THURSDAY, MARCH 27, 1902.

A GERMAN VIEW OF ENGLISH SCHOOLS.

Der Naturwissenschaftliche Unterricht in England, insbesondere in Physik und Chemie. Von Dr. Karl T. Fischer. Pp. viii + 94. (Leipzig: Teubner and Co., 1901.) Price mk. 3·60.

THIS work treats of the various methods of, and provision for, teaching science, principally physics, in English schools. The author, after a preliminary visit to this country in 1897, was commissioned by the Bavarian Government to spend six months in studying the efforts made in England to introduce the study of science into schools. The variety of organisation which exists in England lends itself to educational experiments, and the preference for boarding-schools, where the efforts of the teachers are not interfered with by parental care, often eliminates a disturbing cause which might influence the results of the experiment. It is remarked, that in comparison with continental schools, the school fees are enormously high; but, without reference to the necessities of the case, the parent is often solaced and his pocket relieved by the bestowal of scholarships upon boys capable of excelling in examination.

The author appears to have sampled the schools fairly well. Besides visiting many universities and university colleges, he saw the Manchester Municipal Technical School; the Technical Institutes at Salford, and at Birmingham and Dublin; the Girls' Central Foundation School; schools at York, Darlington and Leeds; the St. Dunstan's College, Catford Bridge; Tunbridge School; Clifton College, and Harrow; besides some smaller schools. The system of object lessons is described, and details of the syllabuses for elementary physics and chemistry in elementary schools are set forth. Similar details are given of the teaching in preparatory schools and in typical grammar schools, as well as in public schools. The work of the London polytechnics is sketched. The author contrasts the German technical institutes with these, not wholly to the advantage of the English institutions. The statistics of the Science and Art Department are quoted, as are also its programmes.

The author has been wrongly informed that chemical laboratories in Great Britain have only of recent years been open to students. Prof. Thomas Thomson's chemical laboratory at Glasgow and Prof. Hope's laboratory of "natural philosophy" at Edinburgh were available at the beginning of the nineteenth century; and in England, Prof. Turner's laboratory was advertised at least as early as 1834. The laboratory of the Pharmaceutical Society is of about the same age.

After quoting from Helmholtz, Tyndall, the late Prince Consort and Huxley, it is suggested that the effect of classical studies is to influence the imagination, that of science the understanding, and that the latter is to be awakened only through experimental acquaintance with the facts of science; and in England, in contrast with most German schools, the end is gained by laboratory practice. This, of course, can be achieved only by making each student carry out the same operation at the same time; in other words, by laboratory drill, and the system has been carried to a high pitch of perfection. In many schools the so-called "heuristic" method is adopted, according to which children make discoveries under leading strings. A typical syllabus of the methods of inducing children to make such discoveries is given in full. It would be, perhaps, too much to ask that those who inculcate such methods should first have practised what they preach; but when it is remembered that it took the best part of two centuries, and the ablest minds of many nations, to discover the composition of air and of water, it is doubtless hardly to be expected that either young children or their teachers would gain much by this method of teaching and learning. The training of science teachers in England is described, and the methods of South Kensington and its imitators are treated of; the cost of apparatus, too, receives ample notice.

Recent criticism of the "heuristic" system in England is, as proved by ample quotations, not favourable; those who have tried it have had to modify it greatly. Indeed, in the reviewer's opinion (who committed an indiscretion in the same direction in 1882), the conclusions are necessarily drawn from far too restricted premisses. While *very* clever lads are interested, they do not, nevertheless, gain the advantages which might be expected from a consideration of the experiments which they make; and the average student of seventeen or eighteen is simply a machine and his mind a fog—all that he learns is manipulation, and even that is faulty.

The conclusion of the book is an attempt to indicate what the English think of the German system and what the Germans hold concerning English methods. For the last, it might have been well to have waited for a second edition, after the present one had made the Germans better acquainted with recent developments of scholastic attempts in England; for, on the whole the author has given a very unprejudiced and correct account of his subject.

