THURSDAY, MAY 21, 1903.

THE PRINCIPLES OF DISEASE.

The Prevention of Disease. Translated from the German. With introduction by H. H. Bulstrode, M.A., M.D. Pp. xviii + 1063. (Westminster: A. Constable and Co., Ltd., 1902.) Price 31*s.* 6*d.* net.

IN all studies we are turning back to remoter and remoter causes, and to the investigation of origins; but, as we abstract and abstract, we are apt to get vaguer and vaguer, more and more are individual features merged in types, and in medicine we may find ourselves reduced at last to the emptiness of general counsels for a temperate and wholesome life. Nevertheless, the modern physician cannot be content with the knowledge that the patients under his care are victims of phthisis, of Bright's disease, of failing heart, of premature senile decay, and so forth, without a desire to learn the nature and direction of the processes by which such changes are initiated. As in but few instances he has discovered these small beginnings he is discontented; and it is well that he should be so. Our ancestors did not fail to see that diseases are moving things, so active that some demon or evil principle might be behind them; but this conception of activity, effective enough for instant purposes, contained no adequate notion of remote or latent causes. Some such notions may be traced in the ancient doctrines of the temperaments or diatheses, but were speculative and comparatively barren. Initial causes were, as we should expect, first observed and revealed in the infections, when a definite external pathogenic factor enters into a healthy or apparently healthy person; but even such events would seem to be very inconstant in their occurrence. Of two men exposed to such an attack, one would betray no sign of suffering, while the other would fall ill; an inconstancy indicating that the causation of an individual case of infection consists of far more than the intrusive element itself, which in some cases impinges upon a series of cooperating, in others of antagonistic causes. And if the patient succumbs, the outbreak of disorder is not immediate; a variable but specific interval elapses before its first manifestations. Now if from the recognised infections we turn to other diseases, we try to discover if some of these also arise from incidental agencies of a more occult kind, but having also their latent periods and gradual initiations. Others, again, may not be attributable to external elements, scarcely even as secondary and accelerating causes; but arise as later terms of processes implicit in the organism itself, perhaps even from the embryo.

Now the more definite and prevalent the outer causes, as in the more notable infectious diseases, the better is our position, if we can discover the laws of them, to take preventive and defensive measures on an extensive scale, and to entrust them to public physicians acting on behalf of individuals only as members of a community. On the other hand, the more a disease is the outcome of individual and peculiar proclivities, the less are such public and universal precautions available against it. Public health may be secured by universal rules and enterprises, but the health of individuals, so far as it involves a study of the constitution of each one of them, must be a matter of private practice; though diseases such as phthisis, which arise from a cooperation of general and personal factors, need for their prevention a combination of public and private means.

In respect of epidemic infections, which can be studied on public lines, and have more definite causes and periods, much has been done in the way of prevention since the time of those first medical officers of health, the fetishman or voodoo; but, as Dr. Bulstrode says in his able preface to the volume before us, similar investigation of remote and initial causes, and the preventions to be based upon them when detected, have made but little way as yet in constitutional diseases. Indeed, Dr. Bulstrode goes so far as to suggest, justly as we think, that one of the uses of this book on the prevention of disease in its broader and yet more intimate sense, will be to force upon the notice of physicians that, meritorious as it is to stem the tide of established maladies, this function would be less and less in demand if our insight into and means of detection of their incipient terms were more largely developed. It is the chief merit of the work before us that, perhaps for the first time, our conception of preventive medicine is carried in a formal and imposing way beyond the sphere of the infections; and the first comprehensive attempt is made to apply preventive principles to the initial phases of all diseases.

The dangers of such an enterprise are obvious; when we leave conspicuous and specific phases of change, and seek for the more abstract and universal springs of disordered health, we run the risk of losing not only colour and vivacity, but grip and precision also. As we empty our conceptions of individual characters, we may lapse into platitude. In the construction then of a pioneer work on these broad lines, and on these remoter and vaguer conditions of disease, especial care should be taken to avoid such triviality, and to convince the reader that in tracing rivers to their sources the explorers have not lost themselves in a multitude of shallow rills and in a confusion of forests and watersheds. In this somewhat uncomely, and, seeing that illustrations were not needed, expensive volume, we think that the dangers we have indicated have not been avoided altogether. In a cooperative work we expect to find writers of very wide differences of merit; some good, some middling, some really trivial: but the jealous regard for precision and touch with nature which, as we have seen, should be the note of such a work, and the antidote to its summary methods, has not always been enforced by the editors. The introductory article on the history of the prevention of disease among the Hindoos, Chinese, Israelites, &c., was scarcely worth doing on so small a scale, and is certainly slight enough: it contains some interesting points; but others are not thought out, many statements are loose, and not a few

positively erroneous. We find, for example, the amazing statement that the *speculum vaginae* was unknown until a hundred years ago; yet of medical historians who could forget, at least, the *locus classicus* in Paul of Egina concerning this instrument in its valve and screw form, and the instructions for its use? In the same article we have dubious quotations from such still more dubious authors as "Tralus" (*sic* in text and index; for Alexander of Tralles?) and "Calomella" (a version redolent of the shop!), slips which do not reinforce our confidence in the author's general accuracy. If the editors are to blame for some of these oversights, they are surely still more to blame for passing sentences either so ignorant or so unfair as this:—

"It has been shown, by Koch and others, that malaria is conveyed largely, if not entirely, through the instrumentality of certain mosquitoes."

"Koch and others" is good. "Surmise," again, is far too feeble a word to indicate the epoch-making theory and practice of Semmelweiss in puerperal fever. The next article, by one Martins of Rostock—so he is called in the contents, index, and in all cross references—is a far abler one. We are disposed to attribute it to Prof. Martius. That we ourselves, and we are glad to observe Dr. Bulstrode also, differ profoundly from him in some important respects is not, of course, to be pressed to his disadvantage.

It would be impossible for us, even within limits far wider than the present, to discuss each of the many articles in turn, or, indeed, within the limits of leisure and patience, to read them all critically. For the most part the bread is too deeply drowned in sack. In many chapters there is little but some character of attenuation to distinguish the contents from the therapeutical sections of current text-books; while there is much to remind us of the lip medicine of the student, with his common formulas, such as that "the patient is to be put upon a light and nutritious diet," &c. In turning to the index for fresh light upon the initial causes of particular maladies, we find too often nothing, as in the case of gall-stones, pernicious anæmia, acute rheumatism,[1] scurvy and certain other maladies in which new knowledge seems to promise to be of high preventive value; or we find such vapid paragraphs as are given to arterial diseases, senile decay, dilatation of the stomach, &c.; or, again, equivocal names, such as "anæmia" undistinguished from chlorosis and other particular kinds of impoverished blood. Thus too often general views are attained only by slurring over essential differences. We have sought in vain, moreover, for recent observations on the geographical distribution of cancer; and for the significant fact of the prevalence of primary cancerous growths upon the surfaces of the body.

We are sorry we cannot speak with more appreciation of this important book; but we feel, as Dr. Windscheid, of Leipzig—the able author of the chapter on the prevention of diseases of the nervous system—evidently does, that it is difficult to avoid falling, as some of his collaborators certainly have done, between the stool of specific detail and that of general gossip. However, that a work with such aims should appear at all is satisfactory; we could scarcely expect the first attempt to be one of full achievement. The translations, if slipshod at times, are, as the editors claim for them, readable English enough; but the editors have failed too frequently, whether in the text or by means of notes, to modify facts and opinions, as, for instance, in respect of the diet of the working classes, hours of labour, the management of schools and so forth, which, however true of German societies, are inapplicable to English conditions. T. C. A.

[1] For the recent views of the causation of rheumatism we searched the index and found a reference to p. 112, but failed there to find any such discussion. There are many errors in the index.

ZOOLOGY FOR ARTISTS.

Anatomie artistique des Animaux. By Ed. Cuyer. Pp. xii+300; 143 figs. (Paris: J.-B. Baillière et fils, 1903.) Price 7.50 francs.

DOZENS of treatises on the anatomy of the human body have been written for the use of artists, but this is the first systematic attempt to place a knowledge of the structure of the more common mammals at their disposal. During the last ten years, M. Édouard Cuyer, who is a lecturer on anatomy at l'École nationale des Beaux-Arts, has been in the habit of adding to his ordinary lectures on the structure of the human body a number dealing with the anatomy of the mammals more commonly drawn by artists. The preparation of these lectures entailed much research, and hence this work, which is based on the lectures, not only treats comparative anatomy from a new point of view, but also contains a number of original observations. In this country M. Cuyer is best known as an illustrator of anatomical subjects; in this *rôle* he stands unrivalled, and the drawings which he has supplied for the work under review are the most accurate representations to be found in any work dealing with the anatomy of mammals.

No question has been more debated than the value of anatomy as an aid to art. Ruskin's dictum was that an artist should paint what he could see, not what he knew he ought to see; he even went further, and held that art was debased by a knowledge of anatomy. However that may be, one might have seen, a few years ago, Onslow Ford, Briton Rivière, and J. M. Swan, three of the most truthful and successful animal modellers and painters this generation has produced, dissecting and drawing, hour after hour, in the prosectorium in the Zoological Gardens at Regent's Park. M. Cuyer cites the great animal painter Barye as an example of an artist whose work has gained in force and precision by his accurate knowledge of anatomy. Anyone familiar with either the work of Barye or Swan will recognise that they are real zoologists who epitomise in their modellings and drawings the living and essential nature of the animals portrayed.

M. Cuyer presumes that the student is already familiar with the structure of the human body, which is made the basis for a comparative study of anatomy.

At first sight the human body may appear too highly specialised to serve as an efficient type for comparison, but in reality this is not so. The fact that the ordinary mammal presents a side view to the artist while the human body is usually studied from the front is merely one of detail. The chief points in which the human and ordinary mammalian bodies differ relate to the head and limbs, and the limbs of man are more primitive in structure, less specialised and evolved than those of the ordinary domestic animals. The evolution of the quadrupedal limbs forms an interesting study in high specialisation of one or more digits and retrogression in others, and it is from this standpoint that M. Cuyer deals with the anatomy of the extremities of the domestic animals. Through the limbs of the cat, dog, pig, ox and horse he traces the gradual retrogression of the clavicle, muscles of supination and pronation, ulna, and lateral digits, and shows how these modifications are due to the specialisation of the limbs as organs of pure support instead of mixed instruments for prehension as well as support. His discovery of a vestige of the *pronator radii teres* in the horse is of great interest; how many millions of years is it since the ancestor of the horse required to supinate or pronate its arm?

In the hands of the artist the whole perspective of anatomy becomes changed, and it would be for the benefit of our text-books if the pure zoologist sometimes looked at his work with the eye of an artist. M. Cuyer recognises the fact that an observation on the dead animal remains dead until it is transferred to the living, and the great merit of his work is that he lays a greater emphasis on the actions than on the attachments of muscles. External form, expression, and action are the points which an artist seeks to understand; hence the systems of the body dealt with here are the skeleton, muscles, proportion, and movements. Everyone must have noticed the marked difference in form between the haunches of an ox and of a horse, yet it is doubtful if any of our modern comparative anatomists could indicate the meaning of these structural differences.

Marey's work forms the basis of the chapters in which are described the various characteristic movements of the horse. In dealing with the proportions of the ideal horse M. Cuyer holds the common-sense opinion that there is no absolute standard such as that suggested by Bourgelat, who held that the length of the body from the shoulder to the rump should measure the same as the height at the withers. The observations of Colonel Duhousset on fifty Arabian horses are quoted; in ten of these the length and height were equal; in twenty-six the height was decidedly the greater measurement; in fourteen the length was the greater.

M. Cuyer, as is the habit with many French scientific writers, quotes no author outside the limits of his country. On p. 33, for instance, he refers to an observation by Marey, made in 1890, that there is no correlation between the power of flight and the development of air cells in birds. This matter was fully studied and accurately described in the well-known work of John Hunter a century before Marey was born.

HINDU CHEMISTRY.

A History of Hindu Chemistry from the Earliest Times to the Middle of the Sixteenth Century A.D., *with Sanskrit Texts, Variants, Translation and Illustrations.* By Prafulla Chandra Rāy, D.Sc., Professor of Chemistry, Presidency College, Calcutta. Vol. i. Pp. lxxix+176+41. (London and Oxford: Williams and Norgate, 1902.) Price 12*s.*/6*d.* net.

THE origin of Hindu chemistry is hidden in the obscurity of past ages. It is certain that the alchemists of western Europe owed much of their learning to the Arabs. M. Berthelot, in "Les Origines de l'Alchemie," has shown that the Arabs derived many of their ideas from the Greeks, but Dr. Rāy quotes other weighty opinions, and furnishes additional evidence in support of the view that the Arabs were even more indebted to the Hindus. In the eighth century the Caliphs of Bagdad ordered several of the medical works of India to be translated, and both then and later learned Arabs were sent to India to study science. Not content with pointing out these facts, Dr. Rāy reminds his readers that the Greeks themselves derived their knowledge of many things from the Hindus, who had, for example, solved the 47th proposition of the first book of Euclid, 200 years before the birth of Pythagoras. Relying on this and similar evidence, Dr. Rāy places the date of the works of Vāghbata at some time before the eighth century A.D., and the surgical and medical treatises of Susruta and Charaka many centuries earlier, in pre-Buddha times. The last-named book, however, "embodies the deliberations of an international congress of medical experts, held in the Himālayan regions," and the fourth veda, the Atharva-veda, appears so archaic by its side that it must be older by "probably a thousand years or more." In the Atharva-veda "plants and vegetable products in general are fully recognised as helpful agents in the treatment of diseases," and at that period (say 2000 B.C.) alchemical notions had already gathered round gold and lead, gold being regarded as the elixir of life, and lead as the dispeller of sorcery.

The progress of chemistry in India, if it were judged only from the manuscripts still in existence, would appear to have been bound up with the study of medicine. Preparations of mercury and other metals were described, and their use recommended in various diseases, several centuries before the time of Paracelsus, the internal use of the black sulphide of mercury dating from the tenth century A.D. at the latest. There are, however, many signs that the study of metals had already progressed far beyond the knowledge required by the medical practitioners.

Thus in "Rasarnava" (twelfth century) we read "copper yields a blue flame . . . that of the tin is pigeon-coloured; that of the lead is pale tinted," and as another example:—

"A pure metal is that which, when melted in a crucible, does not give off sparks nor bubbles, nor spurts, nor emits any sound, nor shows any lines on the surface, but is tranquil as a gem."

Then there is the Kutab pillar near Delhi, a wrought-iron column which weighs ten tons, and is some 1500

years old, the huge iron girders at Puri, the iron-roofed temple porch at Kanurac, and other relics which show the ancient familiarity of the Hindus with this metal. In the fourteenth century brass and bell-metal were stated to be alloys, and zinc, copper and tin to be metals. The manufacture of gold jewellery is also of great antiquity in India.

Dr. Rāy has ably carried out his task of proving that the ancient lore of the Hindus was far in advance of that of the rest of the world, China excepted. The reader who is unversed in Sanskrit may perhaps be pardoned if he sometimes loses himself for a moment in the maze of Hindu names, and it will be well if his "discerning faculty is nimble and agile, and can suddenly surround a proposition." A glossary would be useful, but could scarcely add to the interest of the volume. The second volume, promised when Dr. Rāy has examined further manuscripts, will be welcome.

T. K. R.

OUR BOOK SHELF.

The Soil: an Introduction to the Scientific Study of the Growth of Crops. By A. D. Hall, M.A. Pp. xiii + 286. (London: J. Murray, 1903.) Price 3*s.* 6*d.*

When one who has been for many years both a teacher and an investigator commits to paper the facts and ideas which have formed the substance of his later courses of instruction, we expect a very useful book, and in the present instance we are certainly not disappointed. The book before us takes a wide scope; it deals with the origin of soils, their physical properties, their chemical properties and composition, methods of analysis, the living organisms within the soil, the causes of fertility and sterility, soil types and the natural flora belonging to each. The book is primarily intended for college students. Owing to its wide scope it does not attempt to treat any part of the subject in an exhaustive manner; it possesses, however, the great merits of originality and suggestiveness, virtues which are not always to be found in the formal text-book. A prominent feature of the work is the introduction of the results of investigations carried on by the author while principal of the Agricultural College at Wye. English books on scientific agriculture have hitherto been so necessarily filled with descriptions of foreign researches that any results obtained under English conditions have an exceptional value, and appeal to the farmer in a special manner.

In a work dealing with so many subjects, there are naturally some points open to criticism. The author seems to hesitate in attributing some of the physical properties of soil constituents to their colloid nature, and thus leaves unexplained the enormous amount of hygroscopic water held by humic matter. The indigo method of determining nitrates is mentioned as one that may be used for determining nitrates in soil extracts; the method is, in fact, unsuitable for this purpose, as it gives results much below the truth owing to the presence of organic matter. Nitrification is occasionally spoken of as a kind of "fermentation"; objection may surely be taken to this description. Fermentation is a word of wide meaning, but it surely should not include the oxidation of inorganic matter by a living organism. The chapter dealing with the power of soils to retain various bases and acids is full of interest, yet the theory is incompletely stated, the results of the German, French, and some English investigations on the subject being unnoticed. The laws governing the diffusion of salts, and the results of their molecular diffusion in a moist soil, are also not noticed. The cause of the sterility of alkali lands, and their proper treatment, are, however, well discussed, and many excellent illustrations of the subject are introduced from the experience gained in Egypt.

In a book dealing with many details some slips will inevitably occur; the most important one in the present case is that King's determinations of nitrates in fallow soil appear as determinations of nitrogen as nitrates; the quantity of nitrates present is thus unintentionally much exaggerated.

The concluding chapters on fertility and soil types exhibit most fully the thoroughly practical character of the author's teaching, and will be much valued by many readers. The book is sure to meet with a favourable reception. R. W.

