisite for this country in forestry education is that it should be available at our universities, so that land owners, land agents and future colonial administrators may be taught the importance of forestry. At present it takes several years to teach a new colonial governor not to devastate woodlands, and as soon as he has learned the lesson and prepared a useful forest scheme he has to go, and his successor frequently upsets all he has done.

Several useful papers follow by different authors, chiefly estate woodmen, and in one of these, by Mr. D. A. Glen, on "Forestry in Kent and Sussex," the following passage occurs:—"In many of these woods, not only the dead leaves, but every bit of herbage and vegetable undergrowth is carefully raked together and carted away to make litter, which, after it has been well rotted in the cattle-sheds, is utilised as manure for the hop-fields." This practice is apparently also followed in Hampshire, and the future ruin of these impoverished woodlands is as certain as those treated similarly near Nuremberg, where the Scotch pine has become a dwarf tree rarely exceeding 12 feet in height.

Paper No. 41 of the *Transactions* is an account of a deputation last October to the President of the Board of Agriculture. This has been followed by the appointment by Mr. Hanbury of a Departmental Committee, "to inquire into and report as to the present position and future prospects of forestry, and the planting and management of woodlands in the United Kingdom, and to consider whether any further measures might with advantage be taken, either by the provision of further educational facilities, or otherwise, for their promotion and encouragement." Mr. Hanbury's committee is admirably selected, and the best results may be anticipated from its deliberations if only money is forthcoming to carry them out.

Colonel Bailey, R.E., the Instructor in Forestry at Edinburgh, gives some "Notes on the Forests of Norway," chiefly compiled from an official publication, which will be very useful to the members of the Royal Scottish Arboricultural Society in their proposed excursion to Norway this year. Last year's excursion was to woodlands near Glasgow, an account of which and several useful notes and queries on forest questions close this volume. The Society is to be congratulated on the excellent work done under its auspices.

While the Royal Scottish Arboricultural Society has been in existence for forty-eight years and contains more than 900 members, the English sister society is twenty years old and contained 513 members when the last volume of its transactions was published.

These transactions, in the first place, deal with last year's excursion to some interesting woodlands within easy reach of Peterborough. Then follow the two prize essays, to each of which a silver medal was awarded, the former by Mr. J. Price, on forest roads, with diagrams, a most useful paper, and the latter by Mr. A. Deane, of the Warrington Museum, giving descriptions of the structure of British woods, with beautiful reproductions of photographs of transverse sections of each species. Other interesting papers follow: "Arboreal Tunnellers" (leopard moth, hornet clearwing, goat moth and wood wasp), by Mr. C. Morley; and on an oak canker due to a species of Stereum, which the author considers to be new, and proposes to call *Stereum quercinum*, by Mr. M. C. Potter, Professor of Botany at the College of Science, Newcastle.

Sir Hugh Beevor contributes the financial history of a four-acre mixed plantation, calculating the rate of interest at 4 per cent., which Sir J. Hooker considers forestry should pay before it will attract attention from investors. The financial history of this plantation is summarised in the following statement, which is of sufficient general interest for reproduction in the pages of NATURE.

(1) INCOME.

Annual recurrent Income per acre :—

	£ s. d.
Sporting Rent	£0 7 0
	£0 7 0

(2) FELLING RECEIPTS—4 ACRES.

Date.	Age.	Trees Felled.	Total Receipts including underwood.	Expenses of Extraction.	Expenses of Sale.	Net Receipts.
			£	£ s.	£	£
1861	15	1059 Larch at 9*d.*	40	8 0[1]	3 ...	29
1872	26	251 Larch at 2/4 200 Oak at 7*d.* 56 Spruce at 1/3	42	8 0[1]	3 ...	31
1880	34	162 Larch at 6/8 174 Oak at 2/5 40 Spruce at 2/2	85	Felling 9 10 Clearing 5 10	7 ...	63
1892	46	143 Larch at 6/6 100 Oak at 4/4 8 Spruce at 3/2	76	Felling 8 10 Clearing 4 10	6 ...	57
1901	55	35 Larch, 735 c. ft. 268 Oak, 4000 ,, 10 Spruce, 200 ,,	240[1]	48 0[1]	22[1] ...	170[1]

[1] Items where estimate only was available. Such estimate must be considered approximate only.

(1) EXPENDITURE.

Annual recurrent Expenditure per acre :—

	£ s. d.
Tithe Rent Charge	£0 2 1
Land Tax	0 0 5
Fencing and Draining	0 1 4
Rates	0 0 8
Property Tax	0 0 4
Mole Catching	0 0 2
Bailiff Wage	0 2 0
	£0 7 0

(2) MONEYS DUE AT EACH FELL.