But many Germans have already made up their minds on the general question. One often hears a German professor say that he prefers a pupil to come to him ignorant of the subject he has to study, but well drilled in classics and mathematics. Indeed, a prominent English teacher of science confessed to Dr. Fischer that he preferred to teach boys trained on the "classical side," who had specialised in science later, to those trained exclusively on the modern side; the words are quoted in English: "They prove better, being of higher standard in character." As the late Prof. Fitzgerald once remarked, in arguing in favour of the retention of Latin in schools: "There is no other subject in which it is possible to set so many small problems all within the reach of a boy's intellect." But the problems of science, unless they are confined to those of mechanics, in the solution of which mathematics may be made to bear its important share, are too subtle for the young mind, as indeed the teacher would find who endeavoured to instruct a class in ethics or in jurisprudence, both subjects well deserving of man's attention. One must ask—to what end is all this energy directed? Is it to educate citizens or discoverers? If the former, then the reviewer ventures to suggest that better materials exist than such scraps of science which form the pabulum of the average science master, and are reproduced in wearisome iteration in the scores of elementary text-books which it appears to pay our publishers to bring out; if the latter, it must be confessed that our German neighbours, who have not as yet adopted such methods, are more prolific in quantity of research, at least, than we. W. R.

CHEESE-MITES.

British Tyroglyphidae. By Albert D. Michael, F.L.S., F.Z.S., F.R.M.S., &c. Vol. i. (London: Printed for the Ray Society, 1901.)

IF the world sometimes knows little of its greatest men, it often knows still less of its most familiar fellow-creatures. To work out the story of a cheese-mite with proper completeness is a task which many might undertake in a spirit of condescension, only to retire from it helplessly disconcerted. Yet none need be deterred from the enterprise by want of specimens, for though the Tyroglyphidæ are but one family out of many in the host of the Acarina, they produce a population absolutely beyond estimate in numbers. Together with the few species which, in accordance with the family name, are really "sculptors of cheese," there are many others that use a quite different diet. On learning that they like senna as well as dried figs, cantharides as well as French plums, that they are partial to decaying mush-rooms, that they eat hay with equine avidity and dote on rush-bottom chairs, the reader will infer that they have a fine catholicity of taste in which our prejudiced palates can only partially follow them. The ubiquity of these minute animals betrayed one experimentalist into believing that he had been able to create them by electricity. From such points of general interest with which Mr. Michael enlivens his introductory chapter, he proceeds to aspects of his subject which have a fascination for many who care nothing for the subject itself. There is seldom a group of animals, however low in popular esteem, that does not occupy a considerable space in the literature of science. Still more rarely, perhaps, has any group escaped all erratic movements in the course of classification. A clear-sighted guide, himself in the forefront of existing knowledge, renders first-rate service to scientific progress in general when for his special branch he shows how the explorers have opened the road for their successors or how they have obstructed it. The path of investigation is ever liable to be deflected, arrested or reverted by the failures of the infallible, the specious finality of those who attempt to do too much, and the slovenly ineffectiveness of those who are content to do too little. Notwithstanding the invariable courtesy with which Mr. Michael writes of his predecessors and fellow-workers, one may perceive from the bibliographical survey here, as well as from that in his earlier work on the British Oribatidæ, that the study of mites has not been wholly free from "regrettable incidents." Immortality at any price seems to be the watchword of those who describe species in such a fashion that no succeeding naturalist can make out what animals precisely were intended by the descriptions. In discussing the common properties of a group and the broad lines of its classification, less harm is done by the careless and the muddle-headed, because their mistakes in these departments can eventually be corrected, and as when thieves fall out honest men come by their own, so sometimes from a conflict of errors truth finds a chance of emerging.

In the ordinary doctrine of text-books the Acarina are distinguished from other arachnids as having, not only the head and thorax coalesced, but the cephalothorax itself completely fused with the abdomen. In the present volume, however, it is pointed out that there is very frequently found a constriction or furrowing of the body behind the second pair of legs. This is held to justify the application of the term abdomen to the part of the organism behind the constriction or furrow. But such an allotment of the first two pairs of legs to the cephalothorax and of the last two pairs to the abdomen would surely be equivalent to severing the Acarina from the arachnids altogether. From segmental demarcation between the second pair of legs and the third nothing more can properly be inferred than that one part of the thorax is more intimately fused with the head and the other part with the abdomen. It is quite true, as Mr. Michael argues, that the Malacostraca are abundantly supplied with abdominal limbs, but these are always sharply distinguished in character from the thoracic appendages, unless in some unique monstrosity. In the case of the Acarina, no perceptible advantage is gained by a theoretical transfer of limbs from the thorax, on which they are normal, to the abdomen, where they would be anomalous.