Electrical Problems for Engineering Students. By W. L. Hooper, Ph.D., and R. T. Wells, M.S. Pp. v+170. (Boston and London: Ginn and Co., 1902.) Price 6*s.*

This is a collection of numerical and mathematical exercises in electrical engineering, starting from the most elementary beginning and ending in the more difficult problems presented by the design and working of direct and alternating current dynamos and motors. The exercises have been tested by the practical experience of the authors at Tuft's College, Mass., and are such as would form a useful accompaniment to a two or three years' lecture and practical course. A distinctly good feature of the book is the number of examples requiring graphical solutions, which cannot fail to impress upon the student the advantages gained by plotting curves. It is always an objection to exercises of this sort that they tend too much to the purely arithmetical and academic side of the subject; thus, many of the problems on subjects which are treated only in an elementary manner in this book are little better than arithmetic sums. For example, in the twelfth chapter, on electrochemistry, there are eleven problems, which are all practically simple proportion sums, and we doubt if the student would gain much more by solving them than he would by solving an equal number of problems on, say, the number of able-bodied men and boys required to till a field. But, if the book be used with discretion, these drawbacks will be lessened, and provided the student is taught in other ways to think about and really understand his subject, these exercises will serve to give him a facility in attacking numerical problems as they arise. The book should prove a useful aid to students and teachers of electrical engineering. M. S.

Open-Air Studies in Bird Life; Sketches of British Birds in their Haunts. By C. Dixon. Pp. xii+280; illustrated. (London: Griffin and Co., Ltd., 1903.) Price 7*s.* 6*d.*

Mr. Dixon appears to consider that the appetite of the British public for books on the birds of their own islands is insatiable, and as he seems to find a publisher for all his works on this subject, he is perhaps justified in this opinion. In the present instance the subject is treated from a standpoint somewhat different from the one usually adopted, the birds being described in connection with their environment or "station," instead of systematically. Although this mode of treatment necessarily involves a certain amount of repetition (as in the case of the sparrow and the lapwing), it permits the descriptive side of the subject to be relegated somewhat to the background,

and greater prominence given to habits. So far, however, as we can see, the author appears to have recorded little or nothing new in regard to the latter, and we venture to think that he has missed an opportunity of giving fuller detail as to adaptation to environment, especially as regards coloration. Neither is he to be congratulated as regards his style in many parts of the work, as witness the following sentences in the description of the bearded tit (p. 184):—"The family characters are the same as the generic ones. It is found in various parts of Europe and Asia." It may be also pointed out that "Obb" (p. 261) is not the name of a well-known Siberian river. Again, the introduction of the word "Raptores" in connection with a cut on p. 84 is unnecessary and puzzling, when it is not, so far as we can see, used in the text. And this reminds us that a glossary of *eight* items seems strangely inadequate in a work where a considerable number of technical terms are necessarily employed, for we quite fail to see why it is necessary to explain the meaning of "aftershaft" and leave the reader to find out the signification of "primary."

As regards the illustrations, we have nothing but commendation to bestow, the full-page plates by Mr. Whymper—and especially the one of kingfishers—being exquisite delineations of bird-life. We notice, however, that the small text-figures of birds' heads are for the most part the well-known cuts of Swainson, which were used *with full acknowledgment* by Prof. Newton in his "Dictionary of Birds." Why, we may ask, has the author thought fit to depart from this excellent practice, and to publish the cuts in question as though they were original? R. L.

The Bermuda Islands. By A. E. Verrill, Yale University. (Published by the Author, New Haven, Conn., U.S.A., 1902.)

IN this book, reprinted from the *Transactions* of the Connecticut Academy of Sciences, Prof. Verrill gives an account of the Bermuda group which is intended to subserve four distinct purposes; first, that of a general guide-book on the history, structure, and productions of the islands, for the use of visitors; second, of an introductory text-book to the study of the natural history of the archipelago; third, of a record of the more important changes in the flora and fauna already caused by man; and, lastly, that of a general introduction to a series of more technical memoirs, by the author and other naturalists, on the natural history and geology of the islands, now in course of publication. The present volume includes a general description of the islands, an account of their physical geography and meteorology, a sketch of their discovery and early history, and an account of the animals and plants introduced or exterminated since their discovery by the Spaniards about 1510. The last part of Prof. Verrill's work is of special value, for, so far as appears, no human being had set foot on the islands before that date. Accounts of the geology and marine zoology of the group are promised in a later volume. The book is illustrated by thirty-eight excellent plates, and a large number of cuts, and a valuable bibliography is appended.

La Pratique des Fermentations industrielles. By E. Ozard. Pp. 168. (Paris: Gauthier-Villars, n.d.) Price 2,50 francs.

THIS book is intended specially for the use of brewing chemists. The author gives the essential principles underlying the various fermentation processes, which allow of the transition of sugars and starches into alcoholic products, and also broadly indicates how those processes are carried out in practice.

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.*]

Psychophysical Interaction.

A BRIEF note to remove a possible misunderstanding suggested by Prof. Minchin. He seems to think, or to imagine that others will think, that when speaking of the action of mind on matter I conceive of mind as a thing that can sustain a "reaction"; so that a stress might exist with matter at one end and mind at the other. Such an absurdity would indeed play havoc with the laws of mechanics; at any rate, I never entertained such a notion for a moment, whether for a guiding or for any other kind of force. If I lift a table it is quite certain that the weight of the table, *plus* its mass-acceleration, is transmitted through my boots to the floor: so far mechanics is supreme. But not even Prof. Minchin could calculate whether I shall lift the table or not, nor what I shall do with it when I have lifted it. I should obey every law of mechanics if I cast it on a bonfire; but I should have interfered with the course of nature, regarded as a mechanically determinate problem, even by only lifting it.

I want to understand the nature of this interference better; I have no other "anxiety" on the subject.

Incidentally I should like to transfer to your pages a most interesting and clearly-worded claim made by Sir W. T. Thiselton-Dyer in to-day's *Times*:—

"Directive power . . . wipes out [meaning would wipe out if it were established] . . . the whole position won for us by Darwin. It is no use mincing matters. Students of the Darwinian theory must be permitted to know the strength and weakness of their dialectic position. What that theory did was to complete a mechanical theory of the Universe by including in it the organic world." It is the last sentence to which I would direct attention.

Athenæum Club, May 15. OLIVER LODGE.

I AM not clear that it is wise to endeavour to aid Sir Oliver Lodge out of the pit he has, it seems to me, quite unnecessarily fallen into. But I will put a rope down to him, as it must be very uncomfortable down at the bottom.

Almost every mechanical problem leads by the application of ultimate mechanical principles to a differential equation. The solution of this equation involves a certain number of constants which may be infinitely many, but which we always find to be absolutely determined by the initial conditions. At first sight it seems difficult, without tacitly dropping a fundamental mechanical principle—such as that of momentum—to allow for "guidance" and "freewill" therein. But differential equations occasionally admit of *singular solutions*. We may follow up a particular solution, absolutely defined by the initial conditions, until we run onto the singular solution. After this we can stick to the singular solution or leave it again at any other contact with a particular solution, which will still satisfy the fundamental differential equation. Can "guidance" and freewill correspond to a shunt of this kind?

I am quite unaware of any differential equation in mechanics providing a good illustration of this suggestion. Still, we must get Sir Oliver up to the surface again, and this is the only rope by which I can conceive him ascending. K.A.M.V.

"Red Rain" and the Dust Storm of February 22.

THE Marquess Camden recently sent me a sample of fine sand or dust collected from the roof of Bayham Abbey, Lamberhurst, shortly after the great dust storm of February 22, which I have caused to be examined. As the results appear to be of interest, especially in reference to Mr. Clayton's contribution to the *Proceedings* of the Chemical

Society, I should be glad if you could find space in NATURE for an account of them.

The dust consisted essentially of ferruginous sand, chalk, and silicates of alumina, alkalis, lime and magnesia, mixed with a certain quantity of organic matter and with an appreciable proportion of lead.

The last-named substance is probably due to the sample having been collected from a leaded roof. It may either have been scraped off during the taking of the sample, or, possibly, cut from the leads by the impact of sand particles driven against the roof by a high wind. Traces of tin and arsenic were also present in the sample; these were probably contained as impurities in the lead.

The detailed results of the analysis are as follows:—

(Substance dried at 100° C. before analysis.)

	Per cent.
Loss on heating to redness	11·28
Lead, calculated as oxide	3·31
Arsenic	0·01
Tin	Traces

After deducting the lead, tin and arsenic as being probably adventitious, the remainder of the sample is made up of the following constituents:—

	Per cent.
Silica	45·94
Alumina	18·35
Iron oxide	6·57
Lime	8·64
Magnesia	1·86
Alkalis { Sodium oxide	1·16
Alkalis { Potassium oxide	2·30
Carbonic acid	6·10
Water and organic matter	9·08
	100·00

The organic matter contained 2·19 per cent. of carbon and 0·16 per cent. of nitrogen, the two representing, probably, between 3 and 4 per cent. of organic constituents.

After being heated to redness, 33·30 per cent. of the sample was found to be soluble in hydrochloric acid, the dissolved portion including practically the whole of the lead, with the traces of tin and arsenic. Again deducting those elements, the dissolved constituents were as follows:—

	Per cent.
Silica	0·64
Alumina	11·20
Iron oxide	5·43
Lime	8·19
Magnesia	1·13
Alkalis	1·46
Carbonic acid	3·48
	31·53

Thus about one-third of the sample is dissolved by hydrochloric acid, including the greater part of the alumina, iron, lime and magnesia, but only a small fraction of the silica.

Dilute acetic acid readily dissolved out the greater part of the lime, with liberation of carbonic acid gas. Water alone dissolved practically nothing from the sample except minute traces of lime. These results show that most of the lime is present in the sample in the form of chalk.

One or two particles of metallic lead were detected in the sample, together with others partly oxidised and carbonated.

It has been surmised by Dr. Mill and others that the sand which accompanied the storm of February 22, and was observed to fall in a great number of places in this country as well as on the Continent, was originally derived from the African deserts.

It would be interesting in this connection to compare its characters with that of the dust, also presumably of African origin, which was observed to fall in the neighbourhood of Taormina, by Sir Arthur Rücker, and was made the subject of an interesting communication to NATURE by Prof. Judd about a year ago.

T. E. THORPE.

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The Undistorted Cylindrical Wave.

THE receipt of a paper by Prof. H. Lamb, "On Wave Propagation in Two Dimensions" (*Proc.* Lond. Math. Soc., vol. xxxv. p. 141), stimulates me to publish now a condensation of a portion of a work which will not be further alluded to. I once believed that there could not be an undistorted cylindrical wave from a straight axis as source. But some years ago the late Prof. FitzGerald and I were discussing in what way a plane electromagnetic wave running along the upper side of a plane conducting plate, and coming to a straight edge, managed to turn round to the other side. Taking the wave as a very thin plane slab, one part of the theory is elementary. The slab wave itself goes right on unchanged. Now Prof. FitzGerald speculatively joined it on to the lower side of the plate by means of a semi-cylindrical slab wave. I maintained that this could not possibly work, because the cylindrical wave generated at the edge was a complete one, causing backward waves on both sides of the plate. Moreover, it was not a simple wave, for the disturbance filled the whole cylindrical space, instead of being condensed in a slab. It was in the course of examining this question that I arrived at something else, which I thought was quite a curiosity, namely, the undistorted cylindrical wave.

Maxwell's plane electromagnetic wave consists of perpendicularly crossed straight electric and magnetic forces, in the ratio given by $E=\mu v H$. Thinking of a thin slab only, it travels through the ether perpendicularly to itself at speed v, without any change in transit. I have shown that this may be generalised thus. Put any distribution of electrification in the slab, and arrange the displacement **D** in the proper two-dimensional way, as if the medium were non-permittive outside the slab. Then put in **H** orthogonally, according to the above mentioned rule, and the result is the generalised plane wave, provided the electrification moves with the wave. Otherwise, it will break up. Another way is to have the electrification upon fixed perfectly conducting cylinders arranged with their axes parallel to the direction of propagation.

Now the first kind of plane wave has no spherical analogue, obviously. But I have shown that the other kinds may be generalised spherically. Put equal amounts of positive and negative electrifications on a spherical surface arranged anyhow. Distribute the displacement in the proper way for a spherical sheet, as if constrained not to leave it. Then put in **H** orthogonally as above. The result constitutes an undistorted spherical electromagnetic wave, provided the electrification moves radially with the wave, and attenuates in density as its distance from the centre increases, in the proper way to suit **E** and **H**. This attenuation does not count as distortion. Similarly, the other sort of generalised plane wave may be imitated spherically by having conical boundaries.

But when we examine the cylinder, there is apparently no possibility of having undistorted waves. For with a simple axial source it is known that if it be impulsive, the result is not a cylindrical impulse, but that the whole space up to the wave front is filled with the disturbance. It is easy to see the reason, for any point within the wave front is receiving at any moment disturbances from two points of the source on the axis, and there is no cancellation. And if the source be on a cylindrical surface itself, producing an inward and an outward wave, the whole space between the two wave fronts is filled with the disturbance.

How, then, is it possible to have an undistorted wave from a straight line source? By not arguing about it, but by showing that it can be done. The reason will then come out by itself. As the solution can be easily tested, it is only necessary to give the results here. Take plane coordinates r and θ. Let the magnetic force be perpendicular to the plane, of intensity H. Let Z be its time-integral, then

$$Z=\frac{\cos\frac{1}{2}\theta}{v\sqrt{r}}f(vt-r), \quad H=\frac{\cos\frac{1}{2}\theta}{\sqrt{r}}f'(vt-r), \qquad (1)$$

expresses the magnetic field, f being an arbitrary function. Now the displacement **D** is the curl of **Z**. So if E_1 is the radial component of **E**, and E_2 the tangential component, in the direction of increasing θ, we have the electric field given by

$$E_1=\frac{-\mu v\sin\frac{1}{2}\theta}{2\sqrt{r}}f, \quad E_2=\frac{\mu v\cos\frac{1}{2}\theta}{\sqrt{r}}f'+\frac{\mu v\cos\frac{1}{2}\theta}{2\sqrt{r}}f. \qquad (2)$$

The attenuation factor $r^{-\frac{1}{2}}$ in (1) does not count as distortion.

The wave may go either way, and various cases can be elaborated. If the wave is outward, the axis ($r=0$) is the source. The plane $\theta=0$ is a perfect electric conductor. The electrification is of the same sign on its two sides. Other details may be got from the formulæ.

I give an example to show the not very obvious electrical meaning. Let the infinite plane conductor with the straight edge be one pole of a condenser, and a straight wire placed parallel to the edge, and close to it, be the other pole. Join them by a battery, charging the plate and the wire. Bring the wire right up to the edge, and reduce its magnitude to a mere line. (This is to be done in order to attain the ideal simplicity of the formulæ.) Take away the battery. Then the electric field is given by

$$cvE_1=-\frac{\sin\frac{1}{2}\theta}{2r^{\frac{1}{2}}}f_0, \qquad cvE_2=\frac{\cos\frac{1}{2}\theta}{2r^{\frac{1}{2}}}f_0, \tag{3}$$

where f_0 is a constant and c is the permittivity.

Finally, discharge the condenser by contact between edge and wire. Then the result at time t later is that outside the cylinder of radius $r=vt$ the above field (3) persists, whilst inside the cylinder there is no **E** or **H**. An electromagnetic wave separates these regions. It started from the axis at the moment of contact, and as it expands swallows up the whole energy of the field, and carries it to infinity. Similarly, as regards the charging of the plate, only the "battery" should, to have the same formulæ, be an impressed force acting at the axis, between the edge and the wire. At time t after contact, the electric field is established fully within the cylinder $r=vt$. On its boundary is the impulsive wave which is laying down the remainder. It also, if the contact be instantaneous, wastes an equal amount of energy at infinity.

Similarly, by varying the impressed voltage anyhow with the time, the emission of an arbitrary wave of **H** results. With a real plate and real wire, the main features would no doubt be the same. The use of the line wire introduces infinite voltage.

What somewhat disguises the electromagnetics is the existence of the steady electric force, or parts thereof, along with the electromagnetic **E** and **H**, particularly when f is arbitrary. There is a similar complication in the spherical wave when the total electrification in any thin shell is not zero. There is then an auxiliary internal or external electric force to make continuity.

We cannot have an undistorted wave from a simple line source. But in the example the apparent line source will be found to be a doublet. For the curl of **e** (impressed force) is the source of the wave. It is double, positive on one side, negative on the other.

Solutions of the type

$$H=\sum\frac{Ar^n\cos(n\theta+a)}{(v^2t^2-r^2)^{n+\frac{1}{2}}} \tag{4}$$

or the same with r and vt interchanged in the denominator, are not distortionless, save for the solitary term in which $n=-\frac{1}{2}$. The above distortionless cylindrical wave (1) is unique. Prove by the characteristic.

April 29. OLIVER HEAVISIDE.

Seismometry and Gëite.

UNDER the above heading Prof. J. Milne contributed an interesting article to NATURE of April 9, p. 538, on which I wish to offer some remarks. Prof. Milne seems hardly to realise the significance of the enormous pressures to which the earth's deep-seated material is presumably exposed. One of his objections to the hypothesis of an iron core seems to be that the wave velocities for an infinite isotropic medium of the density and elasticity of iron do not accord with the velocities of earthquake waves. This objection, however, is not conclusive. In an infinite isotropic medium there are *two* purely elastic wave velocities, v_1 and v_2, given by the equations

$$v_1=\sqrt{(m+n)/\rho}, \quad v_2=\sqrt{n/\rho},$$

where ρ is the density, m and n Thomson and Tait's two elastic constants. On the ordinary theory, n/m may possess any value consistent with Poisson's ratio γ, or $(m-n)/2m$, lying between 0 and 0·5. Six years ago I showed (*Phil. Mag.*, March, 1897, p. 199) that observed seismic wave velocities can be accounted for by elastic waves without postulating any abnormal value for Young's modulus—the modulus to which Prof. Milne repeatedly refers. For instance, we get values of 12·5 and 2·5 kilometres per second respectively for v_1 and v_2 in a medium of density 5·5 with a Young's modulus of only 10^9 grammes weight per sq. cm., if we suppose $n/m=1/24$, or $\gamma=0{\cdot}48$ approximately; and the same results follow if we increase density and elastic constants in the same proportion.

In iron, as we know it, γ, of course, is not 0·48, but more nearly 0·25. A material, however, which under low pressures has $\gamma=0{\cdot}25$, *may*, after prolonged exposure to enormous pressures, behave as an elastic medium with γ very nearly 0·5. In fact, if the deep-seated material acts as an elastic medium, the only consistent way yet pointed out for its doing so is by its behaving as if γ were very near the limiting value answering to incompressibility. Neither of the elastic wave velocities, it should be noticed, has anything directly to do with Young's modulus, a point which cannot be too clearly emphasised. Another consideration is the possibly appreciable influence of gravity on the wave velocities.