Date.	Cost and 4 per cent. Interest.	Rent and 4 per cent. Interest.	Total due.	Balance due.
	£	£	£	£
1846–61 ...	72 ...	20 ...	92 ...	63
1861–72 ...	97 ...	13 ...	110 ...	
... ...	... ...	... ...	.. ...	97
1872–80 ..	118 ...	9 ...	127 ...	
... ...	... ...	... ...	... ...	64
1880–92 ...	102 ...	15 ...	117 ...	
... ...	... ...	... ...	... ...	60
1892–1901 ...	85 ...	10 ...	95 ...	

1901 Estimated Profit after paying balance due, £75 = £19 per acre.

PLANTING COST, £40; RENT, £1.

An account follows of some French forests near Valenciennes and Compiègne, the latter having been selected for this year's excursion of the Society. It is shown that the French coppice-with-standards of St. Amand, with a rotation of twenty-five years, produces a net annual revenue of £1 2*s.* 8*d.* per acre, and that the splendid State forest of Retz, with an area of 32,550 acres under beech and oak, produces a net annual revenue of 17*s.* 7*d.* per acre, with a rotation of 150 years. Dr. Somerville, of the Board of Agriculture, the President of the English Arboricultural Society, contributes a notice on Prof. Schwappach's report on Prussian experiments with forest trees. The results most interesting to us are those obtained with *Fraxinus americana*, which withstands inundations better than *Fraxinus excelsior*, and develops its foliage fourteen days later than the latter, thus escaping ordinary spring frosts. *Larix leptolepis*, the Japanese larch, is also said to resist insects and fungi better than the European larch, while it easily reproduces injured leaders.

A Forestry Society has just been started in Ireland, so that all parts of the British Isles are now enlisted in the cause.

W. R. FISHER.

RECENT DISCOVERIES IN CHINESE TURKESTAN.

DURING the last twelve years or so, the attention of scholars has been repeatedly arrested by remarkable discoveries of ancient Hindu manuscripts in Central Asia. In 1889, Lieutenant Bower found an ancient birch-bark manuscript in Kuchâr, in the northern portion of Chinese Turkestan. This "Bower Manuscript" was at once recognised as the oldest Indian manuscript extant. In 1891 and 1892, M. Petrovsky, Imperial Consul-General of Russia at Kashgar, and the Rev. F. Weber, missionary in Leh, Ladakh, made no less important finds of old manuscripts in the region of Kashgar. Again, in 1897, the French traveller M. Dutreuil de Rhins found, in the vicinity of Khotan, some leaves of a very ancient birch-bark manuscript, in which M. Senart recognised fragments of a Prakrit version of the well-known Buddhist text, the Dhammapada. Meanwhile Dr. Hoernle, then principal of the Calcutta Madrasah, to whom we are indebted for a splendid edition of the "Bower Manuscript," had drawn the attention of the Government of India to the remarkable records of ancient Hindu civilisation to be found in Central Asia, and on his recommendation instructions were issued to the British officials in Kashgar and Ladakh concerning the acquisition of antiquities from Chinese Turkestan, and a "British Collection of Central-Asian Antiquities" was gradually formed at Calcutta.

But all these had been more or less casual discoveries, and as soon as it became known that European officials were ready to pay high prices for such antiquities, native "treasure-seekers" made it their business to ransack the ancient sites in the desert, not without damaging them, for manuscripts and other remains, and some of them were even unscrupulous enough to manufacture "old books" and sell them to Europeans as "antiques" unearthed in the desert. In these circumstances it became really a matter of urgency that systematic explorations, by some competent scholar, should at once be undertaken in these parts, all the more so as no part of Chinese Turkestan had ever been explored from an archæological point of view. No man could have been better fitted for this task than Dr. M. A. Stein, who, by his excellent topographical and archæological work in Kashmir and other parts of India, as well as by his scholarly edition and translation of the "Chronicles of the Kings of Kashmir," has shown that he combines the thoroughness and profound knowledge of the true scholar with the energy and hardiness, the practical experience and tact of the explorer. All students of India must feel thankful to the Indian Government for securing the services of such a man for the archæological and topographical exploration of Chinese Turkestan.

In June, 1900, Dr. Stein was placed by the Government of India on a year's special duty, for the purpose of exploring the southern portion of Chinese Turkestan and more especially the region of Khotan. A Chinese passport from the Tsung-li-Yâmen was obtained, authorising him to travel and make excavations in Chinese territory. The Survey of India Department rendered material assistance by deputing one of the sub-surveyors, Babu Ram Singh, to accompany Dr. Stein on his travels, and by providing the necessary equipment of surveying instruments. Thus Dr. Stein was enabled, throughout the whole of his journey, to carry on geographical work along with his most interesting archæological researches.