On other subjects Mr. Michael is much more convincing. His whole discussion of the acarine "nymph" is highly interesting and worthy of admiration. While the larva perhaps never, and certainly hardly ever, has more than six legs, the nymph like the imago or adult has normally eight. The nymphal stage extends from the acquisition of the full number of legs to the last exuviation. There is, however, one group in which it is still uncertain "whether the nubile female is a nymph or an adult." Here the difficulties of investigation are very great, the little creatures being found usually in numbers on the feathers of birds, and, as they will not live away from the host, the isolation necessary for observing the whole series of their transformations seems practically impossible to arrange. Nevertheless, the account given of the genera Hypopus and Homopus shows how difficulties can be made to yield to untiring patience, such as both Mr. and Mrs. Michael evidently combine with other valuable accomplishments. Opinions upon the supposed genera just mentioned have been various and fluctuating. The final result is to establish clearly that the two names in question are not of generic value. They simply refer to a particular stage in the life-history of the Tyroglyphidæ. For designating this stage they are still valid, although they do not add to the musical charm of a sentence by making us speak of hypopial nymphs and homopial hypopi. The difference is concisely expressed by the statement that the hypopus is homopial when "it adheres to its temporary host, not by suckers, but by holding one or more of the hairs of the host between special plates on the ventral surface of the parasite." Suckers facilitate adherence to smooth chitinous insects and other polished surfaces; claspers are used upon hairy mammals, such as moles and squirrels. A strange part of the business is, that by no means all the young nymphs of a species change into hypopi, and yet that those which do change include both sexes. How little they resemble the form from which they emerge and to which they return is indicated in the opinion entertained by one writer, that the hypopus was a parasite which entered the nymph and ate it up, all but the skin. To accuse it of such ravaging propensities is peculiarly unkind, since it has but a rudimentary mouth and there is little reason to believe that it feeds at all. The innocent purpose of the transformation seems to be merely to secure distribution of the species by varied contrivances for adhesion to moving objects. Acarids themselves are a slow-moving race. Unaided they can travel neither fast nor far, though a Gamasid can traverse four inches in a minute. On the other hand, they multiply with a fertility so portentous that any measures for dispersing the surplus population must be welcome in their commonwealth. But guileless as the hypopi are individually, a heart of stone would be touched at the affliction they cause in mass to the industrious ant. That long-suffering tribe is said to find some twelve or thirteen hundred species of other animals willing to share, or at any rate that are present among, the amenities of its civilised nests. One of these species is the cheese-mite *Tyroglyphus wasmanni*, and Wasmann, after whom it is named, found that a single ant might be infested by fifty, or a hundred, or a thousand, or even thousands of the hypopi, not feeding upon it, but clogging all its organs, so that it could neither talk with its antennæ, nor feed with its mouth, nor walk with its feet, nor clean itself with its combs, till the poor creature, against its will made sordid and useless, would fall into a lethargy and die.

Mr. Michael has long held a foremost place among acarologists. It may be confidently assumed that his reputation, high as it is, will be advanced by the present volume. Though the Tyroglyphidæ are comparatively simple in structure, his skilfully drawn plates help us to understand much in them that is peculiar and to admire occasional features that are really beautiful. Notwithstanding the necessarily technical and systematic character of the work, so many suggestive and critical comments diversify the recital that it will be studied with pleasure by readers who are quite outside the limited circle of specialists. T. R. R. S.

OUR BOOK SHELF.

The Journal of the Royal Agricultural Society of England. Vol. lxii., 1901. Pp. cciv + 403. (London: J. Murray.)