Coming now to the question of the behaviour of magnetographs at times of seismic disturbance, there must undoubtedly be magnetic disturbances occasioned by earthquakes in more than one way. When a violent earthquake occurs where magnetic material abounds, there may be a vast movement of magnetised matter; there may be a great change in the stresses throughout adjacent magnetic material; and there may be a great change of local temperature. Any one of these causes will give rise to a magnetic disturbance which should be practically simultaneous all over the world, and should *precede* any seismic movement at distant stations. It should also diminish very rapidly as the distance from the earthquake origin increases.

Again, as the seismic waves travel out from their source they must cross volumes of magnetic matter, and the mechanical effect on any such volume must necessarily produce changes in its magnetic field. Owing to the finite velocity of seismic waves, the displacements and stresses simultaneously existent in different parts of any large magnetic volume must be in all kinds of phases, leading to considerable interference between the magnetic disturbances to which the different parts give rise at any considerable distance. Thus the most plausible explanation of why a magnetic disturbance of some prominence—if real—should appear at one observatory, but not at another only 100 miles off, is certainly the existence of magnetic material close to the former. Supposing that such local material exists, the magnetic phenomena may be expected to vary according to the direction in which the earthquake wave is travelling.

One of the chief difficulties in reaching definite conclusions is the contracted time scale usual in magnetograms. If the true seismic and the apparent magnetic disturbances occur within a few seconds of one another, it is usually practically impossible to say which is the earlier. To see the full force of this, one must remember that a by no means improbable explanation of why apparent magnetic disturbances accompany earthquakes at one station, but not at another, is that the magnets at the former, owing to pattern or site, may be much more sensitive *seismographs* than those at the latter.

Again, it must be remembered that whilst the so-called "large waves"—rather an unfortunate term—produce in general a much greater effect on a horizontal pendulum than do the "preliminary tremors," it by no means follows that the same will be true of either the true magnetic or the purely mechanical effects on a magnet. Much may depend on the method of support and the time of swing.

The passage of the "preliminary tremors" and "large waves" due to an earthquake often occupies several hours, and during this interval several true independent magnetic movements are not at all unlikely to present themselves, even at times of general magnetic calm.

For all these reasons a careful intercomparison is wanted of magnetic and seismic records from a variety of stations. Something might be done by running magnetographs for some time in a district where a local magnetic disturbance

is known to exist, and contrasting the results with those obtained elsewhere with the same instruments.

Prof. Milne mentions Kew and Greenwich as representatives of stations where magnetic and gravitational anomalies do not exist, but, as a matter of fact, Rücker and Thorpe's magnetic survey does show a small magnetic anomaly in the Thames Valley, and certain foreign observers have also inferred a gravitational anomaly.

As to Prof. Milne's special term "gēite" for material in the earth's interior, I must confess that the application of a new word to the unknown material of a problematical core seems to me more likely to hinder than assist. Such special terms constitute an additional obstacle in the way of those who are not specialists. Also existing terms, such as nucleus and core on the one hand, and layer or crust on the other, seem not inadequate, the context showing whether it is the material that is immediately in view.

I have had repeated occasion to deal with elastic problems involving a core and a layer or layers. In fact, the very "earth" for which Prof. Milne expresses a preference, consisting of a layer of about 1/20 of the earth's radius in thickness with a density of average surface rock, and a core of specific gravity approaching 6, is one which I selected some years ago for the purpose of investigating luni-solar tidal action (*Cambridge Phil. Trans.*, vol. xvi. p. 151). Thus I do not speak without experience.

A final point to be remembered is that, according to the investigations of Gauss and others, the earth itself is a magnet of considerable moment. Any theory which claims even provisional acceptance may be expected to give a plausible explanation of this fact, and of the secular change observed in terrestrial magnetism. C. CHREE.

Photograph of Oscillatory Electric Spark.

THE enclosed photograph of an oscillatory electric spark, like most of those which I have taken, differs in some respects, so far as I have seen, from those which have been recorded by other experimenters. It was obtained by the discharge of 22 square feet of coated surface through

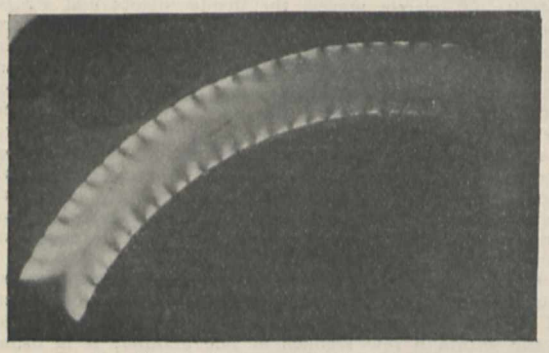

FIG. 1.—Oscillatory electric spark.

¼ mile of coiled wire, the electrodes being of magnesium. The picture was focused on a circular plate fixed on the end of an electric motor, so as to revolve in its own plane. The number of double oscillations was about 3000 per second. C. J. WATSON.

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Our Rainfall in Relation to Brückner's Cycle.

IN the instructive paper on solar and meteorological changes in NATURE (May 7), I observe that Dr. Lockyer suggests 1913 as probably about the centre of the next wet period. A consideration of barometric changes appears to lead to a similar result, and I may be permitted to recall a letter sent you in 1898 (NATURE, December 22, p. 175), in which, discussing with such data the question, "Where do we stand in Brückner's cycle?" I mentioned 1911 as probably near that centre. Such estimates must, of course, be regarded as merely approximate, and open to revision.

This important cycle of Brückner's was lately discussed in a number of letters to the *Times*, and it is satisfactory to see that more adequate attention is now, though tardily, being given it.

Is it not objectionable to treat the British Isles as a whole, since, on Brückner's theory, the western portion shows opposite variation to the eastern?

There is a method of curve-making which seems to be little used by meteorologists, but which is, I think, to be recommended. A series of annual rainfall figures (say) is first translated into a series of plus and minus values (related to the average), and this series is then added algebraically step by step, *e.g.*

$$+9{\cdot}3-1{\cdot}4+0{\cdot}6+0{\cdot}9-1{\cdot}6+1{\cdot}3, \text{ \&c.}$$
$$+7{\cdot}9+8{\cdot}5+9{\cdot}4+7{\cdot}8+9{\cdot}1, \text{ \&c.}$$

This second series is then thrown into curve form. The process is analogous to paying in money to a bank, and drawing money out, and the point reached by the curve at any given time indicates the balance.

Each upward (annual) extension in such a curve represents a wet year, and each downward extension a dry year, and the degree of wetness or dryness is also indicated.

A large comparison of such curves for European and other stations would, I think, throw a good deal of light on the Brückner theory. ALEX. B. MACDOWALL.

The Propagation of Phthisis.

IN a work called "Opera nuova intitulata il Perche, utilissima ad intendere le cagioni de molte cose, &c.," published in Venice in 1520, the following passage occurs:—"Dal sputo del Tisico o da la sua boca viene fuora un vapore fetido e acuto che entra poi per la boca de colui che conversa con quello e corrode simelmente il pulmone de esso e in questo modo genera tisica."

Substitute for *vapore* "material particles," and we have the modern conception of the mode of propagating consumption. This anticipation of modern science seems worthy of note. EDMUND MCCLURE.

TANGANYIKA.[1]

THE title of this work is perhaps somewhat misleading. The reader who expects the book to contain only discussions of speculative questions will be agreeably surprised by finding that the positive contributions made in it to our knowledge of the geology, botany and zoology of Central East Africa are of the most extensive and valuable character. The two expeditions which the author undertook in 1896 and 1899 to Lake Tanganyika and the surrounding districts, following upon the researches of earlier travellers, have thrown a flood of light upon both the geological structure and the fauna and flora of this part of the world, while they have incidentally suggested a number of difficult problems of no small interest alike to the geologist and the biologist.

The surveys of Mr. Moore and of Mr. Malcolm Ferguson, the geologist who accompanied him, have been of value in rectifying and making noteworthy additions to the maps of the area visited. The geographer will find references to a number of new mountain peaks, the heights of many of which are given, with the determination of the heights above sea-level and the depths of many of the lakes, in several of which numerous soundings and dredgings were made.

One of the most valuable results of Mr. Moore's explorations is the confirmation he is able to supply to the conclusions of Mr. Scott Elliot that there exists in East Central Africa a great mountain chain running north and south, and rising at many points, even in this Equatorial region, above the limits of perpetual snow. The height of the snow-line is fixed by Mr.

[1] "The Tanganyika Problem; an Account of the Researches undertaken Concerning the Existence of Marine Animals in Central Africa." By J. E. S. Moore, F.R.G.S., author of "To the Mountains of the Moon." Pp. xxiii + 371; with 7 maps and 140 illustrations. (London: Hurst and Blackett, Ltd., 1903.)

Moore at 13,500 feet, and some of the peaks he thinks may attain a height of 16,500 feet, while Sir Harry Johnston believes that 20,000 feet is a probable minimum of the height of some of them. This great mountain chain, giving rise in some parts of its course to numerous glaciers—the "Mountains of the Moon" of the ancients—Mr. Moore proposes to call "the Great Central African Chain." It extends from the mountains of Abyssinia in the north to the Drakensberg in South Africa, though in some places, as in the neighbourhood of Tanganyika and the Albert Edward Nyanza, it is a broad ridge, the culmination of long eastern and western slopes, rather than a conspicuous chain; so that, viewed from either side, it has little resemblance to a mountain range, even when its summits rise ten or twelve thousand feet above the sea-level.

Mr. Moore discusses the geological structure of this great mountain chain, giving a number of valuable geological sections across it at various points. The origin of the range, he believes, must be assigned to lateral compression, the celebrated "rift-valleys" being regarded by him as subordinate features resulting from the orographic movements in the earth's crust. Although volcanic action has only played a subordinate part in the formation of the great chain itself, in the greater portion of its course, yet in the district lying to the north of Tanganyika, which was carefully explored by our author, we have the still active volcanic district of the Mfumbiro Mountains, a chain of volcanoes running east and west; the highest of these, Karisimbi, is often snow-capped, and has a height of 14,000 feet. Mr. Moore shows that the structure of the great longitudinal valley in which Tanganyika lies has been profoundly modified by the ejection of the materials forming the Mfumbiro chain. The surface of Lake Kivu, to the north of Tanganyika, is 4841 feet above sea-level, while Albert Edward Nyanza, still further north, lies 2000 feet lower, and Tanganyika has a height of 2700 feet. The author points out that previously to the formation of the Mfumbiro volcanic cones, the waters of Lake Kivu must have drained northwards into the Albert Edward Nyanza, and not, as now, into Lake Tanganyika, by the Russisi River. Numerous other volcanic cones occur in the district, generally at the bottom of the rift-valleys. The waters of Lake Kivu contain such a large amount of salts that the pebbles and reeds on the shores become encrusted with a calcareous deposit, which analysis shows to contain 12·66 per cent. of magnesium to 28·65 of calcium. The waters of Lake Kivu, which is sometimes more than 100 fathoms deep, have been analysed and found to contain a very large proportion of magnesium carbonate.

The geological formations met with in the expeditions, the distribution of which in the neighbourhood of the several lakes is shown upon sketch-maps, are as follows, beginning with the oldest:—

(1) Old crystalline rocks—granite, gneisses, schists, quartzite, &c.

(2) Great thickness of unfossiliferous sandstones and shales.

(3) "Drummond's beds," a series of sandstones and shales of about the age of the Trias.

(4) Recent lacustrine strata.

Unfortunately, no satisfactory evidence has yet been adduced as to whether the stratified rocks (2) and (3) can, either or both of them, be regarded as of *marine* origin, and some of the unsolved problems of African geology must await full solution until this determination has been made. At present we have no proof that the stratified masses of the older formation are not, like those of the younger, of lacustrine or fluviatile origin.

Around some of the great Central African lakes there are found extensive alluvial deposits containing the shells of species of Mollusca, which still live in the waters of the adjoining lake. These, with the numerous raised beaches, show that some of the lakes had formerly a much greater extent than at present. It is upon these old alluvial deposits that the celebrated "Park-lands," so well described and so convincingly explained by Mr. Moore, are found. Among the botanical results of the two Tanganyika expeditions, not the least valuable are the investigation of these curious features that have attracted so much attention from all travellers in the district. Mr. Moore shows how the springing up of scattered individuals of the hardy euphorbias has afforded a shade under which plants less able to withstand the burning heat of the sun have grown up and gradually extended outwards. Of course, in the end, these outward spreading patches of vegetation must coalesce and form a tangled forest growth, such as occurs in other parts of Central Africa. Mr. Moore ingeniously argues that the amount of development towards this forest growth may be utilised as a means of determining the geological age of the alluvial flats upon which they are found.

It is on the zoological results of these expeditions, however, that the author of the work before us must be especially congratulated. The addition of nearly 200 species of animals to the fauna of the district is the least important of his achievements, though it shows how assiduous and successful must have been his work as a collector. But Mr. Moore is far more than a collector. By careful observations and experiments carried on during his residence among the lakes, by his studies of living animals in their peculiar environment, and by his work in the laboratory upon the specimens he has brought home, he has made the most substantial additions to zoological science.

On questions of distribution the researches of Mr. Moore have a very important bearing. The discovery by Speke and the missionaries of marine types of mollusca in the waters of Tanganyika, followed as it was by Boehm's discovery of a medusa in the same fresh waters, made it a question of first importance to determine whether the same phenomena were exhibited in any other of the African lakes. To this question Mr. Moore has afforded a complete answer. He has himself examined the faunas of lakes Shirwa, Nyassa, Kela, Tanganyika, Kivu, the Albert Edward Nyanza, the Albert Nyanza, the Victoria Nyanza, and Nivasha. The faunas of four or five more lakes are less perfectly known from the work of other travellers, and it is now certain that the peculiar "halolimnic fauna," as Mr. Moore calls it, is confined to Tanganyika, all the other neighbouring lakes containing only the ordinary types of fresh-water mollusca and fish that occur in similar situations all over the globe. The account given of the distribution of these forms by Mr. Moore, especially in the salt lake of Shirwa, will prove of interest both to zoologists and to geologists.

The fish-fauna of Tanganyika consists of eighty-seven species, of which no less than seventy-four are new to science, and have been described and figured by Mr. Boulenger. The medusa (*Limnocnida tanganyicae*) of Tanganyika has been described from spirit specimens by Mr. Robert Günther, of Oxford; but Mr. Moore has been able, during his residence at the lake, to make drawings of the living animal, to work out its development, and to add much to our knowledge of its habits. We reproduce his drawings of this curious organism, which varies in size from a shilling to a two-shilling piece.

The complete study of the anatomy of the "halolimnic" gasteropods, which so closely resemble marine forms of the Jurassic period, has been carried out by

Mr. Moore and fellow-workers in the Royal College of Science, and a curious form of polyzoan, with some prawns and sponges, have been added to the fauna with marine affinities that have made Tanganyika so interesting to naturalists.

Want of space forbids our entering on a discussion of the theoretical questions dealt with in the work

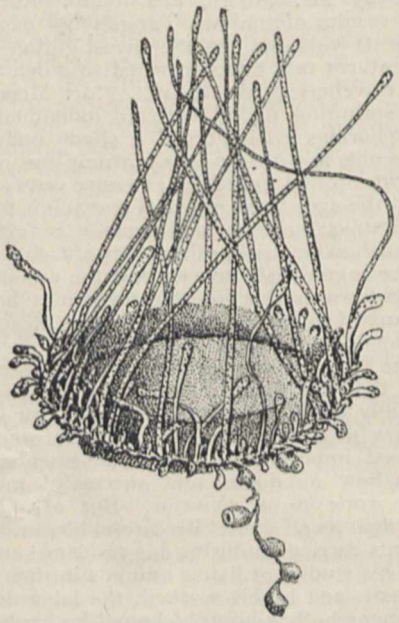

FIG. 1.—Living asexual adult of the Tanganyika medusa, enlarged about one-third. To the right is seen a string of buds becoming detached.

before us. On many of these the last word has not been said, and some of the speculations put forward by the author can be regarded as having only the value of ingenious suggestions. In dealing with so large a mass of new and varied material, the author may have been led in places to express hasty judgments,

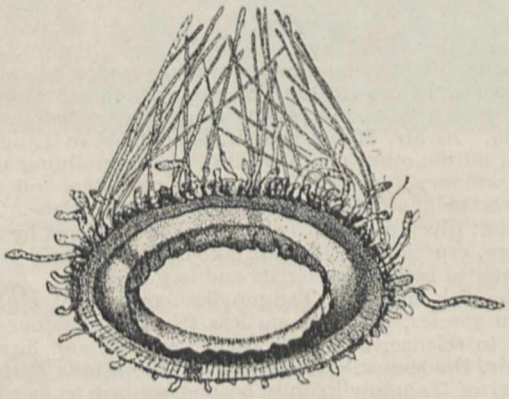

FIG. 2.—Living sexual adult of the Tanganyika medusa, showing the character of the manubrium.

while some of his statements may need qualification or revision; but we are convinced that every naturalist who peruses the work will give him the highest credit for a work of exploration efficiently carried out, and for preparing an account of his researches which is not only satisfactory to the student of science, but is full of interest for the general reader. J. W. J.

ENLARGEMENT OF THE KEW HERBARIUM.

SIR WILLIAM J. HOOKER, the first director of Kew Gardens, as a public establishment, was really the founder of the herbarium at Kew, for before any bequests or gifts were made, his extensive private collection of dried plants and books was, by arrangement with the Government, used for the purposes of the gardens, and accessible to botanists of all countries. When Sir William took up his appointment in 1841, there was neither specimen nor book the property of the garden, and his herbarium and library were first deposited in his own residence at West Park. In 1853 his herbarium and a portion of his library were lodged in the original portion of the present block of buildings, and he received a small annual grant from Government for assistance and maintenance, on the condition that the plants and books were free to other botanists. The same year Miss Bromfield presented the herbarium and library collected by her deceased brother, W. Arnold Bromfield, the author of the "Flora Vectensis," which was edited after his death by Sir Joseph Hooker.