A "Preliminary Report,"[1] published by Dr. Stein shortly after the completion of his journey, gives information about the character and scope of his explorations and their principal

[1] "Preliminary Report on a Journey of Archæological and Topographical Exploration in Chinese Turkestan." By M. A. Stein, Indian Educational Service. Published under the authority of H.M.'s Secretary of State for India in Council. (London, 1901.)

results. As to the intrinsic historical value of the discoveries made there can be only one opinion. It is true their full import will only be realised after the publication of the detailed report to be expected from Dr. Stein himself, and after a thorough examination of the archæological specimens, photographs, coins and manuscripts which will occupy scholars for many years to come; but even a perusal of the "Preliminary Report," and a glance at the illustrations and plates added to it, suffice to show that they will shed a flood of light on the history of an important period, and on the manifold relations between India and Central Asia during the first centuries of our era.

Dr. Stein left Srinagar on May 29. He travelled by the Gilgit-Hunza route, and on June 28 crossed the Kilik Pass and entered Chinese territory on the Tāghdumbāsh Pāmīr. A five days' journey down the valley of this Pāmīr brought him to Tāshkurghān, the chief place of the Sarīkol mountain tract. Marching down the plains of Kashgar, he arrived, on July 29, safely at the capital of Chinese Turkestan. In Kashgar he made the necessary preparations for his travels in the desert, not only by organising a fresh caravan, but also by making efforts to secure the good-will of the Chinese authorities for the intended explorations. In these efforts he was assisted, not only by Mr. Macartney, the diplomatic agent of the Government of India at Kashgar, but also by—the famous Chinese pilgrim of the seventh century, Hiuen-Tsiang. "All educated Chinese officials," writes Dr. Stein, "seem to have read or heard legendary accounts of the famous Chinese pilgrim's visit to the Buddhist kingdoms of the 'Western countries.' In my intercourse with them I never appealed in vain to the memory of the 'great monk of the T'ang dynasty' (T'ang-Sēn), whose footsteps I was now endeavouring to trace in Turkestan, as I had done before in more than one part of India."

On September 11, Dr. Stein left Kashgar and started on his journey to Khotan, choosing for his march to Yarkand, not the ordinary caravan route, but a track leading through the desert. After a short halt in Yarkand, he proceeded on the caravan route leading to Khotan along the southern edge of the desert, following "the same great thoroughfare by which in earlier times the trade from the Oxus region and the far West passed to Khotan and to China." A peculiar feature of this route and of the desert around Khotan are the "Tatis," as the natives call the "extensive patches of ground where the eroded loess is thickly strewn with fragments of coarse pottery, bricks, slag, and similar refuse marking the sites of villages and hamlets long ago abandoned"—an ideal marching ground for the archæological explorer. He reached Khotan town on October 12. The next four weeks were devoted to geographical work in the Kuen-luen range and Khotan mountains, whereupon he turned again to archæological interests, paying a visit to the Kohmārī ridge opposite to the village of Ujat, and examining old sites in the Khotan oasis, more especially those near the village of Yōtkan, where "treasure-seeking" has long been carried on along with jade-digging and gold-washing. Having finished the survey of ancient localities within the oasis, he started on December 7 on his way to Dandān-Uiliq, the site chosen for the first excavations in the Taklamakān desert. Marching through the desert, the small caravan, including a party of thirty labourers for the excavation work, found itself on December 18 in the midst of the scattered ruins of Dandān-Uiliq. This ruined site had been seen by Dr. Sven Hedin on his march to the Keriya Daryā, and is spoken of in the narrative of his travels as "the ancient city of Taklamakān." For fully three weeks most successful excavations were carried on by Dr. Stein amongst these ruins. On January 6, 1901, he left this neighbourhood, and marched across sand dunes, rising to a height of about 200 feet, to the Keriya Daryā, and along the hard frozen river to the oasis and town of Keriya, in order to secure the assistance of the Amban (the Chinese district magistrate) for his further explorations. Making inquiries at Keriya about old localities, he heard of an "old town" in the desert north of the Muhammadan pilgrimage place of Imām Jafar Sādīk. He set out in search of this ancient site, and reached Niya—the Ni-jang town of Hiuen-Tsiang—on January 21. Six days later he was among the ruins of the Niya River site, as Dr. Stein, in absence of any special local designation, calls this site, where the excavations, carried on for nearly three weeks, yielded the most important results of the whole journey. At Niya he had heard of old remains to be found in the desert to the east towards Cherchen, and he set out in search of them. Marching more than a hundred miles to the east from Imām Jafar Sādīk, he reached the point where the Endere stream is lost in the sands. A day's march further to the south-east brought him to the "old town of Endere," which was next explored. Interesting archæological remains and manuscripts were brought to light by the excavations. Some Tibetan manuscripts found here showed that the easternmost point of the exploration area had been reached. Hence Dr. Stein began to march back to Keriya and Khotan. Some 150 miles north of Keriya the ruins of Karadong—as they are called by the nomadic shepherds grazing along the Keriya Daryā—were visited and explored by Dr. Stein, before he continued his march to Khotan. The sand-storms and increasing heat warned him that work in the desert would soon become impossible. He hastened, therefore, to visit the ancient sites to the north-east of Khotan which had still to be explored. After examining the scanty ruins of Aksipil, some fifteen miles from the right bank of the Yurung-Kāsh opposite Khotan, he marched due north through the sands for about fourteen miles, when he reached the ancient site called Rawak by native "treasure-seekers." Here the last, but by no means the least interesting, excavations were carried on for a whole week. On April 18 the work was finished, and, having completed the programme of his explorations in the desert, Dr. Stein could return to the town of Khotan, where he arranged and carefully repacked his archæological finds. On May 1 he set out for Kashgar, where he made arrangements for his journey to Europe. He left Kashgar on May 29, and travelling through Russian Turkestan he reached, at Andijan, the terminus of the Transcaspian Railway. By it he travelled to Krasnovodsk, crossed the Caspian to Baku, and finally, on July 2, arrived in London, where he was able to deposit his important collection—twelve large boxes, containing numerous relievos, frescoes, painted tablets, and other specimens of Central Asian art, coins, manuscripts, and more than 800 negatives on glass plates, the photographic results of his journey—in the British Museum. A three months' period of deputation in London had to suffice for the provisional arrangement and cataloguing of his precious finds and for preparing the "Preliminary Report."