It is greatly to be regretted that the council of the Royal Agricultural Society has decided to publish the Society's journal in future as an annual volume. For fifty years the journal appeared twice in the year, and during the last eleven years it has appeared quarterly. The alteration now made is a very serious retrograde step. Not only is the space occupied by original articles and reports reduced to nearly one-half of that previously found in the *Quarterly Journal*, but the publication of new matter is now seriously delayed. We have in this country a sad lack of any provision for the publication of important agricultural papers. Besides the weekly agricultural newspapers, we have only the journals of our agricultural societies; these are small annual volumes, with the exception of the late *Journal* of the Royal Agricultural Society. This journal, with a circulation of 10,000 copies, has hitherto done something to provide the required means of publication. In it the majority of the reports by Lawes and Gilbert has appeared. Where could such reports be published now? The question is a very serious one, for it involves the ignorance or instruction of our agricultural readers; and an agricultural society could do nothing more useful than the regular and systematic publication of all work relating to the improvement of agriculture. The *Quarterly Journal* now issued by the Board of Agriculture does not attempt to discharge this function; it is principally confined to the publication of statistical matter and the results of experiments carried out with funds supplied by the Board.

The present volume contains much interesting matter. The long paper on English agriculture in the reign of Queen Victoria is full of facts worth recording, though some strange mistakes are made. What, for instance, was the Royal Chemical Society, founded in 1845 through the efforts of Johnston and Voelcker? The Chemical Society of London, to which the author probably refers, was, in fact, founded in 1841. The Society originated in London. At this time Johnston was a lecturer at Durham, and Voelcker was being educated in Germany, and did not join the Society until 1849! There is a very clear and concise statement by Prof. J. McFadyean on the evidence at present existing as to the relationship between human and bovine tuberculosis. This is a weighty utterance on a most important subject. The paper on English varieties of hops will be welcomed by hop-growers. The articles are followed by the usual reports of the Society's chemist, botanist and zoologist. The most notable result in the Society's experiments at Woburn is the immense effect produced by a dressing of lime in the barley-field; this application of lime has increased the produce by ammonium salts in one case by more than thirty bushels. An appreciative biography of Sir J. H. Gilbert is contributed by Dr. J. A. Voelcker.

R. W.

Selection of Subject in Pictorial Photography. By W. E. Tindall, R.B.A. Pp. 83. (London: Iliffe and Sons, Ltd., 1901.)

MANY of us who frequent photographic galleries or exhibitions have often been struck with the fact that, although a great amount of photographic skill has evidently been bestowed on the production of some particular print, yet in spite of this the effect is not at all pleasing to the eye, and the picture is not "a success." In many cases this is due to faulty composition, the photographer not having paid sufficient, if any, attention to the elementary laws governing this branch of the art. In photography, as in painting, there are many fundamental rules which must be followed to secure a pleasing effect, and the aim of the author of this book is to set out these points for the use of the photographer.

In a series of very instructive and interesting chapters, attention is directed to the composition of all kinds of subjects with which the photographer is likely to meet, and the difficulties peculiar to each class are described.

Further, the author does not restrict himself solely to describing the chief points in the composition of any one subject, but he illustrates them by means of paintings, drawings and photographs, which add greatly to the force of the text.

In conclusion, it may be stated that the author has given us a book which should prove of great service to those who require information on composition in pictorial photography, and a useful addition to the photographer's library.

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.*]

The Teaching of Mathematics.

MANY correspondents who hold views much like my own are angry that I should lend my countenance to the sort of reform in mathematical teaching which is now being so strongly advocated by the recognised teachers and by mathematicians. I beg to assure these friends that I am acting in a very consistent way, and I mean to help the reformers so long as they do me the honour to let me assist them.