This gift, though not so extensive as some subsequent ones, was very valuable, both in plants and books, the latter including a number of excellent copies of the best editions of many of the early authors, or "old masters." The following year, 1854, Mr. George Bentham presented his very rich herbarium and library to the nation, on the condition that they should be deposited at Kew, and so housed and arranged as to be accessible to himself and other botanists. I may add, parenthetically, that Bentham continued his botanical work at Kew, almost uninterruptedly, for thirty years, the end of which saw the completion of the "Genera Plantarum" of Bentham and Hooker, a work which has not yet been replaced by an equally concise and useful synopsis of a uniform character. Sir William Hooker died in 1865, and in 1866 the Government purchased his herbarium and library, so far as they were not already represented in the national collection at Kew. This purchase included museum specimens, drawings, manuscripts, portraits of botanists, and Sir William's botanical correspondence, covering a period of sixty years. As is well known to the older generations, Sir Joseph Hooker succeeded his father in the directorship, and he in turn was succeeded by his son-in-law, Sir William Thiselton-Dyer, the present director.

Under these successive directors, due greatly to their activity and zeal, the collections of plants and books have continued to increase with great rapidity, partly from increasing Government grants, and partly from private munificence. Among the latter the collections specially deserving mention are:—A. Cunningham's Australasian; Burchell's St. Helena, S. African and S. American; Borrer's British; H. C. Watson's British; Miss Griffith's Algæ; Wight and Rottler's Indian; Boott's Carices; J. Gay's general, presented by Sir Joseph Hooker; Ball's general herbarium and botanical library; Carey's N. American; and quite recently Dr. Alexander Prior's general herbarium, received through Sir Prior Goldney.

All these important gifts consist mainly of named and mounted specimens. Smaller donations number many hundreds. The enormous Indian collections of Hooker and Thomson reached Kew in 1851. They were estimated at 8000 species, and the specimens were so numerous that no less than sixty sets were given away to other botanists and botanical establishments. The distribution of these specimens, and seven wagon-loads of specimens (chiefly of Griffith, Helfer and Falconer's collecting) received from the India House in 1858, was not completed until 1863.

The rapid growth of the herbarium and library neces-

sitated enlargement of the building about twenty-five years ago, when a large hall was added. This is a quadrangular structure eighty-six feet by forty-three feet, with a ground floor and two galleries connected by two spiral staircases, and lighted by forty-eight windows. A second hall of the same dimensions has just been completed, and will soon be occupied. It is connected with the old hall on each floor by a corridor fifty-six feet long, and the floors and roof are of concrete, and it is intended to replace those of the old hall with the same material at once. It is estimated that the entire collection comprises considerably more than 2,000,000 specimens, attached to 1,300,000 sheets.

With the exception of Carey's North American herbarium, Lindley's orchids, and Borrer and Watson's British herbaria, the plants from all parts of the world are arranged in one series, the genera according to Bentham and Hooker's "Genera Plantarum," and the species geographically. It is unnecessary to enlarge on the value of a herbarium containing the types of all the colonial floras and other works issued from Kew—it is known to all botanists. The library, which the present director has made his special care, is one of the richest, even if not the richest, in existence, and is in admirable condition. It comprises upwards of 20,000 volumes, besides about 10,000 pamphlets. The Government published a catalogue of the books in 1899, and annual supplements since. There is also a separate collection of about 100,000 published figures and original drawings of plants.

W. BOTTING HEMSLEY.

THE SOUTH AFRICAN ASSOCIATION.

THE inauguration of the South African Association for the Advancement of Science took place at Cape Town on April 27. The *Cape Times*, to which we are indebted for the details of the proceedings, describes the successful gathering as a British Association meeting in miniature. The new Association enters upon its career with a membership of seven hundred persons from many parts of South Africa.

The main objects of the organisation are the same as those of the parent body. As defined in the Constitution, they are "to give a stronger impulse and a systematic direction to scientific inquiry; to promote the intercourse of societies and individuals interested in science in different parts of South Africa; to obtain a more general attention to the objects of pure and applied science, and the removal of any disadvantages of a public kind which may impede its progress."

The presidential address was delivered by Sir David Gill, K.C.B., the Astronomer Royal for South Africa, who explained the nature of the work which it was hoped the new Association would accomplish. During the course of his able address Sir David Gill announced that Lord Kelvin had written that, although in 1905 he will be eighty-one years of age, he intends, if he is as well then as he is now, to accompany the British Association on the visit to South Africa.

The work of the sections began on the second day of the meeting. The presidential addresses in the various sections were delivered by the following men of science:—

Section A.—Astronomy, Chemistry, Mathematics, Meteorology, and Physics, by Prof. P. D. Hahn; Section B.—Anthropology, Ethnology, Bacteriology, Botany, Geography, Geology, Mineralogy, and Zoology, by Dr. R. Marlotti; and Section C.—Archæology, Education, Mental Science, Philology, Political Economy, Sociology, and Statistics, by Dr. Thomas Muir, C.M.G., F.R.S., Director of Education for Cape Colony.

Among the papers read during the course of the meetings the following deserve mention. In Section A, on ferments causing "casse" in wine, by Mr. Raymond Dubois; meteorology in South Africa: a retrospect and prospect, by Mr. C. M. Stewart; close binary systems, by Dr. Alex. W. Roberts; determination of mean temperature, &c., from observations made at second-order stations on the Table Land, by Mr. J. R. Sutton; some recent work on the discharge of electricity from heated bodies, by Prof. J. C. Beattie.

In Section B, (1) on the occurrence of an epidemic among the domesticated animals in Mauritius in which Trypanosomata were found in the blood; (2) note on the co-relation of several diseases occurring among animals in South Africa; (3) on the production of a malarial form of South African horse sickness, by Dr. Alex. Edington; the minerals of some South African granites, by Mr. F. P. Mennell; on the classification of the Theriodonts and their allies, by Dr. R. Broom; (1) some morphological and biological observations on the genus Anacampseros; (2) on some stone implements in the Albany Museum, by Dr. S. Schonland.

In Section C, some aspects of South African forestry, by Mr. D. E. Hutchins; dry crushing of ore preparatory to the extraction of gold, by Mr. Franklin White; sewage disposal in Cape Colony, by Mr. J. Edward Fitt.

In Section D, the library system of South Africa in comparison with those of England and America, by Mr. Bertram L. Dyer; iteration as a factor in language, by Prof. W. Ritchie; common sense and examination, by Mr. P. A. Barnett; Cape Dutch, by Prof. W. S. Logeman; how we get knowledge through our senses, by Rev. Dr. F. C. Kolbe.

The example set by the British Association of arranging for receptions and other social functions to lighten the intellectual fare provided was followed at Cape Town, and the excursions, conversazioni, &c., were well attended and much appreciated.

THE ROYAL SOCIETY CONVERSAZIONE.

THE conversazione held at the Royal Society on Friday last was attended by a large and distinguished company, among the visitors being H.R.H. the Prince of Wales and H.S.H. the Duke of Teck. There were numerous exhibits illustrating progress in various branches of science, several of them being of great interest. Following our usual course, we abridge the particulars given in the descriptive catalogue as to the character and purpose of the objects on view.

Sir William Crookes, F.R.S., exhibited objects illustrating certain properties of the emanations of radium. If a solid piece of radium nitrate is brought near a blende screen, and the surface examined with a pocket lens magnifying about 20 diameters, scintillating spots are seen to be sparsely scattered over the surface. On bringing the radium nearer the screen the scintillations become more numerous and brighter, until when close together the flashes follow each other so quickly that the surface looks like a turbulent luminous sea. A convenient way to show these scintillations is to fit the blende screen at the end of a brass tube with a speck of radium salt in front of it and about a millimetre off, and to have a lens at the other end. Focusing, which must be accurately effected to see the best effects, is done by drawing the lens tube in or out. It is proposed to call this little instrument the "Spinthariscope."

Specimens of brittle gold and photographs illustrating their microstructure were shown by Dr. T. K. Rose. Gold of the British imperial standard, containing 91·6 per cent. of gold and 8·3̇ per cent. of copper, is made brittle and unfit for coinage by the presence of minute traces of certain impurities such as tellurium, lead, bismuth, &c. Similar or even considerably greater quantities of these elements, excepting bismuth, do not affect the ductility of fine gold. The deleterious effects of the impurities are removed by the presence of oxide of copper dissolved in the metal. The changes in the quality of coinage bars are accompanied by profound changes in the microstructure of the metal.

Dr. Morris W. Travers exhibited hydrogen thermometers for measuring low temperatures. The thermometers are of the constant-volume type, and are intended for the

measurement of temperatures between 0° and −253° C. One is graduated directly in degrees on the hydrogen scale, and can be employed for the direct measurement of low temperatures to within one degree. The other is intended for more accurate measurements.

A new coherer, as applied to wireless telegraphy, was shown by Sir Oliver Lodge, F.R.S., and Dr. Alexander Muirhead. A steel wheel rotates so that its edge touches a pool of mercury through a film of oil. (See *Proc.* Roy. Soc., March.) This is the coherer, and its decoherence is automatic. A fraction of a volt is used in the detecting circuit, which works a siphon recorder as the receiving instrument. The sending part of a station, including an automatic transmitter and a "buzzer" for carving a steady current into intermittencies, was also shown.

Incandescent oil burners were exhibited by Mr. T. Matthews. These burners have been designed by the exhibitor primarily for use in the Trinity House Lighthouse Service. The intensity of the single mantle burner for flashing lights is 1100 candles, and the consumption of oil one pint per hour; the intensity of the triple mantle burner for fixed and occulting lights is 2700 candles, and the consumption of oil three pints per hour, the flashing point of the oil being in each case from 145° to 160° Fahrenheit (close test).

Experiments on controlling and regulating spark discharges, shown by Mr. Alfred Williams, illustrate how the use of a shunt, or of a point and shunt, or of plates of high resistance, so influence the field in a spark gap that the discharges are made more regular and placed more under control for therapeutic and wireless telegraphy purposes.

The "Elasmometer," a new form of interference apparatus for the determination of the elasticity of solid substances, was exhibited by Mr. A. E. Tutton, F.R.S. The apparatus is designed to measure the amount of bending suffered by a thin plate of the substance investigated, when supported near its ends against a pair of platinum-iridium knife-edges, under a weight applied at its centre.

Prof. A. G. Greenhill, F.R.S., showed a gyroscopic pendulum, for lecture experiment. A bicycle wheel is suspended by a prolongation of its axis from a universal joint, formed with a hub and its ball-bearings. The wheel is rotated by a stick inserted in the spokes, and projected to illustrate the variety of gyroscopic motion.

Dr. W. Ramsden demonstrated by experiments and illustrated by photomicrographs and specimens, the presence and spontaneous formation of solid membranes upon the free surfaces of certain solutions. He also showed that solid membranes are present on certain bubbles.

Aërial photographs were shown by the Rev. John M. Bacon. Among the pictures was one showing the sea bottom at a depth of ten fathoms photographed from an altitude of 600 feet.

The physical sciences were also represented by the following objects and experiments:—A series of photographs and objects relating to Dr. William Gilbert, of Colchester (1544–1603), author of the treatise "De Magnete," Prof. Silvanus P. Thompson, F.R.S.; a direct vision spectroscope of one kind of glass, and of minimum deviation for any ray in the centre of the field of view, Mr. T. H. Blakesley (see p. 71); apparatus for the detection and estimation of minute quantities of arsenic in beer and brewing materials, as recommended by a Departmental Committee of the Board of Inland Revenue, Prof. T. E. Thorpe, C.B., For.Sec.R.S.; ephelkystika, or tractate curves, and machine for drawing them, Col. Hippisley, C.B., R.E.; (1) gravimetric recording hygrometer, (2) an electrical dewpoint hygrometer, Prof. F. T. Trouton, F.R.S.; Callendar's compensated barometer, Mr. N. Eumorfopoulos; light mirrors, suitable for galvanometers (see p. 72), Mr. W. Watson, F.R.S.; micrometer for measuring screws, made for the British Association Screw Gauge Committee, the Cambridge Scientific Instrument Company; photographs of dust deposits, Dr. W. J. Russell, F.R.S.; examples of Lippmann's process of photography in colours, Mr. Edwin Edser and Mr. Edgar Senior; an experiment illustrating the conductivity imparted to a vacuum by hot carbon, Mr. O. W. Richardson; a high pressure spark-gap used in connection with an inductor of the Tesla type, and also in connection with a radiator of Hertzian waves, Rev. F. J. Jervis-Smith, F.R.S.; diagrams illustrating the order and origin of the musical scales, Mr. Joseph Goold.

An artificial horizon attachment to sextants, exhibited by Commander Campbell Hepworth, C.B., consists essentially of a contact maker, operated by a plummet mounted on a sextant, and connected with a galvanic battery. It is so adjusted as to close the circuit and ring a bell when a slit or line on the horizon glass is in alignment with the eye of the observer and the sensible horizon. Observations for latitude and longitude at sea are rendered impossible when the natural horizon is obscured by fog or mist, although sun, moon, or stars may be shining clearly; but with the aid of this instrument the observer may obtain the true altitude of a heavenly body within five minutes of arc.

The Solar Physics Observatory, South Kensington, exhibited (1) photographic comparison of the arc spectra of various samples of dust; (2) curves, illustrating the long period solar and meteorological (rainfall) variations of about thirty-five years; (3) photographs of new curved slit by Hilger. This slit is used at the focus of the second objective of the photo-spectro-heliograph, and is intended for the isolation of the K (calcium) line in the solar spectrum, Nos. 3 *a* and *b*.

The use of a colour screen in photographing bright stars was illustrated by the Cambridge Observatory. By the use of a yellow spot on a worked glass screen in contact with the sensitive plate, the image of a bright star can be reduced to equality with the images of the comparison stars. It thus becomes possible to apply photography to the determination of the parallaxes of bright stars, which have been dealt with hitherto almost entirely by the heliometer.

The chromospheric spectrum near the South Pole of the Sun was shown by Mr. J. Evershed. Nebular spectra of Nova Persei from May 3, 1901, to January 14, 1902, with previous spectra for comparison, were illustrated by Mr. Frank McClean, F.R.S. Other exhibits were:—(1) collimating gun sight for day and night; (2) optical sight for guns and rifles; (3) spherometer of great delicacy, by Dr. A. A. Common, F.R.S.

Methods of disintegrating cells and microorganisms, and of obtaining their intracellular constituents, were shown by Dr. A. Macfadyen and Mr. S. Rowland. In the first method the cells are disintegrated by the violent impact of sand particles in the apparatus exhibited. In the second method the use of extraneous disintegrating material is dispensed with, the cells or organisms being disintegrated when in a frozen condition. In the apparatus exhibited the necessary cold and brittleness are secured by the use of liquid air.

Dr. Leonard Rogers exhibited five specimens of Hydrophidæ (poisonous sea snakes). These snakes swarm round the coasts of India and in other tropical seas, and cause some loss of life among fishermen. Their poison has recently been found to be more powerful than that of any other snakes.

Miss E. R. Saunders illustrated interesting cases of structural atavism resulting from cross-breeding. Experiments (Report Evolution Committee, 1902) with stocks suggested that when glabrous plants of dissimilar colours are crossed together, the offspring might be hoary. Actual trials have proved this to be true. When glabrous cream or white are crossed with each other, or with glabrous plants of other colours, the offspring are all hoary; but when colours other than white or cream are crossed together, the offspring are all glabrous.

Fossils in Cambrian quartzite were shown by Prof. J. Norman Collie, F.R.S. These fossils were found on the surface of a glacier in Desolation Valley (near Laggan Railway Station), Canadian Rocky Mountains.

Dr. Henry Woodward, F.R.S., exhibited two photographs of *Tetrabelodon* (*Mastodon*) *angustidens*, Cuvier, from the Miocene of Sansan, France, taken from the skeleton in the Museum of Natural History, Paris. This primitive form of Mastodon still retains two pairs of functional incisor teeth (tusks), one pair in the upper and one pair in the lower jaw, the upper ones being directed *downwards*. In modern elephants only one pair (the upper) incisors are present, and these are usually curved upwards. (See Dr. C. W. Andrews's paper, *Proc.* Roy. Soc., No. 474.)

The Royal Geographical Society had on view (1) hypso-

metrical and bathymetrical map of the Western Mediterranean and surrounding countries, curved to show the figure of the earth; (2) relief map of a part of the valley of the Semois in the neighbourhood of Rochepaut, Belgian Ardennes. These maps have been prepared under the direction of Prof. Elisée Reclus by Mr. E. Patesson. The map of the Mediterranean, in aluminium, is drawn on the scale of 1 : 5,000,000. It is curved to show the exact figure of the earth. Elevations of land and depths of water are shown by a system of contours and tinting. The second map is in copper, and represents the relief of the district without exaggeration of the vertical scale, and with the surface features carefully laid down. Both maps are intended for educational purposes.

Pictures shown by Mr. Arthur J. Evans, F.R.S., illustrated excavations at Knossos, in Crete, and included: (1) general plan of the palace, showing excavations to June, 1902, and general section, showing successive terrace levels, &c.; (2) photographic views; (3) coloured drawings of palace frescoes.

Other exhibits were chloroformed calf lymph; method of its preparation (from the Government Lymph Laboratories), Dr. Alan B. Green; development and variation of the colour-pattern in Mexican species of lizards (Cnemidophorus and Ameiva), Dr. H. Gadow, F.R.S.; (1) true (glandular) hermaphroditism in a domestic fowl; (2) microscopic sections of prehistoric human bone, and of a prehistoric human urinary calculus, Mr. S. G. Shattock. Mimicry in butterflies from British East Africa and Uganda, Mr. S. A. Neave; specimen of Trypanosoma found by Dr. Castellani in cerebro-spinal fluid from sleeping sickness patients (Uganda), Dr. Aldo Castellani; specimens of a remarkable radiolarian of complex structure, Dr. G. H. Fowler; restored models of extinct fishes, the Director, British Museum (Natural History); preparations illustrating the cell-phenomena met with in apogamy, Prof. J. B. Farmer, F.R.S., Mr. J. E. S. Moore, and Miss L. Digby (see p. 71); remains of pigmy elephant and pigmy hippopotamus obtained from caves in Cyprus, Miss Dorothy M. A. Bate (see p. 71); (1) photographs illustrating the late eruptions in St. Vincent and Martinique; (2) volcanic dusts, ashes, and other ejecta of the West Indian volcanoes, West Indies Volcanoes Committee of the Royal Society; micrographs of volcanic dust from Mount Soufrière, St. Vincent, eruption, May 8, 1902, Mr. Thomas Andrews, F.R.S.; (1) the experimental demonstration of the curvature of the earth's surface recorded by photography; (2) photograph of ship hull-down at sea, Mr. H. Yule Oldham.