It would require far more space than I could be allowed in these columns to mention only the most important results of Dr. Stein's explorations. I must content myself with just pointing out the most striking features of the discoveries recorded in the "Preliminary Report." Though archæology and historical topography were the chief interests, and the desert around Khotan was the principal area of the explorations made by Dr. Stein, he missed no opportunity, throughout the whole of his journey, to attend to general geographical work as well and to make valuable anthropological and ethnographical observations.

Thus, in the interests of geography, he superintended the survey on the Tāghdumbāsh Pāmīr and in the Sarīkol mountain tract; and by choosing for his march to Kashgar the route which passes through the valleys between the Russian Pāmīrs and the western slopes of the Muztāgh-Ata range, he was able to extend this survey to the Muztāgh-Ata and the mountain ranges overlooking the Little Karakul Lake. Again, on his march from Kashgar to Yarkand he succeeded in fixing the position of Ordam Pādshāh more accurately than is done on the existing maps. After his arrival in Khotan he devoted a whole month to survey operations in the Kuen-luen mountain range, especially in that portion of it which contains the head-waters of the Yurung-Kāsh River. He also explored the hitherto unknown mountain tract towards the Karakāsh River and was able to complete the triangulation of the Khotan Mountains.

Anthropometric observations were made by Dr. Stein in all regions offering any anthropo-geographical interest, for instance among the Iranian hillmen in the Sarīkol settlements. Nor did he omit to make notes of any popular legends and folklore connected with interesting localities, and often he found "old stories" which Hiuen-Tsiang had heard and recorded in the account of his travels, still alive among the population. The tenacity with which local legends survive proved often very useful in the identification of old sites. Thus, near the frontier of the Khotan district, there is a Muhammadan shrine known as Kaptar-Mazar, *i.e.* "the pigeon's shrine," at which thousands of pigeons are kept and propitiated by food offerings, and a legend is told of a great victory won with the help of pigeons by some Muhammadan hero over a host of Khotan unbelievers. Now Hiuen-Tsiang tells us that some thirty miles to the west of the capital of Khotan there was a range of hills supposed to have been formed by the burrowing of rats, the rats having been

worshipped there owing to the popular belief that in ancient Buddhist times they had saved the land by destroying the leather of the harness and armour of some hostile army. The locality indicated by the Chinese pilgrim corresponds exactly to Kaptar-Mazar, and Dr. Stein has no doubts that the pigeons of the Muhammadan legend have taken the place of the rats of the legend as related by Hiuen-Tsiang.