My dearest wish is that Englishmen should prepare for the new phase in the struggle for existence which has so suddenly come upon the world. I believe that it has been growing for sixty years, that it is going to be very intense during the next twenty years, that it will be important for the next hundred years and that the weaker nations will have been completely defeated before the end of that time, before people in general recognise their foolishness in wasting coal. At Glasgow I was sneered at as thinking that all men were going to be engineers. Would to heaven that I could think of all young Englishmen as being fit to become engineers! I firmly believe that no nation will survive the coming struggle which does not equip itself with that thorough training in applied science which I call engineering. I do not expect to be believed by our schoolmen. They do not know, and they would not care much if they did know. The study of natural science has been discouraged by clerical schoolmasters and ecclesiastics, and men like Huxley worried themselves very vainly in consequence. But the time is quickly coming when, instead of the castigating rod of Huxley, we shall feel the stinging scorpions which fate provides for all men who set themselves to believe lies. There is just one chance for us; it has befriended the English people at several critical times, namely, that however foolish we may be, other nations may be as foolish or even more foolish still; and possibly our people may attend, in good time, to the sort of advice which they so usually laugh at.

I say that if even a small amount of knowledge of natural science and of scientific method could be given to our public men it would be a good thing. Now all influential Englishmen pass their youth and get what is fondly called education at the public schools and the two older universities. I have satisfied myself that the authorities of these institutions will steadfastly set their faces against any such large and radical reform as I have asked for; I was quite sure of this before I gave my address at Glasgow. It was only during the discussion that I began to get hope of any reform whatsoever in these institutions, and now I am sure that, not only is a small immediate reform really possible, but that this reform will increase as the years go on.

It is true that I was thinking of other universities, of other schools and colleges, but if any reform, however small, is possible in these great institutions, surely it is the duty of every lover of his country to help forward this movement. When one thinks that Clifford and Cayley and Sylvester and the other great mathematicians of the British Association Committee of 1873 advocated for English public schools the very reforms in geometrical teaching which are now being asked for, and that in most of the public schools the teaching is even more stupefying now than it was in 1873, one is not likely to be very sanguine. But I have satisfied myself that there is a power now behind the reformers which is very much more earnest and persistent than Clifford could rely upon; indeed, I am satisfied that the reformers have with them the good wishes of every thoughtful teacher of the whole country. And after all, would not even the smallest reforms be exceedingly important in the public schools of England?

Eton and Harrow and Winchester and the rest, are they not great in every way? Oxford and Cambridge, what greater names are there than these among universities? These institutions in the past have educated the great men of England. I think I see immense faults in them, but when I compare them with all other schools of which I know anything, do I not know that in mental and bodily health their pupils are great in number and in quality? And if just now a time of strain is coming for which these institutions are quite unprepared, shall I sulk and say that because they will not do as I think they ought to do, then it is better that they should do nothing? To tell the truth, I think that our schools with a small reform will be equal to foreign schools even if these have every advantage that the latest notions in pedagogy can give them. Nevertheless, is it not rather the good material that comes to these schools for education than the schoolmasters of the schools that has our admiration? I feel myself that we are arming our people with bows and arrows when we might easily give them magazine rifles with telescopic sights. But surely, if it must be bows and arrows, and nothing better is possible, one is doing good by advocating the employment of the very best kind of bows and arrows.

I asked for a countenance from the mathematicians at Glasgow for a much more radical reform, not in the public schools and the two older universities—there I thought all reform impossible—but in the new universities, in all colleges where the study of natural science, and especially of applied science, is important. Although all the speakers were in favour of reform, quite half of them were out of sympathy with what I consider to be most essential. I know that they represent the great majority of the mathematicians and teachers of the country, and I should like again, however hopelessly, to explain my position to them. They refuse to attempt to look at things from my point of view. Their minds are beautifully in tune; what one scholar says, the mind of another responds to, but if anyone not a scholar of the orthodox type says anything, it is not heard at all, or only that part of the message is heard which is in tune with the receiving brain. My message must continue to seem to them very absurd if they make no effort to synchronise their mental apparatus with mine.

I assert that the orthodox logical sequence in mathematics is not the only possible one. I can imagine a sequence leading men of twenty-five to a proof of the axioms of Euclid; where it would start I do not know, perhaps in Berkeley's notions of sensation and that all matter and motion and shape are merely forms of consciousness. Surely every academic person will admit this as feasible. But he will not admit that there might be a thoroughly logical sequence starting with axioms which are now "proved" after many years of study, the notions underlying the infinitesimal calculus, for example; the notion that a map may be drawn to scale; the notions underlying the many uses of squared paper; the notion that decimals may be dealt with like ordinary numbers.