During the evening lantern demonstrations were given by Sir Benjamin Baker, K.C.B., F.R.S., illustrative of the Nile Dam Works, and by Prof. Harold B. Dixon, F.R.S., on the analysis of explosion flames by photography. The latter demonstration included (1) photographs of explosion flames, taken on very rapidly moving films, showing the genesis of the explosion-wave as the flame travels from the point of ignition, and the influence of reflections from the ends of the tube; (2) photographs of sound-waves moving through the explosion-flame, by which the approximate temperature of the flame may be calculated.

COOPERATION IN ASTRONOMY.

THE suggestions contained in the subjoined extracts from a paper by Prof. E. C. Pickering on "The Endowment of Astronomical Research," recently issued from Harvard College Observatory, will, we hope, be taken up by one of the many generous benefactors of science and higher education in the United States. The fundamental idea is the organisation of the forces which exist for the advancement of knowledge of astronomy. Many gifts have been made to astronomy in the United States, but in some cases the results have been disappointing, because the donors have not consulted astronomers as to the best way to promote scientific advance.

Imposing observatories are useless without instruments, and fine telescopes and spectroscopes depend upon "the man at the eye end" for the return they will give for the expenditure upon them. To obtain the best results, the astronomer with original ideas and progressive spirit should be placed in a position where he can carry on his work to the best advantage, and instruments should be used by men who require them for the increase of knowledge. This is the object of the plan proposed by Prof. Pickering. Money, materials and men available for astronomical research are to be brought together so that each is used to the best advantage.

In the United States, where the liberal benefactor has endowed scientific work to an extent unparalleled in any other country, the scheme will probably be taken up. Though the gifts to higher education and research have been so many and generous in the past, Prof. Pickering remarks that owing to the industrial prosperity of America "gifts may be expected ten times as large as those of the last century, during which Harvard College Observatory received three funds exceeding one, two, and three hundred thousand dollars respectively." He has therefore considered how a gift of one or two million dollars, if given to Harvard for astronomical purposes, could be best expended. The cooperative scheme of work suggested is one which would certainly accelerate progress, and the results attained would be such that enlightened donors could see and appreciate them.

There would be no attempt to interfere with independent work; in fact, the scheme aims at promoting such work and providing for the publication of the results. The Carnegie Institution was established with the same objects, and has already provided the means for carrying on important inquiries in various branches of science. Prof. Pickering's plan is worthy of the broad views associated with Harvard College Observatory, and we trust that means will be forthcoming to carry it into effect. We reprint part of the circular in which the plan is put forward.

The following outline of a plan will show how a sum of fifty to one hundred thousand dollars annually could be advantageously expended for astronomy by this observatory. A board of advisers, consisting of several of the leading astronomers of the country, would be appointed which would meet once a year, or at first oftener, to consider how the available income could be best expended in order to receive the greatest scientific return.

This board would consist partly of the directors of observatories who could expend portions of the income themselves, and partly of older astronomers who, having retired from active work, could decide without prejudice how the income could be expended to the best advantage by others. They would have authority to add temporarily to their number astronomers who might be invited to participate in any special work, and who could thus take part in their discussions on equal terms. All expenses of this board would be paid from the income, and except for clerk hire these would be almost the only executive expenses. A circular letter would be sent to all astronomers, inviting application for aid and suggestions for methods of expending the income. If possible, close relations would be established with the trustees of all the research funds which could be used for astronomical purposes, to increase efficiency and avoid duplication of work. The most important duty of the board of advisers would be to consider each year what departments of astronomy were being neglected, and to secure the needed observations, or if necessary undertake them themselves, or see that they were made at Harvard. As every astronomer is inclined to undertake the work which attracts him most, especially interesting investigations are likely to be duplicated unnecessarily, while laborious or unattractive investigations are neglected. This is particularly objectionable, since in astronomy, a science of observation and not of experiment, an opportunity once missed can in many cases never be recovered. As an example of needless duplication, fifty observatories agreed to observe the planet Eros during its opposition in 1900, but, so far

as known, only two or three have made the reductions needed to render their observations of any value. When a plan was decided on, it would be discussed by the entire board, and it is obvious that their combined experience would render serious mistakes less probable than when all depends on the judgment of a single individual, as is now the case. They could find the best man for a given research, and give him the best possible facilities for carrying it on. They could undertake larger and more difficult researches than a single observatory could attempt. It would be the power of many, instead of one, and of large, instead of restricted, resources. The opportunity offered to such a board of advisers, having control of the principal instruments of the country and a large sum of money available to set at work any particular corps of astronomers, ought to secure results far beyond those attainable at any existing observatory. All the advantages of a trust would be secured, with none of its objections. No one could object to a trust in wheat, for example, if its only object was to increase the quality and quantity of the crop, and to furnish it to consumers at the lowest rates, also to aid those not members of the trust in every possible way. In the present case, these conditions would be enforced by a body of men entirely unprejudiced, the Corporation of Harvard College. It is universally admitted that in the industrial arts there is a great advantage in cooperation, and in carrying on work on a very large scale. The same remarks apply to scientific investigation, with the added advantage that the supply and demand are indefinitely great, so that the market can never be glutted.

Apart from the advantages to astronomy of such a plan as is here outlined, it is believed that it would serve as a valuable example to the other sciences, and the moral effect of promoting uniformity of purpose, and friendly aid to one another by astronomers of all countries, would encourage other donors. An incidental advantage of this plan is that it could be tried on a small scale, as for a single year, and the donor could thus see what results were likely to follow if he made the plan permanent.

Of course, every effort would be made to establish the closest relations with astronomers in general, as the object of the institution could not be attained if the work done was not regarded as advancing astronomical research in the best way. Much might be accomplished through existing societies and periodicals. Another matter of especial importance is that when an astronomer is aided who is qualified to carry on a work in the best way, no restrictions should be made on the appropriation which would in any way interfere with his obtaining the best results.

It will be noticed that this plan differs from those governing existing funds for research in being active and not passive. While the trustees of other funds wait for applications, and then consider what appropriations can be made, it would be the aim of the advisers of this fund to learn what astronomers desired aid, what instruments now unused were available for work, and what valuable material remained unpublished and consequently useless for lack of means. Its special object would be to determine the needs of astronomers, to find what subjects were being neglected, especially those the usefulness of which would be lost by delay, and, if possible, to take the necessary steps to secure their execution. Much might be done with existing funds, and it is believed that the trustees of such funds would, in many cases, welcome the means of expending the available income to the best advantage. The opportunities for good work are far in excess of the present means for supplying them. Even the great resources of the Carnegie Institution will be able to respond to only a portion of the excellent applications made to it for aid.

It is most important that unnecessary delays should be avoided. It often happens that an astronomer could undertake a piece of work at once, perhaps during a summer vacation, while after a delay of several months he might be unable to carry it out, or might have lost many of the details then fresh in his mind. This is still more important with large pieces of work. A delay of several years may render a mature astronomer incapable of completing a work, which if undertaken at once, he could carry out with his greatest vigour and skill.

These remarks apply with equal force to the present plan of work. The Harvard Observatory has now the appliances, both intellectual and physical, for undertaking large pieces of work. Several of the leading astronomers of the country are in sympathy with such a plan for cooperation, so that the important methods of organising and initiating a system could be devised at the present time under very favourable conditions which may not prevail a few years hence, although the plan once started could easily be carried on by others. It therefore seems wise to make a beginning, however small, hoping to show results that will lead to an early fulfilment of the entire plan.

The undersigned, therefore, invites the astronomers of this and other countries to send to him applications for aid. A brief statement of the case in form for publication should be made, generally not exceeding two hundred words in length, with an estimate of the cost, and any additional necessary details. If publication is not desired, it should be stated.

The undersigned will then use his best efforts to secure the execution of such of these plans as commend themselves to him, reserving the right to omit all others. If the list of applications received seems worthy of it, he will publish and distribute it to possible donors, and will endeavour to secure its publication elsewhere. He will also bring such applications as commend themselves to him to the attention of the officers in charge of the following research funds, with which he is officially connected :—

Rumford Fund of the American Academy. Principal, 52,000 dollars. Income available to aid American investigators in light and heat.

Elizabeth Thompson Science Fund. Principal, 26,000 dollars. Income available for investigators of all countries in all departments of science. Appropriations seldom exceed 300 dollars.

Henry Draper Fund of the National Academy. Principal, 6000 dollars. Accumulated income April 15, 1902, 1515·99 dollars. Available for investigations in astronomical physics, by citizens of the United States.

Advancement of Astronomical Science Fund of the Harvard College Observatory. Principal, 70,000 dollars, of which 10,000 dollars is now available as stated above. Income may be used for astronomers of any country.

When we consider the great sums at the disposal of the trustees of the Carnegie Institution, and the large unexpended balances of the various research funds of the National Academy, it is not probable that any really worthy investigation requiring only a few hundred dollars for its execution need fail for want of such a sum.

There is another direction in which the writer believes that a great astronomical return could be obtained for a reasonable expenditure of money, some of which is already available. There are, in the United States, many telescopes of large size, which are now in use during only a small portion of every clear night. It is believed that in many cases advanced students in astronomy would be glad to undertake systematic observations with such instruments for a salary equivalent to a fellowship. They would thus be enabled to continue their studies, and at the same time make valuable additions to our knowledge of astronomy.

Larger investigations may be carried on by the Carnegie Institution or by private gift. For such investigations the undersigned offers assistance to prospective donors, *if they desire it*. He will in that case secure for them the opinions of the leading astronomers of the country regarding any proposed investigation. A wealthy man, when making a large investment in an industrial enterprise with which he was not familiar, would always obtain the opinion of an expert, for which he would often pay a large sum. How much more important is it in a subject like astronomy, with which he is likely to be still less familiar, that he should learn the views, which would be given freely and without charge, of the principal experts in the country who have devoted their entire lives to the consideration of these subjects.

In brief, it is proposed to establish an institution in connection with the Harvard Observatory the aim of which should be to advance astronomy as much as possible by making appropriations under the combined advice of the leading astronomers of the country. Much attention would be paid to neglected subjects, especially to those which cannot be

provided for by later observations, to secure for persons properly qualified the use of powerful telescopes now idle and therefore useless, and, in general, to secure for the person best qualified for any given research the best possible means of carrying it on. It would provide means for co-operation, and would aim at the advancement of astronomy, regardless of country or any personal considerations. The cost of this plan, if fully carried out, would be less than that of a first-class observatory, and it could be fairly tried for a short time at a moderate expense. For success, it must be wholly unselfish and this condition permanently secured, the investments must be safe, and the net income large. It is believed that no guardian would more surely fulfil these conditions than the Corporation of Harvard College.

EDWARD C. PICKERING.

THE ROYAL VISIT TO GLASGOW.

THE laying of the memorial stone of the new buildings for the Glasgow and West of Scotland Technical College by His Majesty King Edward on Thursday, May 14, is a gratifying indication of the importance now attached to an efficient system of technical education. The ceremony at the College was the first item on the programme of the Royal visit to the city, and, except as regards the weather, which was more lavish of the April shower than the May sunshine, was most successfully carried out. An hour before the arrival of the King and Queen upwards of 4000 guests had assembled on the site of the new buildings, and their Majesties, on stepping on to the royal platform, received a most loyal welcome. Lord Balfour of Burleigh, the minister in attendance on the King, introduced to His Majesty Mr. W. R. Copland, the chairman of the Governors of the College, and Mr. D. Barclay, the architect of the new buildings, and the laying of the memorial stone was immediately proceeded with. In thanking His Majesty, Mr. Copland recalled the fact that, so long ago as 1881, on the laying of the memorial stone of the Central Technical College of the City and Guilds of London, His Majesty was pleased to recognise the importance of educating persons destined to take part in the productive industries of the kingdom, and referred to the training of the intelligence of the industrial community as the great factor in retaining the position of Britain as a manufacturing nation. The King, in reply, expressed the great pleasure it had given him to lay the memorial stone; he had long recognised the importance of the work done by institutions of this kind, and hoped the building now to be erected would realise to the full the expectations of the governors.

In the course of the day their Majesties visited the University, the foundation stone of which they had laid on October 8, 1868. The Very Rev. R. H. Story, D.D., Principal and Vice-Chancellor of the University, the professors, lecturers and demonstrators, and a large body of graduates were assembled in front of the magnificent building on Gilmorehill, and in the name of the University the principal presented an address to His Majesty. In the address it was noted that, except on two occasions, in 1849 and in 1888, when Queen Victoria visited Glasgow, no Sovereign of Great Britain had seen this University since King James VI. visited it on his return to his ancient kingdom after succeeding to the throne of England. In his reply the King expressed his great gratification at having an opportunity, accompanied by the Queen, of renewing his acquaintance with the ancient University; he was deeply interested in the allusions to the visits of his predecessor King James VI. and of his august and beloved mother, Queen Victoria; he recalled with satisfaction his own share in laying the foundation stone of the noble building, and he earnestly desired that this and other universities as schools of higher learning might grow and prosper, and so advance the material progress of his people.

After His Majesty had replied to the address, the Deans of Faculties were presented to him by Lord Balfour.

The constitution under which the Glasgow and West of Scotland Technical College is now working dates from 1886, but the institution itself had its origin in Anderson's College, which was founded in 1796 under the will of John Anderson, M.A., F.R.S., professor of natural philosophy in the University of Glasgow, and is thus certainly the oldest institution of the kind in Great Britain, and probably in the world. Prof. Anderson was in many respects a remarkable man. The idiosyncrasies of his character brought him into frequent conflict with his colleagues in the University, but it is more pleasant to record that he seems to have been deeply impressed with the importance to the industries of the city of awakening in masters and workmen an intelligent interest in the scientific aspects of their trade. He made frequent visits to the local workshops, and took great pains to make himself familiar with local industries. It is well known that when James Watt had difficulties put in his way by the incorporation of hammermen of Glasgow he was appointed mathematical instrument maker to the University, and it was Anderson with whom he was most closely associated in this post. In furtherance of his aims Prof. Anderson inaugurated classes in the University designed to attract employers and workmen as well as the ordinary university students, and these he carried on until his death in 1796. At the present day, when technical education has assumed such a prominent position in the public mind, it is but fair to recall with gratitude the work of the man who may be justly named its pioneer.

On his death Prof. Anderson bequeathed all his means "to the public, for the good of mankind and the improvement of science, in an institution to be denominated 'Anderson's University.'" He directed that the management of the institution was to be vested in the Board of Trustees constituted under his will, and this Board continued in existence until 1886, when the institution was incorporated in the Glasgow and West of Scotland Technical College.

The first chair created was that of chemistry and natural philosophy, and was occupied by Dr. Thomas Garnett until 1799, when he was called to fill the first professorship in the Royal Institution. His successor in Glasgow was Dr. George Birkbeck, who formed a special class for "the gratuitous instruction of the operatives of Glasgow in mechanical and chemical philosophy," in the belief that "men should be taught the principles of the arts they practise." This class, which was named "the Mechanics' Class," separated in 1823 from Anderson's College and took the title of "Mechanics' Institution," the first of the many mechanics' institutions that marked the movement for the scientific education of artisans. In 1881 the Glasgow Mechanics' Institution changed its title to that of "The College of Science and Arts," and continued to maintain a separate existence until it was merged with the parent institution in the present Technical College.

The names of many eminent men are associated with Anderson's College. Among its professors were Dr. Andrew Ure, author of "The Dictionary of Arts and Manufactures"; Dr. Thomas Graham, afterwards Master of the Mint, for whom the honour is claimed of establishing the first laboratory for public instruction in chemistry in Great Britain; Dr. Thorpe, the present Director of the Government Laboratories; Dr. W. Dittmar; and Dr. G. Carey Foster, the present Principal of University College, London. Among its students were Dr. Livingstone; Lord Playfair; Dr. James Young, the founder of the Scottish oil industry; and Sir J. H. Gilbert, of Rothamsted. Lord Kelvin and his brother, Prof. James Thomson, were students of the Mechanics' Institution.

In 1886, by an Order of Her late Majesty, Queen Victoria, in Council, Anderson's College, the College of Science and Arts, the "Young" Chair of Technical Chemistry—founded

in connection with Anderson's College by its then president, Dr. James Young, referred to above—Allan Glen's Institution, and the Atkinson Institution were amalgamated to form the Glasgow and West of Scotland Technical College. The main object of the governors of the reconstituted institution has been from the first "to afford a suitable education to those who wished to qualify themselves for following an industrial profession or trade"; it is not the purpose of the College to supersede the ordinary apprenticeship, but rather to supplement it, and the courses for day students in engineering are arranged to permit of their spending the summer months in serving part of their apprenticeship, while devoting the winter months to college work.

The maintenance of the institution entails an annual expenditure of about 25,000*l.*, derived in approximately equal proportions from endowments, students' fees, Government grants, and grants from the Corporation of Glasgow and other public bodies.

The College work has hitherto been conducted in the buildings formerly occupied by the amalgamated institutions and in hired premises scattered over the centre of the city, but these have long been inadequate, and for some years it has been necessary to refuse admission to hundreds of students for lack of room. So serious is the want of accommodation that a gift of 5000*l.* by Mrs. John Elder to make provision for lectures of a popular character on descriptive astronomy cannot be utilised under existing conditions, and contemplated extensions in other directions are meanwhile impossible for similar reasons. In December, 1900, a meeting of the citizens was convened by the Lord Provost of Glasgow to consider the scheme which the Governors, after full deliberation on the various alternatives, had adopted for the erection of new buildings. A committee was formed to obtain subscriptions, and in less than two years a sum of nearly 180,000*l.* was raised.

The Governors appointed Mr. David Barclay, F.R.I.B.A., to be their architect, and they are satisfied that he has designed buildings admirably adapted to the purpose in view. They will consist of five large wings, two being parallel to George Street; the other three will be placed at right angles to them, and parallel to Montrose Street. The walls facing the streets will be of red Dumfriesshire stone; all the other exterior walls will be of white enamelled brick, thus securing a surface which will give the greatest amount of light to the rooms facing the three interior courts.