During the whole of his journey, Dr. Stein paid the greatest attention to historical topography. Everywhere he tried to trace and identify ancient sites mentioned by Hiuen-Tsiang and other Chinese travellers. Thus—to mention only some of the more important results—Paloyo, the Dard designation of the people of Baltistān, was identified with the term Po-liu, as used in the Chinese Annals and in the narratives of the Chinese pilgrims. Sir Henry Yule's identification of Sarīkol with the K'ie-p'an-to territory of Hiuen-Tsiang was fully confirmed by Dr. Stein's investigations. On his march to Khotan he was able to identify the small oasis of Mōji with the town of Po-Kia-i, where a famous Buddha statue brought from Kashmir was worshipped in the times of Hiuen-Tsiang. Following the road once used by the Chinese pilgrim, he traced other ancient sites near the oasis of Zangūya, and close to the frontier of the Khotan district. Two identifications, previously made by M. Grenard, were fully borne out by the evidence found by Dr. Stein—that of the Kohmārī ridge and cave with the ancient Gośṛṅga mountain and the cave where the popular legend of Hiuen-Tsiang's time supposed a Buddhist saint to reside "plunged in ecstasy and awaiting the coming of Maitreya Buddha"; and that of the village of Yōtkan with the ancient capital of Khotan. Among the many proofs for the latter identification, the most convincing was that, from this starting point, Dr. Stein was able to identify the positions of the most important Buddhist shrines visited by Hiuen-Tsiang, the places of which are generally occupied now by Muhammadan Ziārats. Thus, the small hamlet of Somiya was found to correspond exactly to the Buddhist convent described by the Chinese pilgrim under the name of Sa-mo-joh. Finally, we may mention that on his march from the Karadong ruins to Keriya, Dr. Stein identified the position of the town of Pi-mo, described by Hiuen-Tsiang, in the neighbourhood of Lachim-Ata Mazar.

But it is chiefly for his archæological discoveries and his manuscript finds that Dr. Stein's journey of exploration will ever be memorable. We cannot enter here into details about the many interesting Buddhist monuments examined by Dr. Stein in the course of his travels in Gilgit, Hunza, Sarīkol and Kashgar, and the antiquities collected by him on the Yarkand-Khotan route, in Khotan town and in the village of Yōtkan. Also for the excavations made at the Endere site, at Karadong and at Ak-sipil we must refer the reader to Dr. Stein's "Preliminary Report." But a word or two must be said about the most important results of the excavations carried on among the ruins of Dandān-Uiliq, the Niya River site and of Rawak.

No less than fourteen detached temples and dwelling-houses were excavated in Dandān-Uiliq. First of all two temple cellas were brought to light, richly decorated with wall paintings and stucco images. The interior of the larger cella was occupied by a colossal stucco statue, probably representing a Buddha. Each of the four corners of the same cella was occupied by a draped stucco figure standing on a lotus-shaped pedestal. The cella walls were decorated, inside with frescoes showing figures of Buddhas or Buddhist saints, and outside with fresco bands containing small representations of saints, seated in an attitude of meditation. In style of composition and the drawing of figures, these wall decorations are similar to the later of the Ajanta frescoes. But as we possess only very few specimens of old Indian painting, the study of the Dandān-Uiliq frescoes will prove of particular interest. For the same reason, the small painted tablets which Dr. Stein discovered on excavating the temple cellas are of importance. They were probably votive offerings from worshippers who had come to visit the shrines in ancient times. A figure represented on one of these tablets shows the head of a rat—which is interesting in view of the legend of sacred rats mentioned above. Near the excavated buildings Dr. Stein generally found groups of shrivelled and bleached trunks of poplar and fruit trees, the remains of ancient orchards or avenues. Also traces of old irrigation channels were recognisable in the sand.

Of the manuscripts excavated at Dandān-Uiliq, the most important are some oblong leaves of paper inscribed with old Indian Brāhmī characters (*i.e.* the alphabet which is written from left to right, and used in the edicts of King Asoka, and similar epigraphic documents), and belonging to five different manuscripts, three of which are in Sanskrit and contain Buddhist texts. From their palæographic peculiarities Dr. Stein concludes that they cannot be later than the seventh, and may belong even to the sixth or fifth, century. Moreover, there were found single leaves of thin, coarse paper, inscribed with cursive Indian characters, but showing a non-Indian language, and some Chinese documents of similar material and appearance. Two of the latter bear dates, according to which they must have been written between 763–805 A.D. Dr. Stein thinks that these dates indicate about the time when the dwellings were abandoned. The evidence of numerous coins found in the course of excavations supports this dating of the Dandān-Uiliq ruins.

Among the most interesting discoveries in the ruins at the Niya River site, there are remains of two large dwelling-houses, excavated by Dr. Stein. In one of them some specimens of household furniture, illustrating the industrial arts of the period, were found, amongst others a wooden chair with ornamental wood carving, the decorative motives of which closely resemble those of the relievo sculptures of the Buddhist monasteries of Yusufzai and Swat (the ancient Gandhāra). In one room, the stuccoed walls of which showed a carefully executed fresco decoration, the pieces of a coloured rug—an interesting specimen of ancient textile industry—were brought to light. Again, in another of the excavated houses there were found the legs and arm-rests of a wooden chair, representing lions and human-headed monsters, and still retaining traces of colour, and also the broken end of a kind of guitar, resembling the popular "Rahāb" of modern Turkestan.