The swineherd Ho-ti and his son Bo-bo discovered the wonders of roast pork through the burning of their cottage, and they and their neighbours and every mandarin of China who studied the matter considered that it was absolutely necessary to burn a house down if one wanted roast pork. So the cult of house-burning arose in the land. But after many generations there came a sage of the name Pel-li, who pointed out to everybody that it was not necessary to burn houses, as a simple domestic fire was all that was needed. And he and his growing number of disciples were envied till a charge of impiety was brought against him. And of all the hundred accusers of Pel-li, all mandarins of high rank, every one was absolutely honest and sure that it was really impious to roast pork without burning houses, and so Pel-li and his followers were crucified. If I were to tell my friends that I am Pel-li and that there is a very perfect parallelism between the two cases, they would laugh at the absurdity of such a statement, even if I made it from the cross. And yet, O mandarins, I say to you that you have brought against me the charge of impiety because you cannot imagine any other way of getting to the notions of the infinitesimal calculus than the way in which you yourselves arrived at them, and because I say that they are easier to take in than the axioms of Euclid.

Is it impossible, then, to imagine a different logical sequence from that in which one has been brought up? The very greatest difficulty which I meet with is in getting men to see that if a boy has practised measurement with a scale of inches and tenths of an inch he can understand decimals without a philosophical explanation. This fact, obvious to me, I have not been able to get believed in by any one teacher of arithmetic who plumes himself on his knowledge of the theory of teaching. Well, I go further and say that as an explanation is not necessary for a boy, to give him a grown-up explanation is a crime. Again, I like when dealing with quite easy arithmetic to make boys evaluate most complex formulæ, using all sorts of tabulated functions so that they may regard algebraic signs as a sort of shorthand. I cannot in a few words explain the wonderful mental value of this practice. My critics not only see no value in it, they look upon it with abhorrence. This is not through an effort of their reasoning; it is merely because the thing is strange to them, and, like the Dudley miner, they say, "'Ere's a stranger, Bill, let's 'eave a brick at him." If my critic has any kind of satisfying reason for his abhorrence I suppose it is because he thinks this new custom of mine resembles some most pernicious slipshod habits for which he is continually blaming his pupils—getting off propositions by heart and pretending one knows them; using a rule of arithmetic or dynamics in a mechanical way without understanding why; assuming that one understands a part of an investigation when one does not, and in all sorts of other fraudulent ways pretending to follow a logical sequence and degrading it. Now I also abhor these things. But what my students do is very different and is perfectly logical. They make no pretence of having proved anything, they are merely familiarising themselves with the shorthand of algebra, a thing that they cannot do too soon. If they get to look upon this as the A B C of mathematics they will not after many years of study feel proud of their mathematical knowledge when all they can do is to merely use formulæ in a text-book. Not long ago in an engineering journal the writer of a letter complained that he had been asked to evaluate the expression

$$a\epsilon^{-\alpha t} \sin (bt+g)$$

(being given the values of a, α, b and g) for several values of t. He said he had passed most difficult examinations and knew higher mathematics, but it was quite ridiculous that anyone should expect him to know so much. His anger was extreme. Now some of my students have evaluated things like this before they did any formal algebra at all, but they do not dream of calling it higher mathematics. Surely there is every good in letting a boy become familiar with all sorts of formulæ long before we lead him through the logical sequence which deals with such formulæ, just as we let a boy learn to use words before we teach him grammar or philology. But whether I am right or wrong, I do wish that my critics would try to see exactly what I advocate before they throw blame. The cock-shies that they fling their stones at have nothing in common with any part of my scheme.

I want it to be understood that I advocate a sequence as logical as the orthodox one, or rather, I should say, ever so much more logical, because in the orthodox sequence a boy is really unfamiliar with the ideas to which his so-called logic is applied. The usual sequence may be logical to a philosopher, but it is quite illogical to the average English boy.