The following table indicates the main departments of the College, and, approximately, the space (in square feet) allotted to each:—mathematics, 5500; natural philosophy, 10,400; chemistry, 16,500; technical chemistry, 7500; mechanics, 10,000; machine design, 10,000; prime movers, 15,100; metallurgy, 4800; electrical engineering, 15,900; practical engineering, 4000; mining and geology, 3400; architecture and building construction, 7700; biology, 3200; industrial arts, 4000; workshops, 7900; bakery school, 2100; administration, library, general class-rooms, &c., 37,000.

The prime movers laboratory, the dynamo laboratory, and the practical engineering laboratory will be placed at the bottom of the interior courts, and will be lighted entirely from glass roofs. The chemical departments will occupy practically the whole of the top floor, and will contain several large laboratories and other similar rooms set apart for special purposes. The plan of confining each department to one floor has been followed throughout, with a view to promote efficiency in working.

The buildings will be the largest of the kind in Great Britain, and will cover nearly two acres; their cost, with the site, but exclusive of the equipment, will amount to about 210,000*l.* Meantime, contracts have been made for the erection of the first section of the buildings, comprising nearly three-fourths of the whole.

The inadequacy of the present buildings for the work of a technical institution has been long felt by teachers and students, but there are many scattered all over the world who have a grateful remembrance of the instruction and guidance they obtained in these old-fashioned rooms; there is every reason to hope that with improved facilities for work there will be quickened zeal to take advantage of them. G. A. G.

NOTES.

We are glad to know that steps have been taken to secure and erect a memorial of the late Sir George Stokes in Westminster Abbey. At a meeting of a joint committee of the University of Cambridge and the Royal Society, held on March 12, the Duke of Devonshire being in the chair, it was resolved that the authority of the Dean and Chapter of Westminster be requested to place a medallion relief portrait of Sir George Stokes in the Abbey of the same general character as the memorials of Darwin and other scientific men already there. A letter has since been received from the Dean of Westminster expressing his general assent to the proposal and his willingness to take detailed plans into consideration. Mr. Hamo Thornycroft, R.A., has undertaken to prepare a medallion, the material to be bronze, and the head to be in high relief. It is estimated that the cost of placing this memorial in Westminster Abbey will be about 400*l.*, and as there are doubtless many admirers of Stokes who would like to contribute to the fund being raised for the purpose of the memorial to him, a subscription list has been opened. The treasurers of the fund are the Vice-Chancellor of the University of Cambridge and the treasurer of the Royal Society. Subscriptions should be made payable to Messrs. Barclay and Co., Ltd., and should be sent either to them at their Cambridge branch or to the treasurer of the Royal Society.

The two gold Hofmann medals, established in 1888 in connection with the seventieth birthday of August Wilhelm von Hofmann, for award to distinguished foreign men of science, have been conferred by the German Chemical Society upon Prof. Henri Moissan and Sir William Ramsay.

The centenary of the announcement of the atomic theory by Dalton was celebrated at Manchester on Tuesday and Wednesday. We propose to publish an account of the celebration in our next number with an article upon the atomic theory.

The Royal Society of Edinburgh will hold a conversazione in the rooms of the Royal Institution, Edinburgh, on Saturday, June 6.

An International Exhibition will be opened at Athens on June 3, and will last six months. The British exhibits, as at present arranged, will occupy 500 square metres, and will consist mainly of engines, ship-models, and guns.

The Central News Agency reports that, according to a despatch from the city of Mexico, the Colima volcano is again in active eruption.

During the week beginning June 1, Prof. J. J. Thomson, F.R.S., Cavendish professor of experimental physics in the University of Cambridge, will, says *Science*, give a course of lectures in the physical laboratory of the Johns Hopkins University on "A Theory of the Arc and Spark Discharges."

Mr. W. L. Sclater left England last week to resume his duties as director of the South African Museum at Cape Town. Before his departure he was presented with an address signed by nearly six hundred members of the Zoological Society, testifying to the tact and ability shown by him while occupying the post of secretary, to which he was provisionally elected.

A marble bust of George Stephenson was unveiled at the railway station at Rome on April 23. The bust was presented by the Institution of Civil Engineers to the municipality of Rome as a supplement to the tablet placed in the vestibule of the railway station at Rome in 1881 to commemorate the centenary of the birth of the father of the railway system.

A GENERAL meeting of the British Academy was held on May 14, Lord Reay, the president, being in the chair. Papers were read by Dr. Edward Caird, Master of Balliol College, Oxford, on "Idealism and the Theory of Knowledge," and by Prof. W. M. Ramsay on "The Importance of a Systematic Exploration of Asia Minor (in conjunction with the recently formed societies for the same purpose in Austria and in Germany)."

WE regret to record the death, on May 12, of Mr. William Talbot Aveline, at the age of eighty-one. He was engaged on the staff of the Geological Survey under De la Beche, as long ago as 1840. His early field-work was carried on in the region of the Mendip Hills and in South Wales; subsequently in many parts of North Wales, the western and midland counties of England, he personally surveyed large areas, while in later years he was called on to superintend the field-work in the Lake District. The maps and sections of the Geological Survey, especially in Silurian regions, form the chief records of his labours, for he wrote but little. He became a fellow of the Geological Society in 1848, and in 1894 he was awarded the Murchison medal in appreciation of his long-continued and careful labours in field-geology.

WE learn from the *Athenæum* that a Norwegian expedition, commanded by Captain Roald Amundsen, left Christiania a few days ago with the object of fixing the exact situation of the magnetic North Pole. The party are expected to be absent for four years, the route taken being by Lancaster Sound, Boothia Felix, where a magnetic observatory will be established for a period of two years under control of two members of the scientific staff, and back by the North-West Passage, Victoria Land, and the Behring Straits.

ON Tuesday next, May 26, Prof. E. J. Garwood delivers the first of two lectures at the Royal Institution on "The Work of Ice as a Geological Agent"; on Thursday, May 28, Prof. J. A. Fleming commences a course of two lectures on "Electric Resonance and Wireless Telegraphy"; and on Saturday, May 30, Prof. S. P. Thompson begins a course of two lectures on "The 'De Magnete' and its Author." The Friday evening discourse on May 29 will be delivered by His Highness the Prince of Monaco on "The Progress of Oceanography," and on June 5 by Prof. H. H. Turner on "The New Star in Gemini." The extra discourse on June 19 will be delivered in French by Prof. Pierre Curie on "Radium."

A PARIS correspondent states that on May 8, a balloon built for MM. Lebaudy made a notable performance. The balloon left the Moisson Aërodrome in the morning and returned to it after having navigated round Mantes at a distance of 10 kilometres. The performance was executed in 1h. 36m. by a circuitous way the length of which has been estimated as 37 kilometres. The length of the air-ship is 56 metres, and the volume 2300 cubic metres. The engine is a 40 horse-power. There were two persons on board, M. Juchmès, a well-known professional aëronaut, and a mechanician. The peculiarity of the balloon is that it has two screws working in the central part, and not a single propeller at some distance behind. There are two rudders behind at a distance of about 20 metres from the car, one for the vertical motion and the other for movement in a horizontal direction.

DURING the course of his speech at the opening of the Johnston Laboratories of the University College of Liverpool, of which a short account was given in these columns last week, the President of the Local Government Board made it clear that he at least understands fully the important part science has taken in the work of civilisation and progress. Mr. Long said that so long as he had the honour to occupy the position he now held he would do his best to secure on behalf of the Government of the day the utmost assistance that could be given to the advancement of science in all parts of the country. It seemed to him that the connection was very close between the development of science, and especially of that form of science which was known as preventive medicine, and the commerce for which this great country was so justly famous. There is no doubt of this intimate interdependence of scientific knowledge and commercial success, and Mr. Long did well to commend the people of Liverpool for having raised by donations to university education the sum of 200,000*l*.

AT the anniversary meeting of the Royal Geographical Society on Monday, the medals and awards which are given annually for the encouragement of geographical science and discovery, and have already been announced (March 19, p. 469), were presented. In the course of an address the president said that Captain Sverdrup, in completing our knowledge of the Parry archipelago, had also completed our general knowledge of Arctic geography. The whole problem of Arctic geography had now been solved. There were many isolated pieces of work that would have to be undertaken, but none which would justify the dispatch of an expedition on a large scale. With regard to the Antarctic regions, he said that the German expedition had the great advantage of having selected one of the two best routes for Antarctic discovery. After giving a short summary of the position of the British expedition, the president said that the *Morning* must go south again next December, and for this purpose funds, amounting to perhaps 15,000*l*., must be provided.

THE fall of dust between February 21 and 23 last was observed over such an exceptionally extensive area of Europe, from Ireland eastward into Austria, that the phenomenon has attracted more than usual attention, and already a number of papers dealing with local falls have been written. On the May pilot chart, just published by the Meteorological Office, there is, however, an extremely interesting map of the area from the Equator to 55° N., and from 40° W. to 20° E., exhibiting at a glance the distribution of dust or sand, of mist, haze or fog, the mean barometric pressure for the five days February 18 to 22, and the wind direction recorded by observers out at sea. The accompanying letterpress shows that prior to the dust reaching Europe, sandstorms had interfered with the progress of the British Boundary Commission in Nigeria, south of the Sahara, and had also been experienced on the northern edge of the Sahara. At sea, off Africa, ships were hampered in their movements by the obscuration due to the great quantities of sand in the air, from the Gulf of Guinea to 30° W. and up to the Azores. The map shows very clearly that the wind about the Canaries, becoming easterly to south-easterly in direction on February 19, drove the dust-cloud to west and north-west, and near the Azores, the wind being south-westerly, the cloud was quickly carried north-eastward to England and Europe. It is deserving of notice that, according to the log of the R.M.S. *Briton*, keeping near the African coast, the sand was very dense, "huge quantities of red dust," with the wind at north-east, but a temporary change to south-south-west for ten minutes cleared the air immediately. On the wind going back into north-east, the sandstorm came over again. The steamer *Kirkby*, on the other hand, running westward from Madeira, had the dust fall with a south-east wind; when the wind changed to north the dust ceased.

A CORRESPONDENT of the *Times*, writing from St. Vincent on April 22, gives some interesting particulars of the Soufrière eruption of that date. Soon after daylight, he observed that inside of a quarter of an hour the enormous umbrella-like steam-cloud spread out enormously. At this time no noise was noticeable in the town. A little later, violent explosions occurred at frequent intervals. It soon became quite dark, but, following previous cases, everything began to go in the direction of Barbados. Fine metallic dust fell until next day, black and gritty, apparently magnetite. Châteaubelair did not suffer this time except for another deposit of sand and small stones. Georgetown suffered much, and large stones fell throughout the Carib country.

MUCH discussion has recently taken place with reference to the behaviour of the Weston galvanic cell as a standard of electromotive force. The observed anomalies appear to be dependent upon the behaviour of the particular concentration (14·3 per cent.) of the cadmium amalgam previously recommended for the standard form of the instrument, and are not connected with any change in the condition of the cadmium sulphate which enters into the composition of the cell. It seems to be now definitely established that with less concentrated cadmium amalgams the Weston element gives quite normal and trustworthy indications.

IN the *Sitzungsberichte der Berliner Akademie* Profs. Holborn and Austin describe some important experiments on the loss of weight of the platinum metals when heated to temperatures of 1000° to 1500° C. by means of an electric current. In the case of platinum, rhodium and iridium this loss of weight only takes place in an atmosphere containing oxygen, and is probably due to a chemical change. With palladium the phenomenon is independent of the nature of the surrounding gas, but depends very considerably on the pressure, the rate of loss of weight increasing as the pressure of the gas decreases. The behaviour of palladium agrees with the supposition that the loss of weight is simply due to sublimation.

WE have received from Dr. Jansen a short summary of the work already accomplished in the preparation of the "Technolexicon," to which we have referred on one or two occasions recently. Up to the present assistance has been received from 341 societies and more than 2000 industrial establishments and individuals. Of the societies, 272 are German, 42 English and American, and 27 French. An analysis of existing dictionaries, catalogues, &c., has given a list of something like one and a quarter million words, and it is expected that a large number more will be obtained from the note-books of collaborators, which will be called in during 1904. It is not expected that the dictionary will be ready for printing until the end of 1906.

PROF. LADISLAUS NATANSON has published in the *Journal of Physical Chemistry* for February a lecture delivered before the Cracow Academy of Sciences on "Inertia and Coercion." The author considers that the phenomena of nature can be divided into two classes, those which bear a character of permanence, and those which tend to subside. Under the first category he places the motions considered in the ideal systems of rational dynamics, and the equilibria of classical thermodynamics. There are, however, other cases in which the two classes of phenomena cannot be considered separately; these are studied in the subject of thermokinetics. Equilibrium is only a limit to phenomena, and to study what actually occurs in nature we must go on to study the laws which preside over their progress. In cases where a disturbance tends to subside, as in the diffusion of gases, the conduction of heat, and the flow of electricity, we find that the progress of the phenomenon is represented quantitatively by the flux of a certain quantity per unit time across unit surface. This flux depends in general on what may be called the stimulus of the phenomenon. This "stimulus" may give impetus to the flux, but it will in every case be largely employed in overcoming "coercion," a property which always tends to impede the flow, but does not in general (*e.g.* in the case of diffusion of gases) destroy it altogether.

IN the *Contemporary Review* for May, Mr. Frederick Soddy, whose name is well-known as a co-worker with Prof. E. Rutherford at the McGill University, Montreal, describes what may be referred to as the Canadian view of radioactivity. Briefly stated, this is to the effect that the radioactive thorium X, which is contained in ordinary thorium, and can be separated by precipitating the inactive thorium by means of ammonia, is a first decomposition-product of the unstable thorium atoms, that the radio-active emanations which are transmitted by thorium X to neutral gases, such as hydrogen and nitrogen, and which are condensed by cooling to −130° C., represent a further stage in the atomic degradation, and finally it is suggested that helium —an invariable constituent of radio-active minerals—is possibly the last and stable product of the shattered thorium atoms. According to this view, which will not be received without an effort by chemists trained to believe in the conservation of matter and the immutability of the elements, the energy of radium is derived from the deflagration of a minute and unweighable proportion of the almost explosive radium atoms.

IN the *Nineteenth Century*, Mr. William Ackroyd, writing on "Radium and its Position in Nature," directs attention to the fact that radium not only has the highest atomic weight, but probably, in accordance with a well-known law, is also the rarest of the known elements. The close resemblance between Becquerel rays and X-rays is referred to, and it is suggested that the production of the former is analogous to the phosphorescence of calcium sulphide after exposure to sunlight. The possibility that an atomic bombardment may be the source of energy of radio-active bodies is, however, inferred from a reversed phenomenon observed by Prof. Graham Bell and Mr. Sumner Tainter, in which solids, liquids and gases are made to emit a musical sound under the influence of an intermittent beam of light pulsating 500 or 600 times in a second.

IN a paper dealing with the infection-powers of ascospores in the Erysiphaceæ (*Journal of Botany*, May), Mr. E. S. Salmon takes up a subject which has been almost untouched. It is known that conidial forms of apparently the same species are restricted in their power of germinating to definite and distinct host-plants, and thus there are differentiated a number of so-called biologic forms. Whether ascospores show a similar selective capacity for infecting host-plants is the problem which Mr. E. S. Salmon endeavours to elucidate.

AN article of considerable interest which appears in the *Transactions* of the Royal Scottish Arboricultural Society refers to the inception of the scheme for laying out tree plantations on the gathering grounds of waterworks. On the lands belonging to the Halifax Corporation, which took the lead in this matter, ash, sycamore and alder have been planted along with Scots pine and larch, but the intention is to leave the hardwood only as a permanent crop. Other papers which are of primary importance to foresters relate to the larch and its diseases, thinnings in planted spruce, and the injurious effect of smoke on trees.

THE study of ecological botany has not been so vigorously pursued during recent years in Great Britain as in other countries, but the few papers that have appeared have been the outcome of thoroughly sound work. A botanical survey of the West Riding of Yorkshire has been completed, and the results obtained by Dr. W. G. Smith and Mr. C. E. Moss for the south-western district are incorporated in an article published in the *Geographical Journal*. Both the descriptions and photographic illustrations are exceedingly good, but the main feature is the representation of the various formations on a map on the scale of two miles to the inch, which should be carefully studied by all ecological workers; also the origin and relationships of the types of vegetation are critically discussed.

NO. 5 of the *Proceedings* of the Chester Society of Natural History contains a list of the species of Lepidoptera recorded from Chester and four adjacent counties, drawn up by Mr. G. O. Day, with the assistance of two other gentlemen.

WE have received vol. iv. of "El Peru," a work on the geology and mineralogy of that country published by the Geographical Society of Lima. It appears that by the decease of Dr. Antonio Raimondi in 1890, the publication of this work, which commenced in 1874, was interrupted. The present volume is based on that observer's manuscripts, which it has taken a long time to prepare for publication. The bulk of the volume is devoted to the rocks of the country, both igneous and sedimentary; but the latter part includes a series of miscellaneous observations, including the description of a lower jaw of *Mastodon andium* from a Peruvian locality. The work should be invaluable to Peruvian geologists and petrologists.

A VERY important and interesting contribution to the study of the venation of the wings of dragon-flies appears in No. 1331 of the *Proceedings* of the U.S. Nat. Museum, illustrated by no less than twenty-four plates and many text-figures. The author, Mr. J. G. Needham, treats the subject from a phylogenetic point of view, and claims to have discovered features in wing-development which will be applicable to insects generally, as well as others affecting the classification of dragon-flies. He finds, for example, that the same type of wing, in accordance with the needs of the mode of life, has been independently developed in totally different sections of the group. This, of course, largely affects the determination of fossil dragon-flies, which have been to a great extent named on the evidence of the wings, or portions of the same, and it is shown that in several instances these determinations are wholly incorrect. *Libellulium kaupi*, for instance, is probably not a dragon-fly at all, while *L. agrias* belongs to the Æschnidæ, the details of the specimen figured by Westwood being entirely different to those characteristic of the Libellulidæ.