But most important of all are the manuscripts unearthed at the Niya River site. More than 500 wooden tablets inscribed with ancient Kharoshthī characters (*i.e.* the alphabet written from right to left, and known chiefly from Indo-Scythian and Indo-Greek coins, found in the north-west of India) were found among the ruins of this site. Most of them are wedge-shaped, from 7 to 15 inches long, and arranged in pairs; and some of them still retained their string and clay sealing intact, thus illustrating the ingenious manner adopted for the fastening and sealing of these documents. Other tablets were oblong, some of considerable length (up to 30 inches), resembling the Indian palm-leaf manuscripts. An ancient pen, made of tamarisk wood, with a bone knob, was found, and gives us some idea of clerical work in this remote period. A considerable number of these tablets were found in an ancient rubbish heap, and there were also some narrow pieces of wood inscribed with Chinese characters. The same rubbish heap yielded another very rare, and in a Buddhist country particularly surprising, writing material, namely, about two dozen documents written in Indian Kharoshthī characters on leather. A thorough examination of all these documents as to their contents will take much more time than Dr. Stein was able to bestow on them during his short deputation. But he could make out that most of them were written in an old Prakrit dialect with an admixture of Sanskrit terms, and the wedge-shaped tablets seem to contain correspondence, records of agreement, bonds, memoranda and the like, while religious texts, votive records, &c., will probably be found to form the contents of the longer tablets. As to the date of these documents, palæographical evidence proves them to belong to the first centuries of our era. For the writing resembles closely that on the inscriptions of the Indo-Scythian kings who ruled over the Punjab and the Kabul region during the first two centuries, and the Kharoshthī alphabet soon ceased to be used after that period. These wooden tablets must, therefore, be considered at present as the oldest Indian manuscripts extant. The use of wood as writing material is also a proof of considerable antiquity. From the fourth century onward, the use of paper as writing material is attested for Turkestan. Yet not the smallest scrap of paper was discovered in the ruins of the Niya River site. Numismatic finds, as well as the influence of classical art shown on some of the clay seals attached to the tablets, confirm this dating.

The last excavations were those made at Rawak, where Dr. Stein found an imposing Stūpa surrounded by a court forming a quadrangle 164 feet long and 143 feet broad. Both inside and outside, the walls of this Stūpa court were decorated with rows of colossal statues in stucco, representing Buddhas or Bodhisattvas, and between them at frequent intervals with smaller relievos

representing deities and saints. The whole of the relievo work had originally been coloured, and there were fresco paintings besides. The excavations of these relievos proved no easy task, as the structures threatened to collapse when the sand was removed. Yet Dr. Stein succeeded in clearing ninety-one large and numerous small relievos. Photos were taken of the larger relievos, while the smaller ones were taken to England. In style and details of execution the Rawak sculptures resemble the Græco-Buddhist sculptures of the Peshawar Valley and the neighbouring regions. Chinese copper coins, found among the ruins, proved to be coins of the Han dynasty. As the rule of the kings of this dynasty covers the period of 25–220 A.D., and some of their coins are known to have been current until the close of the fourth century, we have thus a chronological limit, to which the Rawak sculptures may safely be referred.

Finally, we must at least touch upon one negative, though none the less important, result of Dr. Stein's journey of exploration. During his last eight days' stay at Khotan he succeeded in clearing up the doubts he had long entertained concerning the genuineness of certain very puzzling manuscripts and blockprints "in unknown characters" which had for some years past been purchased from Khotan and added to the "British Collection of Central-Asian Antiquities" in Calcutta. With the help of the Chinese authorities he got hold of the very man—one Islām Ākhūn—from whom most of these documents had been bought. The man was brought before Dr. Stein, who forced from him, in the course of a prolonged cross-examination, an open confession of his manufacture of "old books." Dr. Stein has shown that it is easy to distinguish the forgeries from genuine old manuscripts, and there is no fear that any scholar will, in future, be deceived into trying to decipher the "unknown characters" of Khotan manuscripts.

This brief sketch will suffice to give an idea of the singular importance of the discoveries made by Dr. Stein. But the costly treasures brought by him from Chinese Turkestan will require the most careful examination and study to be made fruitful for further research, and who could be better fitted for this task than the happy discoverer himself? While congratulating both the Indian Government and Dr. Stein on the brilliant discoveries made in Central Asia, we can only express our sincerest hope that the authorities of the India Office may see their way to grant Dr. Stein the leisure required for completing the work so happily begun, in order that the present "Preliminary Report" may soon be followed by a Detailed Report of Dr. Stein's tried workmanship.

M. WINTERNITZ.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE authorities of Reading College have received an intimation that the Treasury recommends the advancement of the College to the list of University Colleges, with a Government grant of 1000*l.* a year for five years. The grant will be subject to the Treasury audit, but local subscribers have assured the necessary income.