I say that what is essential is that the student should be thoroughly familiar through experiment, illustration, measurement and every other possible method with the ideas to which he applies his logic. Also that the study should be of interest to him. I submit that the sequence which I recommend can really be made interesting to the average English boy, whereas the orthodox sequence is painfully uninteresting to him. One reason for this great interest lies in its immediate application to all sorts of actual problems such as he meets with in the study of natural science, and I do not care to hide the fact that there is a special interest which is due to the usefulness of the results of the study in the life-work that lie before him. If anybody cares he may misrepresent me here to any extent. Over and over again the academic person has been kind enough to sneer at my utilitarianism as if I were sacrificing the spiritual for the material, as if engineering were a thing of mere formula. On this I can add nothing to what I have already given in my British Association address and in my other papers. But if my critics only knew what wonderful regions of logical thought and high emotion are connected with the practical applications of natural science, if they had the respect which I confess to have for common things, they also might say as Heracleitus said of his kitchen with its pots and pans, "Here also are the gods." In his typical poem "Shop," Browning takes the college-common-room point of view. Heavens, what a sordid narrow point of view it is! The Bloomsbury bric-à-brac shopkeeper gets all the poet's scorn because he does not hate shopkeeping, because to him "shop was shop only." Does anybody imagine that Shakespeare could not have glorified the life of the shopman? But this poet, with all the arrogance of his caste, says, "I want to know a butcher paints, a baker rhymes for his pursuit." The moment a man has leisure he must escape from his trade! For my part, I believe that whatever a man finds to do he ought to do with all his might and with all love and devotion, or not attempt to do it at all. If he hates shopkeeping, let him give it up to someone else to whom shopkeeping is a perfect happiness. If Ruskin's influence over a man has been great enough to prevent his seeing the romance, the wonder of engineering, so that it is to him a mere trade by which he earns his bread and butter, in heaven's name let him give it up altogether and take to art criticism. For my lovely mistress, Applied Science, scorns a divided worship. It is disgusting to see young engineers who cannot compute, who know nothing of science, whose souls are not engrossed all the time with the greatness of their profession, who never think of their business after office hours, who think it all a mere matter of formulæ and tools. If they were fit for their work their lives would fill with happiness, and even the power to rhyme and paint and to create music might belong to them; but woe unto the nation whose shopkeepers scorn shopkeeping while they paint or fiddle; whose schoolmasters rely on cricket and a housemaster to do their proper business whilst they discuss Browning and the musical glasses. To make a man fit for, so that he may also love, his profession, is this a function to be scorned by schools and colleges? and am I to be sneered at as a utilitarian because I consider this a most important function of the schoolmaster?

Nobody has contradicted my statement that the orthodox method of cramming average boys with demonstrative geometry stupefies them and makes them hate mathematics all their life after. May I also point out that the beautiful philosophy of Euclid is also degraded, just as the literature of Greece and Rome is degraded, by our school methods. Is there anybody who does not think of Euclid merely as a lower school subject? At the British Association discussion a great mathematician was astonished that I should ever have had to study the fifth book of Euclid. He said he was more fortunate, because he was never taught it. Well, I was never compelled to study it, but I took to it through mere affection such as my critic deems it his good fortune never to have experienced. What I regret is that any kind of demonstrative geometry was given me when a boy, but since it was given me I am glad to think that I had Euclid's philosophy undefiled. I even dipped into those books now never published—the seventh, eighth, ninth, tenth, and also the thirteenth, fourteenth, and the books added by some Greek author whose name I forget, the fifteenth and sixteenth. At the same time, I feel that if demonstrative geometry is to remain a school subject for the average boy, it is absolutely necessary to replace the second and fifth books by algebra. The view to which I hold most firmly of all my views about the teaching of mathematics is that demonstrative geometry ought never to be taught to boys at all; it ought never to be taught in schools. It is a higher university subject. Euclid's treatment of proportion and of incommensurables is one of the most beautiful parts of that exact philosophy which the conventional schoolmasters are constantly seeking to degrade. The old philosophers thought that only a very few men of the most acute race that ever lived on this earth were fit to begin the study of geometry, and we use it as "an instrument for the cultivation of the mind" of the average young barbarian. Even my sense of the parlous state of the country cannot prevent me from grinning at the Rabelaisian humour of the position. Boys are not swine, but if you will force pearls upon them for food (poor boys, they do not know that the pearls are only cheap imitations) you must expect but small results either physically or spiritually. It must always be a pleasant memory to them, however, that they once did have pearls to trample under foot or to give them indigestion, and one may say that they are fairly safe from pearl hunger all the rest of their lives. Will any of my opponents deny that they ceased to study Euclid when they left school, except in the way of their trade as teachers? How many of them know anything of—I need not say Euclid's real philosophy—but even of modern geometry and the beautiful system of transversals developed by the Irish geometers? I recollect a lovely year of my life in which I was introduced to three new things—Tennyson's "Idyls" and McDowell's "Geometry" and Homer's "Odyssey" (Bohn's translation), and I hardly know even now which of the three gave me most pleasure. But I had had the good fortune not to have pearls forced upon me as a boy. Yes, Cæsar wrote a book for the third form; what man who ever passed through the third form would now read Cæsar? Euclid wrote a book for the lower school; a lower school book let it remain.