VISITORS to the Natural History Museum will not fail to notice a great improvement in the appearance and instructiveness of the exhibits in the reptile and fish galleries, which were left at the death of Sir W. H. Flower in their original condition. Until the director undertook the rearrangement, the cases were crammed with a number of faded and "khaki"-coloured specimens, unaccompanied by any descriptive labels. The duplicate and superfluous specimens have now, for the most part, been weeded out, and those that are left placed so that they can be well seen by visitors. In many instances old specimens have either been replaced by new ones or have been painted up so as to give them, so far as possible, some sort of resemblance to the living animals; and this process of replacement and renovation is being actively continued. A large specimen of a thunny which has been for many years in the museum affords an excellent example of what can be done by judicious painting. The splendid colouring of the Malay python is displayed in a specimen presented by Mr. Rothschild, as well as by a second example, on which an artist was still engaged at the time when this was written. In the reptile gallery, which is in the more forward condition, descriptive labels have already been placed in several of the cases, in which the specimens have been removed from the old hideous sycamore stands and set on sanded ground-work.

THE fourth part of vol. lxxiii. of the *Zeitschrift für wissenschaftliche Zoologie* is entirely occupied by the first part of an exhaustive memoir on the structure of the cell, the author, Prof. E. Rohde, in this section devoting his attention to the nucleus and nucleolus. No less than nine beautifully coloured plates (some of which are double) illustrate this section of the subject. To the first part of the succeeding volume (lxxiv.) Herr E. H. Zietzschmann contributes an account of the morphology and histology of the scent-glands which occur on the face and limbs of different members of the deer family. Very full details are given of the nature of these structures in the greater number of the generic groups, and the existence of a small metatarsal gland in the elk is confirmed. It is perhaps a matter for regret that the author did not see his way to express any opinion as to the existence of an homology between the limb-glands of the deer and those of other ungulates. The scent-gland of the centipede *Iulus communis* forms the subject of an article by Dr. G. Rosse in the same fasciculus, which also contains papers on the spermatogenesis of Cœlenterata, and on the development of Dolomedes.

THAT our village ancestors were not devoid of artistic sense is apparent from many old articles of furniture that are bought up and treasured by the more wealthy classes. In a paper on the decorative arts of our forefathers as exemplified in a Southdown village in the *Reliquary* for April, Mr. W. Heneage Legge has given some interesting examples of beautiful objects still to be found in a single village, but the trend of modern ideas is to induce a dead monotony of machine-made shop goods. In the same journal Mr. F. W. Galpin gives an illustrated account of the Portland reeve staffs. These are notched quadrangular rods, by means of which the annually appointed reeve, or steward, keeps his account of the rents due to the King as Lord of the Manor.

MARRIAGE customs are generally interesting on account of the often rude symbolism that accompanies them; students of this branch of ethnology will find many marriage customs of various southern Indian tribes related by E. Thurston in *Bulletin* vol. iv., No. 3, of the Madras Government Museum. Ethnologists are fully aware of the value of the *Bulletins* of this museum, and the current number contains a mass of valuable material contributed by the energetic director of the museum. A short account of fire-walking in Ganjám does not record any new feature. Our schoolmasters are not likely to adopt any of the forty-two kinds of punishment inflicted on naughty boys in native schools.

WE have received the April number of the *Journal of Hygiene* (vol. iii. No. 2). Several papers deal with preventive medicine, *e.g.* the significance of the presence of the colon bacillus in ground waters, by Mr. Horton; the

distribution of the diphtheria bacillus in the throats of "contacts," by Dr. Graham Smith; and upon the correlation of several diseases of animals in South Africa, by Dr. Edington. Messrs. Graham Smith and Sanger discuss the biological or precipitin test for blood in its medico-legal aspects, and Messrs. Nuttall and Shipley complete their monograph upon the structure and biology of the Anopheles mosquito. The last is an important contribution, and is illustrated with some beautiful figures.

A SECOND, revised and enlarged, edition of Mr. H. M. Leaf's "The Internal Wiring of Buildings" has been published by Messrs. Archibald Constable and Co., Ltd. The new edition contains an additional chapter on electricity meters.

MR. EDWARD ARNOLD has published a revised edition of "A Course of Practical Chemistry," by Mr. W. A. Shenstone, F.R.S. This little book is intended as a laboratory companion for use with the author's "Inorganic Chemistry."

THE fourth volume of the "Petite Encyclopédie Scientifique du XX^{e} Siècle," viz., "La Chimie dans l'Industrie, dans la Vie et dans la Nature," by M. A. Perret, published by MM. Schleicher Frères and Co., of Paris, has reached a second edition.

WE have received a copy of "A Guide to the Early Christian and Byzantine Antiquities in the Department of British and Mediæval Antiquities," printed by order of the Trustees of the British Museum. The book runs to 116 pages, and is illustrated with fifteen plates and eighty-four wood-cuts. Visits to the Christian Room of the British Museum with this guide as a companion will, if the book has been previously studied, be full of interest. The guide, even without the visits, will prove of great value to teachers of history.

A SECOND edition of the "Life History Album," edited some years ago by Mr. Francis Galton, F.R.S., has been published by Messrs. Macmillan and Co., Ltd. The "Album" was, in its original form, the joint production of a small committee of medical men, but Mr. Galton has largely rearranged and rewritten the contents, so that the present volume may be regarded almost as a new publication. Convenient provision is made in numerous well-arranged tables for a record of the genealogy, description at birth, the life and medical history for each year from birth to a hundred years of age, and for records as to wife (or husband) and children. An appendix supplies tests of vision and nine charts on which to represent graphically the weight and stature for each year of life.

A SUPPLEMENTARY volume to the "Scientific Memoirs of Thomas Henry Huxley," edited by Sir Michael Foster and Prof. E. Ray Lankester, has been published by Messrs. Macmillan and Co., Ltd. In the preface to the new volume Prof. Lankester says, "when it was discovered that owing to a bibliographical obscurity we had omitted the later portions of Huxley's 'Survey Memoir' on fossil fishes from our collection, it became necessary to issue a supplement containing the important work which we had inadvertently passed over. The opportunity is taken to add three interesting essays by Huxley, which, . . . have considerable interest for zoologists." These essays are "Vestiges of the Natural History of Creation. Tenth Edition. London, 1853." "The Rede Lecture, 1883," and the "Inaugural Address. Fisheries Exhibition. London, 1883." The essays referred to are not contained in the published edition of Huxley's more general essays.

IN a recent number of the *Berichte* Carl Neuberg describes a method of resolving racemic aldehydes and ketones by means of an optically active hydrazine. The difference in solubility between the stereoisomeric hydrazones is very considerable, and on combining racemic arabinose with *l*-menthylhydrazine, it was found that the hydrazone of the lævorotatory *d*-arabinose readily crystallised out in colourless prisms, which were practically pure, whilst the hydrazone of the *l*-sugar remained in solution as syrup, which could not be crystallised.

THE wandering of a methyl group in the conversion of pinacone into pinacoline is a phenomenon that has long been familiar to chemists, and further illustrations have recently been given by Crossley in the case of the dimethyldihydroresorcins. Three further examples occurring in the antipyrin group of compounds are described by Knorr in the *Berichte*, and it is noteworthy that in every case the transference of the methyl radicle takes place from a $>C(CH_3)_2$ group. It would therefore appear that the reluctance of one carbon atom to carry two methyl groups is an important factor in bringing about this somewhat unusual type of change.

THE additions to the Zoological Society's Gardens during the past week include a Great Wallaroo (*Macropus robustus*) from South Australia, presented by Mr. T. Becket Birt; a Black-crested Eagle (*Lophaëtus occipitalis*) from West Africa, presented by Mr. A. Boyd; a Black-eared Marmoset (*Hapale penicillata*) from South-east Brazil, a Schneider's Skink (*Eumeces schneideri*), five Common Skinks (*Scincus officinalis*), four Common Chameleons (*Chamæleon vulgaris*) from North Africa, six Hispid Lizards (*Agama hispida*) from South Africa, a Naked-necked Iguana (*Iguana delictissima*) from Tropical America, two Seven-banded Snakes (*Tropidonotus septemvittatus*), a Mocassin Snake (*Tropidonotus fasciatus*), two Testaceous Snakes (*Zamenis flagelliformis*), a Hog-nosed Snake (*Heterodon platyrhinos*) from North America, four Gallot's Lizards (*Lacerta galloti*), four Atlantic Lizards (*Lacerta atlantica*) from the Canary Islands, deposited; a Cape Zorilla (*Ictonyx zorilla*) from South Africa, purchased.

OUR ASTRONOMICAL COLUMN.

NOVA GEMINORUM.—*Bulletin* No. 19 of the Yerkes Observatory is devoted to the observations of Nova Geminorum which have been made since the telegram announcing its discovery was received on March 27.

Prof. Hale records the colour of the Nova as "a strong red," and when in the best focus of the 40-inch telescope there is a decided crimson glow around the image for about 2″ or 3″, which is not present with the images of the comparison stars. Prof. Barnard found that with the 40-inch refractor the focus of the Nova did not differ appreciably from that of the surrounding stars.

Magnitude observations show a decrease from 8·51 on March 27·715 to 8·96 on April 4·583, with a secondary maximum of 8·76 intervening on March 30·673 (H.C.O. scale of magnitudes).

Two of the prisms of the Bruce spectroscope were removed and a special camera constructed on March 28, and the spectrum of the Nova photographed the same night with an exposure of 3h. 12m. In the spectrogram obtained Prof. Frost has found a band extending from about λ 4598 to λ 4696 (mean about λ 4647), and a very strong Hβ line having its mean value at λ 4862, with two narrow bright maxima near the less refrangible end at about λλ 4877 and 4882. A less refrangible band extends from λ 5647 to λ 5685 (mean at λ 5666), and another from λ 5729 to λ 5775 (mean about λ 5752); a sharp boundary on the violet side of the latter suggests the presence of a dark band.

The kind of plate used is not very sensitive at about λ 5000, and this may account for the absence of the band λ 5016, which, however, is exceedingly faint in this Nova. Hγ is present, but scarcely strong enough to measure, and merges into a brighter band which extends from λ 4347 to λ 4371 (mean at λ 4359).

A reproduction of the spectrogram is given, and it is seen that the spectrum corresponds to those of Nova Aurigæ and Nova Persei at the later stages of their development.

A very faint bright band in the spectrum of Nova Geminorum in the region of the chief nebula lines is far too weak to measure.

PARALLAX OF THE BINARY SYSTEM δ EQUULEI.—Mr. W. J. Hussey publishes in *Bulletin* No. 32 of the Lick Observatory the results of his calculation of the parallax of δ Equulei, based on the micrometrical and spectroscopical measurements made at the Lick Observatory during the past three years. The method pursued is theoretically absolute, for in no way is the result dependent upon the assumption of values for comparison stars, as it is in the ordinary method of calculating parallax.

The formula used was published by Prof. A. A. Rambaut (*M.N.* March, 1890), and gives the absolute parallax of a system when the elements of the orbit, the relative velocity of the components in the line of sight, and the orbital velocity of the earth at the time are known.

The determination of the elements of the orbit made at Lick has led to the adoption of 5·7 years as the periodic time of revolution; using this value for the period, and taking the mean distance as 0″·28, the eccentricity as 0·46, the apastron and periastron distances as 0″·409 and 0″·151 respectively, the relative velocity in the line of sight, determined by the observers using the Mills spectrograph, as 20·5 miles per second, and the orbital velocity of the earth at the time as 18·2 miles per second, Mr. Hussey obtains

$$\pi = 0''\cdot071$$

as the parallax of this system, but states that this is probably not the final value, for the elements may be appreciably modified during the critical observations it is proposed to make during the next three years.

Taking this value for the parallax and the mean distance and period given above, the mass of the system becomes 1·89, the mass of the sun being taken as unity, and, as the components are not quite equal in magnitude, the brighter may have a mass equal to, but not greatly exceeding, that of the sun. The mean distance of the components is about four times that of the earth from the sun, but, owing to the great eccentricity of the orbit, the actual distance at periastron is just more than twice, and at apastron about five times, that unit. As the spectra of the components are both of the solar type, and as their masses are comparable with that of the sun, it might be reasonably assumed that their densities do not differ to any great extent from the density of that body.

A REGULATING OR RECORDING THERMOMETER.

A THERMOMETER which is capable of regulating the temperature of a room with considerable accuracy, or of keeping a continuous record of the temperature, is frequently required in laboratory work. Such a thermometer is described in the present article. Although there is little essentially new in its construction, the details on which success depends are the result of considerable practical experience, and as the manufacture of such an instrument should be within the powers of most laboratories employing a mechanic, it has been thought desirable to publish an account of it.

The estimation of temperature in this thermometer depends on the alteration in shape of a piece of flat brass tubing bent into spiral form and filled with a liquid possessing a large coefficient of expansion. If one end of the tube is fixed, the motion of the other end, magnified by a suitable arrangement of levers, serves as a measure of temperature. As the thermometer is intended for use within a range of temperature of at most three or four degrees, we are not concerned with the equality of the graduations per degree at different parts of the scale.

The illustration (Fig. 1) shows the general appearance of the thermometer arranged as a recording instrument. The brass tubing of which the spiral is formed has a section in the shape of a very flat ellipse, the longer diameter being ⅞ inch, the shorter 3/16 inch, while the thickness of the wall is 0·02 inch. The tube is bent into the spiral form by filling it with melted resin and bending it round a cylinder 8 inches in diameter, on which is cut a spiral groove. After the resin has been removed by heating the tube, brass plugs[1] are soldered into the ends, each plug having a central hole for the purpose of filling the tube with liquid. In the thermometer illustrated, these holes are shown closed by steel screws. A simpler and more efficient plan is to solder a short length of lead tubing into the brass plug. Then, when the thermometer has been filled with liquid, the end of the lead tube is pinched together and soldered. The spiral can thus be hermetically sealed without loss of liquid.

In order that the thermometer may acquire the temperature of the surrounding air as rapidly as possible, the surface is increased by soldering to the spiral a strip of thin sheet copper about four inches wide. The whole is painted dead black.

For filling the tube creosote has been found to answer well. The process of filling the tube is the most troublesome part of the work, as it is difficult to get rid of the air bubbles which cling to the interior. While it is being carried out the tube should be placed in melting ice.

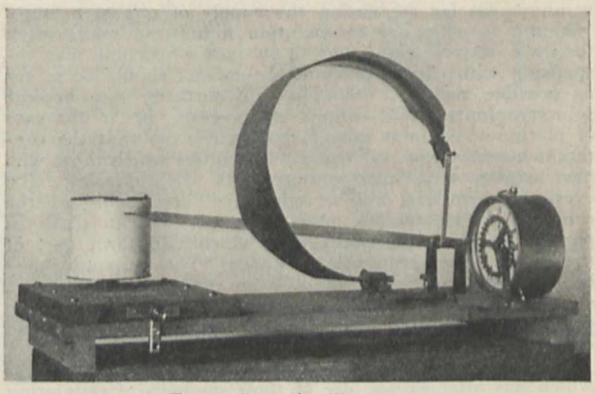

FIG. 1.—Recording Thermometer.

Funnels may be attached to the open ends of the spiral to facilitate the introduction of the liquid. When the tube is nearly full, liquid should be poured into either end in turn until the creosote rises in the other funnel free from air bubbles.

When the tube has been hermetically sealed, it is ready for attachment to the stand. Instead of fixing one end of the tube directly to the base board, it is fastened to one flap of a common brass hinge, the other end of which is screwed to the board. A hole is tapped in the upper flap and fitted with a screw the point of which bears against the lower flap, thus providing an adjustment for the distance between the two. This is a very simple method of giving a small alteration to the position of the fixed end of the spiral, and so adjusting the pen to any desired height on the recording cylinder.

The free end of the spiral is attached by a connecting rod of thin aluminium to a brass lever, half an inch in length, fixed to the spindle that carries the tracing arm. The length of the light arm which carries the pen is sixteen inches. Thus the actual motion of the end of the spiral is multiplied by the factor 32 at the recording drum.

The bracket carrying the spindle is formed of two uprights of thin sheet brass, screwed and soldered to a thicker base plate. The spindle itself is made of steel wire about three-sixteenths of an inch in diameter; the ends forming the pivots are turned down to a somewhat smaller diameter and ground into holes bored in the uprights. On the outer side of each upright is screwed a short length of flat steel

[1] The plugs should be of drawn brass, as it is found that creosote gradually percolates through cast brass.

spring, which bears against the projecting point of the spindle and so controls any lateral movement.

In addition to the recording cylinder a second clock will be noticed in the illustration. This was introduced because it was found that the pen was inclined to stick to the paper, so that the full range of temperature was not recorded. The clock once in every minute draws the pen away from the paper, so that it is free to take up its natural position. Hence the trace is made up of a series of dots instead of being a continuous line. The minute hand of the clock is replaced by a wheel in which sixty teeth are cut. Every minute one of the teeth engages with a short pin supported by a flat steel spring. When this pin is pushed aside it draws after it one of the springs referred to above as pressing against the point of the spindle. The spring at the opposite end of the spindle consequently comes into play and pushes the spindle in the direction of its length, thus relieving the pen from the paper.

In this thermometer the motion of the pen for a change in temperature of one degree Fahrenheit is about one inch (4·5 cm. per degree C.) at ordinary temperatures.

The thermometer selected for description is adapted for securing a continuous record of temperature. When it is desired to use such a thermometer to regulate the temperature, the pen may be replaced by a platinum point which is arranged to complete an electric circuit by contact with a platinum terminal or by dipping into a mercury cup. The current so set up may be used to operate a relay, and so switch on a stronger current, if heating by electricity is employed, or it may actuate some suitable mechanical arrangement for regulating the supply of gas to a stove. When it is necessary to maintain a uniform temperature for days or weeks together, it is most important that the sparking which takes place at the contact should be as far as possible reduced, otherwise the surfaces may become so contaminated that contact is uncertain, or in the case of platinum contacts may fuse together so that the contact is never broken. These are difficulties which those who have worked with such arrangements will appreciate. To overcome them it is well to reduce the current through the contact to the smallest possible value, and to place in parallel with the electromagnet which will form part of the circuit a non-inductive resistance. This resistance may be kept comparatively small, even at the expense of a somewhat larger current. A condenser inserted between the points of contact may be of service, but is not so effective as the plan mentioned.