PROF. HEWLETT, director of the Department of General Pathology and Bacteriology at King's College, London, has arranged a vacation course in practical and clinical bacteriology to commence Wednesday, August 6, and end Saturday, August 16. The course will consist of lectures, demonstrations and practical work; in the latter, the members of the class will make for themselves permanent preparations of the chief pathogenic micro-organisms and will carry out the principal manipulations employed in bacteriological investigations.

A MEETING of numerous representatives of primary, secondary (including technical) and other branches of education was recently held at the Municipal School of Technology, Manchester, to consider whether arrangements should be made for a conference of science teachers in the north of England on the lines of those established by the Technical Education Board of the London County Council, which have been held in London during the Christmas vacation for some years past. The proposal to hold similar conferences in the north of England was unanimously adopted, and a committee formed to make the necessary arrangements. The first conference will be held on Friday and Saturday, January 2 and 3, 1903, at Manchester.

A LIST of requirements and courses at the Clarkson Memorial School of Technology, Potsdam, New York State, has been received. The institution was founded in 1895 to provide technological education of college standard, and is a constituent college of the University of the State of New York. It is of interest to note that the regular courses of work extend over four years and that satisfactory evidence of thorough preparation must be given by students who wish to enter the college. Now that the London polytechnics are part of the University of London, efforts should be made to introduce or extend the same kind of regulations as to systematic work and preliminary studies.

HITHERTO none of the technical institutes has been specially organised for the optical trades, though optical classes have been held in several of them, notably in the Northampton Institute in Clerkenwell. But the optical trades appear to have awakened to the need of specialised instruction of the highest kind for the young men in their industry, and a movement to create a real Optical Institute is on foot. The Optical Society has approached the Technical Education Board of the London County Council to urge upon it the creation of such an establishment. If the Technical Education Board could see its way to organise and equip a special technical school in optics, and endow it with a grant of 3000*l.* or 4000*l.* a year, we might expect great things for the future of the optical trades. When it is remembered how greatly the electrical industries of Great Britain have benefited by the electrical teaching and the electrical laboratories established twenty years ago by the City and Guilds Institute, one wonders why similar optical laboratories, properly equipped for the teaching of technical optics, have not been long ago organised. The present movement is a sign that England is waking up.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 13.—"The Refractive Indices of Fluorite, Quartz and Calcite." By J. William Gifford. Communicated by Prof. Silvanus P. Thompson, F.R.S.

Tables are given of the refractive indices of the above substances for twenty-six wave-lengths, from wave-length 7950 Rb to wave-length 1852 Al inclusive at 15° C., and of the temperature refraction coefficients. To ensure accuracy a new method of observation was adopted. The prisms were polished on three sides, and deviations were measured at each of the three angles. The indices were calculated by the formula

$$\mu = \sin \tfrac{1}{2}(D + 60^\circ)/\sin 30^\circ.$$

The difference of the angles of the prisms from 60° were in each case less than 4 seconds of arc. When this is the case the error introduced is less than 0·0000001 in the index. It is not, therefore, necessary to measure the angles with accuracy. Some of the rays from the collimator are reflected from the base of the prism and enter the telescope. The image of the slit thus obtained coincides with the refracted image only when minimum deviation is reached. In cutting the goniometer circle a burr is thrown up by the engraving tool on each side of every division. By two small electric lamps behind the reading microscope either or both burrs are made to appear as fine white lines. With the help of quartz fibres measurements are made on these and the mean taken. A correction is made for the error of the reading microscope, and special precautions have been taken to ensure the optical correctness of the prisms. An exact copy of the original measurements for line C fluorite is given. An approximate estimate of the total error gave for the 119 indices in the table,

33 less than... ...	0·0000023
39 ,, ...	0·0000034
31 ,, ...	0·0000084
15 more than ...	0·0000084
1 only as great as but not more than ...	0·0000150

Some indices for left-handed quartz are given, and a rough determination of the specific gravities of right and left quartz. The partial and proportional dispersions of fluorite, quartz and calcite for the visual spectrum and their lens combinations are also given, together with a list of focal lengths for unity and a table of curves for the whole spectrum with ordinates for a mean focal length of six thousand nine hundred and eighty-five millimetres.

PARIS.