It may be of interest to give some account of the success which has attended the use of these methods of regulating temperature in connection with the Blythswood dividing engine. The engine is placed in a detached building in a room fifteen feet long, ten feet wide, and ten feet high. Local conditions render it impossible to make use of a cellar. The room has double windows and shutters; it is warmed by two gas stoves, of which one is controlled by the regulating thermometer. During the greater part of the year this room can be kept at a temperature of 60° F., the variation in temperature being not more than one degree.

The controlling thermometer in this instance actuates, by an electromagnetic release, clockwork which supplies the necessary power for turning the gas on or off.

The dividing engine is enclosed in a wooden case inside this room. Originally the interior of the case was heated by electricity under the control of a regulating thermometer. The variations in temperature that were introduced by this method were sufficient to produce disastrous results in cutting a diffraction grating. Accordingly the case was surrounded with a lining of six inches of wool, and all the arrangements for securing a uniform temperature were made in the room outside. When this was done it was found that the temperature inside the case fell slowly but continuously. This was shown to be due to leakage of heat through the stand of the machine, which rested on a large stone block. To prevent this a space was cleared round the bottom of the stand, and this space was kept at a uniform temperature by electrical heating. This precaution was found to be effective, and the temperature of the case can now be kept constant with very considerable accuracy, the variation in four or five days not amounting to more than two-tenths of a degree Fahrenheit.

H. S. ALLEN.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Public Orator, Dr. Sandys, spoke as follows on May 14, in presenting Mr. Robert Bell, LL.D., F.R.S., Director of the Geological Survey in Canada, for the degree of Doctor in Science *honoris causa*:

Magnu n profecto est provinciae maximae penitus explorandae et scientiarum terminus latius proferendis vitam suam totam dedicasse. Salutamus virum, qui per annos plus quam quadraginta provinciae maximae Canadensis flumina, lacus, montes, campos denique latissime patentes exploravit; ibi locis plurimis nomina primus imposuit, et, ipse mortalium modestissimus, flumini a se primum indagato suum nomen ab aliis inditum audivit. Atqui nomen suum non in aqua scriptum, sed provinciae tantae in saxis potius insculptum reliquit; regionis illius immensae geologiam, geographiam, biologiam, archaeologiam libellorum in serie longa illustravit, et non modo provinciae ipsius terminos ubique definivit, sed etiam scientiarum fines ubique propagavit.

Duco ad vos Reginae Universitatis Canadensis doctorem, Societatis Regiae Londinensis socium, provinciae Canadensis exploratorem indefessum, ROBERTUM BELL.

A university lectureship in mathematics, stipend 50*l*. a year, is vacant by the election of Prof. Larmor to the Lucasian chair. Candidates are to send their names to the Vice-Chancellor by June 3, with statements of the branches of mathematics on which they are prepared to lecture.

In a report on the administration of the engineering laboratory it is proposed that two readerships, one in mechanical engineering and one in electrical engineering, should be established for Mr. Peace and Mr. Lamb, the present demonstrators; that two new university demonstrators should also be appointed, and that, in addition to their stipends, each of these should receive certain payments from the fees of students receiving instruction in the department. The growth of the latter under Prof. Ewing's direction may be gathered from the fact that in 1892 the number of students was 39, and the fees 546*l*., while in 1902 there were 211 students, who paid 5005*l*. in fees. In the present year there are twelve teachers, in addition to the professor and the two demonstrators, engaged in the work.

The syndicate report that the new building for the medical school is almost completed, and that the last stone of the Humphry Museum has been laid. A sum of 8062*l*. is required for fittings, furniture, electric lighting, and heating appliances.

The discussion in the Senate on the proposed reestablishment of the professorship of surgery turned chiefly on the question whether or not full residence should be required of the professor. If non-residence were permitted, a smaller stipend might suffice, and the field of choice might be widened. Prof. Liveing, Prof. Woodhead and others urged strongly that the professor's usefulness would depend on his being resident in the University.

MR. EDWIN EDSER has been appointed head of the physical department of the Goldsmiths' Institute, New Cross.

A CONVERSAZIONE of the Parents' National Educational Union will be held at the Kensington Town Hall on Monday, June 8. The Countess of Aberdeen will preside, and a paper will be contributed by Miss Mason, founder of the Union.

THE Court of Governors of University College, Sheffield, has adopted resolutions to the effect that in the interests of higher education in the city and district it is essential that Sheffield College shall have the powers and *status* of a university similar to those granted to Birmingham, Liverpool, and Manchester, and also that application be made to the Privy Council for a charter.

THE Secretary of State for India has appointed a small committee to inquire and report to him on the question of the expediency of maintaining the Engineering College at Coopers Hill, as a Government institution for the supply of officers to the Public Works Department in India. The committee will be composed as follows:—Sir Charles Crosthwaite, Sir James Mackay, G.C.M.G., Sir William Arrol,

M.P., Sir Arthur Rücker, and Sir Thomas Higham, K.C.I.E., with Mr. J. E. Ferard, of the India Office, as secretary.

THE new science rooms of the Colston's Girls' School, Bristol, were opened on Friday last, May 15, by the Right Hon. Henry Hobhouse, M.P. The new building comprises three rooms, about 30 feet by 26 feet, and one smaller. The lecture room will be largely used for the study of botany, and is provided with a small conservatory, or window box, in which experiments, such as those showing the process of germination, will be carried out. In the chemistry laboratory benches are provided at which girls will work in sets of two, and each set will have a balance on side benches close at hand. The physics laboratory is on very much the same plan as the chemistry room. Mr. Hobhouse, in the course of his speech, remarked that the education of girls was of the highest importance, not only in order to fit them for their domestic duties, but also to provide good women teachers. Prof. Armstrong hailed the opening of the new science rooms as a proof that science, once almost neglected, was now considered a necessary part of a liberal education.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 26.—"On the Cytology of Apogamy and Apospory. (1) Preliminary Note on Apogamy." By J. B. **Farmer,** F.R.S., J. E. S. **Moore,** and Miss L. **Digby.**

The phenomenon of apogamy is exhibited when the young fern-plant springs directly from the tissue cells of the prothallium generation, instead of arising as the result of segmentation of the egg within the archegonium. It has been regarded as a "short cut" in the life-cycle, and some theoretical importance has been attached to it in connection

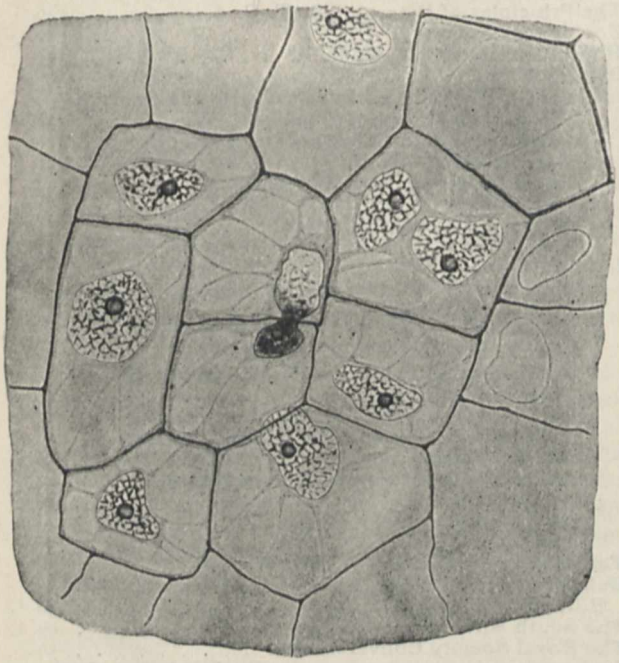

FIG. 1.—Group of prothallial cells with migrating nuclei.

with the relationships believed to exist between the gametophyte and the sporophyte, that is, between the prothallium and the fern-plant. Now it has been known for some years that the nuclei of these two generations exhibit a constant difference *inter se* of such a nature that each sporophyte nucleus contains twice as many chromosomes as do the individual nuclei of the gametophyte.

Evidence is brought forward to show that this nuclear change is brought about, in the apogamous development, by the migration of a nucleus to an adjacent cell, and its subsequent fusion with the nucleus of that cell. A considerable number of instances were observed in which single cells contained two nuclei, and when this was the case, one of the contiguous cells was always seen to be destitute of a nucleus. Instances of the transit of the nuclei through the walls were also seen. Further, the nuclei of some of the cells in the region where these occurrences were discoverable could occasionally be met with in stages at which it was found possible to estimate the number of chromosomes. In such cases these were double the number of those of the ordinary prothallial nuclei.

These facts lead to the inference that we are dealing with an irregular kind of fertilisation, or, at any rate, with a mechanism for doubling the nuclear chromosomes that is practically identical with what is seen in normal fertilisation. In the latter case the double number is arrived at by the addition of the chromosomes of the sperm-nucleus to those of the nucleus of the egg.

The annexed figure illustrates (1) two cells in which the nucleus of the one is passing through the parti-wall, and apparently fusing directly with the other nucleus; (2) a cell with two nuclei, one of which has been derived from the cell at the top right-hand corner of the figure.

May 7.—"Preliminary Note on the Discovery of a Pigmy Elephant in the Pleistocene of Cyprus." By Dorothy M. A. **Bate.** Communicated by Henry Woodward, LL.D., F.R.S., F.G.S., V.P.Z.S., late Keeper of Geology, British Museum, Natural History.

The elephant described was discovered by the author in 1902 during a search for bone-caves in the Kerynia Range in the north of the island. The collection obtained chiefly consists of a series of teeth, all procured from a single deposit, which also contained a very much larger quantity of the remains of *Hippopotamus minutus.*

The teeth of the Cypriote elephant are considerably smaller than those of *Elephas mnaidriensis,* the largest of the Maltese forms, and are also slightly inferior in size to those of *E. melitensis.* As a general feature it may be said that the molars from Cyprus are more simply constructed than those of the last-mentioned species, showing a slighter tendency to "crimping" in the enamel and in being less inclined to develop the mesial expansion of the plates of dentine so characteristic of those of *E. africanus.* Taking into consideration the several characters in which the teeth of the Cyprus form differ from those of all hitherto described dwarf species (putting on one side *E. lamarmorae,* the teeth of which are unknown to science), as well as the distinct habitat of the animal, it is believed to be specifically distinct, and it is therefore proposed to name it *Elephas cypriotes.* The discovery of this pigmy species is interesting in comparison with those from Malta and Sicily, and the occurrence of these different, though apparently closely related, small races of elephants in widely separated islands of the Mediterranean lends probability to the theory that this is a case of independent development along similar lines, the result of similar conditions of existence.

Physical Society, May 8.—Dr. R. T. Glazebrook, F.R.S., president, in the chair.—Mr. T. H. **Blakesley** exhibited and described a spectroscope of direct vision, of one kind of glass, and of minimum deviation for every ray that comes into the centre of the field of view. The refracting angles are such that the cosines of half the refracting angles are equal to half the index of refraction for the ray which is to have no deviation. The first prism is right-angled, and has one angle equal to the refracting angle calculated by the above rule. The second prism and the third possess the refracting angle so obtained, and the fourth is similar to the first. The plan adopted can be extended by employing more than one of the arrangements described, in sequence.—Prof. J. D. **Everett** read a paper on the mathematics of bees' cells.—Mr. W. A. **Price** read a note on the coloured map problem. He referred to the fact that only four colours are required to colour a map on the surface of a simply connected region, such as a sphere, in such a way that two countries marching on a boundary line are coloured differently, and exhibited two models of anchor rings the surfaces of which were divided in each case into six sections, each of which marched with

the other five; and a model of a ring having a cross-bar or stud, the surface of which was divided into eight sections, each of which marched with the other seven. In the case of maps on such surfaces, at least six and eight colours would be required in the respective cases.—Dr. **Watson** read a note on the construction and attachment of galvanometer mirrors. It has often been pointed out, notably by Lord Rayleigh and Prof. Threlfall, that it is better to increase the sensitiveness of galvanometers and similar instruments by improving the optical system, rather than by pushing the electrical sensitiveness to extreme limits. When working with ordinary silver on glass mirrors difficulties arise in connection with the attachment of the fibre and the fact that it is necessary to use a varnish, which in all cases produces distortion. These difficulties have been overcome by using quartz instead of glass, and platinum instead of silver.

Mathematical Society, May 14.—Prof. H. Lamb, president, in the chair.—Lieut.-Colonel A. **Cunningham** announced the discovery of seven new factors of Fermat's numbers (2^{2^n}), viz. when n is 9, the factor $2^{16}.37+1$; when n is 11, the factors $2^{13}.3.13+1$ and $2^{46}.7.17+1$; when n is 12, the factors $2^{16}.397+1$ and $2^{16}.7.139+1$; when n is 18, the factor $2^{20}.13+1$; when n is 38, the factor $2^{41}.3+1$. In the cases of 9, 12, 18, the factors were discovered by Mr. A. E. Western; in the case of 11, by Lieut.-Colonel Cunningham; in the case of 38, jointly by collaboration of these authors with Rev. J. Cullen.—Dr. H. F. **Baker** communicated a series of notes:—(1) On the definiteness of quadratic forms with imaginary coefficients; (2) On a certain form of logical argument which occurs in the proofs of several fundamental theorems of pure mathematics; (3) On the summation of Neumann's series representing a potential determined by boundary values; (4) On the formation of the variant equation in the theory of differential equations; (5) On some points in the theory of continuous groups.—The following papers were communicated:—Mrs. **Young**, The surface representing all right-angled spherical triangles.—Mr. W. H. **Bussey**, Generational relations defining an abstract simple group of order 32736.—Mr. W. H. **Young**, (1) On skew surfaces contained in a linear congruence; (2) On closed sets of points and Cantor's numbers. In the last of these papers methods and results obtained by the author in a previous paper on the theory of sets of intervals are applied to the theory of linear sets of points. The theory of the higher transfinite numbers is avoided, but the transition to these numbers is shown to arise naturally, and a short account is given of the most recent work on this subject.

NEW SOUTH WALES.

Linnean Society, March 25.—Mr. J. H. Maiden, president, in the chair.—The president delivered the annual address, which was devoted chiefly to the consideration of the principles of botanical nomenclature.—The newly-elected president, Dr. T. Storie Dixson, then took the chair, and the following papers were read:—A monograph of the Australian Membracidæ, by Dr. F. W. **Goding**. In studying this group, twelve genera, represented by thirty-five species, have been recognised.—Revision of Australian Lepidoptera, by Dr. A. Jefferis **Turner**. Under the above heading the author hopes to publish a series of papers dealing with the different families as time and opportunity permit. This first instalment treats of the Notodontidæ and Hyponomeutidæ.

DIARY OF SOCIETIES.

THURSDAY, MAY 21.

ROYAL INSTITUTION, at 5.—Proteid-Digestion in Plants: Prof. S. H. Vines, F.R.S.

INSTITUTION OF MINING AND METALLURGY, at 8.—Diamond Drilling in West Africa: J. N. Justice.—On the Occurrence of Mica in Brazil, and on its Preparation for the Market: H. Kilburn Scott.—Analytical Work in Connection with the Cyanide Process: J. E. Clennell.—Notes on the Treatment of Gold Slimes in Venezuela: Leslie Symonds.—Notes on Cupriferous Cyanide Solutions: H. A. Barker.—Notes on Chorolque Tin Mines and Alluvial Deposits, Bolivia: M. Roberts.

FRIDAY, MAY 22.

ROYAL INSTITUTION, at 9.—Dictionaries: Dr. J. A. H. Murray.

PHYSICAL SOCIETY, at 5.—Exhibition of Nernst Lamps, showing their Development from the Experimental Form up to the most Recent Types: J. Stöttner.—Exhibition of a Diagram of Single-piece Lenses: T. H. Blakesley.—On an Instrument for Measuring the Lateral Contraction of Tie-Bars, and on the Determination of Poisson's Ratio: J. Morrow.

MONDAY, MAY 25.

LINNEAN SOCIETY, at 3.—Anniversary Meeting.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—(1) Neatsfoot Oil; (2) The Nitric Acid Test for Cotton Seed Oil: J. H. Coste and E. T. Shelbourn.

TUESDAY, MAY 26.

ROYAL INSTITUTION, at 5.—The Work of Ice as a Geological Agent: Prof. E. J. Garwood.

ZOOLOGICAL SOCIETY, at 8.30.—On the present State of Knowledge as to the Inheritance of Colour in Fancy Rats and Mice: W. Bateson, F.R.S.—List of the Batrachians and Reptiles collected by M. A. Robert at Chapadá, Matto Grosso (Percy Sladen Expedition to Central Brazil): G. A. Boulenger, F.R.S.—Note on some Bulimulidæ from Matto Grosso (Percy Sladen Expedition to Central Brazil): Edgar A. Smith.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Etiology of Leprosy: Jonathan Hutchinson, F.R.S.

WEDNESDAY, MAY 27.

GEOLOGICAL SOCIETY, at 8.—An Experiment in Mountain-Building: Lord Avebury, P.C., F.R.S.—(1) The Toarcian of Bredon Hill, and a Comparison with Deposits Elsewhere; (2) Two Toarcian Ammonites: Sydney S. Buckman.

THURSDAY, MAY 28.

ROYAL SOCIETY, at 4.30.—*Probable Papers*:—On the Bending of Waves round a Spherical Obstacle: Lord Rayleigh, O.M., F.R.S.—Sur la Diffraction des Ondes Électriques a propos d'un Article de M. Macdonald: Prof. H. Poincaré, For.Mem.R.S.—An Analysis of the Results from the Kew Magnetographs on Quiet Days during the Eleven Years 1890–1900, with a Discussion of Certain Phenomena in the Absolute Observations: Dr. C. Chree, F.R.S.—On the Theory of Refraction in Gases: G. W. Walker.—Researches on Tetanus: Prof. Hans Meyer and Dr. F. Ransom.—The Hydrolysis of Fats in vitro by Means of Steapsin: Dr. J. Lewkowitsch and Dr. J. J. R. Macleod.

ROYAL INSTITUTION, at 5.—Electric Resonance and Wireless Telegraphy: Prof. J. A. Fleming, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 5.—Annual General Meeting.

FRIDAY, MAY 29

ROYAL INSTITUTION, at 9.—The Progress of Oceanography: Prince of Monaco.

SATURDAY, MAY 30.

ROYAL INSTITUTION, at 3.—The "De Magnete" and its Author: Prof. S. P. Thompson, F.R.S.

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