Academy of Sciences, July 7.—M. Bouquet de la Grye in the chair.—The president announced to the Academy the loss it had sustained by the death of M. Faye, member of the Section of Astronomy.—On the relation between the intensity of the voltaic current and the amount of electrolytic action, by M. Berthelot.—The properties of a certain anomaly capable of replacing the anomalies already known in the calculation of the disturbances of the smaller planets, by M. O. Callandreau.—On the development of analytical functions in a series of polynomials, by M. Paul Painlevé.—The local treatment of the localisations of rheumatism, by M. Ch. Bouchard. From the experimental results quoted, the superiority of local treatment by injection over general treatment by the same drug (sodium salicylate) is well marked. The author concludes that in general it is better to apply the drug only at the place where it is useful, by injection.—M. Bouvier was nominated a member of the Section of Anatomy and Zoology in the place of the late M. Filhol.—On a new linear group of four variables, of finite order, by M. Léon Autonne.—On the electrolysis of silver nitrate, by M. A. Leduc. It is generally stated that the bath of nitrate of silver becomes more and more acid after prolonged electrolysis; the contrary effect was, however, observed by Rodger and Watson. It is shown how either result may be obtained by varying the conditions in a definite manner. It is noted incidentally that the counter electromotive force of a silver nitrate voltameter, which has been usually assumed to be zero or extremely small, is in reality by no means negligible, amounting to about 0·03 volt.—On the action of self-induction in the ultra-violet portion of spark spectra, by M. Eugène Néculcéa. A continuation of previous papers, the present instalment giving a study of tin.—New researches on open currents, by M. V. Crémieu.—On the nature of the coherer, by M. J. Fenyi. A coherer formed of four steel needles in parallel is no more sensitive than a single needle, but if the four are placed in series a greater electromotive force can be placed in the circuit, and the sensibility is accordingly increased.—The dissociating action of the divers regions of the spectrum on matter, by M. Gustave le Bon.—Dark light and actinoelectric phenomena, by M. Gustave le Bon.—On the hydration of zinc oxide, by M. de Forcrand. A thermochemical study of the solution of zinc oxide.—The oxidising properties of a pyranol, by M. R. Fosse. Dinaphthopyranol possesses an oxidising action towards hydriodic acid, an attempt to prepare the hypoiodite resulting in the formation of the tri-iodide of the oxonium compound.—The condensation of nitromethane with aromatic aldehydes, by MM. L. Bouveault and A. Wahl. The best condensing agent for the reaction between the nitromethane and the aromatic aldehyde is sodium methylate; the sodium salt which separates is then treated with zinc chloride. The reaction has been applied to anisic, piperonylic and ortho-nitrobenzoic aldehydes and to furfurol.—The action of diazoic salts on desmotroposantonine and desmotroposantonous acid, by MM. E. Wedekind and Oscar Schmidt.—On a new proof of the cellular resistance of the saccharomyces and on a new application of this property to industry and the distillery, by M. Henri Alliot. The method which is usual in distilleries for removing nitric acid and other volatile acids prejudicial to the development of the yeast is to add sulphuric acid to the molasses, heat to boiling and force through a current of air. To avoid this, the author takes some of these volatile compounds and grows an acclimatised yeast by gradually adding increasing quantities of these antiseptic compounds to the cultures. The properties thus acquired by the yeast are sufficiently permanent for industrial use in the distillery.—On the active principles of the poison of the toad, *Bufo vulgaris*, by MM. C. Phisalix and Gab. Bertrand. Toad poison owes its activity to two principal substances—bufotaline, of a resinoid nature, and bufotenine.—On the nature of bufonine, by M. Gabriel Bertrand. The bufonine described by Faust does not exist in toad poison directly extracted from the glands, but has its origin in other parts of the skin. It appears to be an impure cholesterine.—The influence of sulphocyanic acid on the growth of *Aspergillus niger*, by M. A. Fernbach. The sulphocyanide does not appear to interfere with the growth of the mycelium, but arrests fructification.—On the influence of choline on the glandular secretions, by M. A. Desgrez. Although an advanced decomposition product of albumin, choline is not without use to the organism in which it is produced, it exerts a favourable influence on the nutritive exchanges and contributes especially to the retention of phosphorus.—The disappearance of ethers in the blood *in vitro*, by MM. Maurice Doyon and Albert Morel.—Inhibition produced by interference on the retina, by M. Aug. Charpentier.—On the autoregulation by carbonic acid of the energetic working of organisms, by M. Raphael Dubois.—The influence of temperature on the parthenogenetic development, by M. C. Viguier.—On the evolution of the branchial formations in the lizard and slow-worm, by MM. Prenant and Saint-Remy.—Contributions to the anatomical study of *Rhabdopleura Normani*, by MM. A. Conte and C. Vaney.—On the cause of the changing colours of teguments, by M. H. Mandoul.—On a new method for the destruction of the pyralis and other noxious insects, by MM. Vermorel and Gastine. The use of liquid insecticides having proved non-efficacious, recourse was had to gaseous poisons, hydrocyanic and sulphurous acids, sulphuretted hydrogen, &c., but without effect. By means of a special apparatus, steam at 50° C. was then applied to the leaves, and this mechanical method, which used with due care proved to be without injurious effects on the vines, was found to be very serviceable.—On the presence of the Aptian stage in south-east Africa, by M. W. Kilian.—On the volcanic eruption of May 8 at Martinique, by M. Thierry.

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