And $(a+b)^2=a^2+2ab+b^2$ is equivalent to II. 4. And if $\frac{a}{b}=\frac{c}{d}$, then $\frac{ma\pm nb}{pa\pm qb}=\frac{mc\pm nd}{pc\pm qd}$, and this is equivalent to the immortal philosophy of the fifth book. "Great God, I'd rather be a pagan cradled in a creed outworn!" I would rather be utterly ignorant of all the wonderful literature and science of the last twenty-four centuries, even of the wonderful achievements of the last fifty years, than not to have the sense that our whole system of so-called education is as degrading to literature and philosophy as it is to English boys and men.

We are not the heirs of all the ages, and we shall not for very long remain in the foremost files of our time if we depend upon the schoolmasters. I place my faith in the common sense of the common people. In one way or another I find that they are learning to compute, to gain a knowledge of natural science. I know of many hundreds of night-school boys who were poor who are now successful engineers, and already youths are being warned from trying to become engineers because their public school education would actually prevent their having a chance of success. They cannot understand the most elementary lectures in applied science. I know of a large employer who has already told the headmaster of a great public school that he will no longer employ public school boys unless a more rational method of teaching mathematics is adopted. And he is a public school boy himself! I am constantly being asked to recommend men to teach mathematics in technical schools and colleges, and warned that I must not recommend a Cambridge man. There is nobody who has a higher respect for Cambridge mathematics, for the achievements of past and present Cambridge men, than I have; but if Cambridge men will put themselves altogether out of sympathy with the needs of young engineers; if they will make no attempt whatsoever to look at things from the new point of view to which we have been forced; if without any attempt at examination they will in an off-hand way settle it that what we ask for is an illogical and soul-debasing non-educational preparation of an olla podrida of mere formulæ, then in sorrow and not without some anger we must try to get on without them. They do not know what a lovely bit of fighting they are leaving us to do all by ourselves, but I sincerely hope that they will not hamper us. Indeed, they must sooner or later help us against the common enemy, even if they are only to be armed as were the children of the mist. Because Isaac Newton was such a superb bowman and the English yew was ever the finest of materials, they will insist on the use of the antiquated weapon only. I sincerely hope that the English yew, which is very much of a graveyard tree, may not yet flourish over the grave of British industry.

But enough of these notions. I see a great fight ahead of our people, and bows and arrows are better than no weapons, as a twentieth of a loaf is better than no bread at all, and I welcome any instalment of reform, however small, in the teaching of mathematics in the public schools of England. And so long as my help is not rejected on the ground that I openly ask for a much greater reform and may be dangerous to my friends on that account, so long am I anxious to give my help and proud that it should be accepted.

JOHN PERRY.

Birds attacking Butterflies and Moths.

WITH reference to my previous letter in NATURE (January 16), I would say that the butterfly referred to was the *Terias silhetana* or *Terias laeta*, probably both.

Another bird that frequently catches these butterflies on the wing is the Indian Bee Eater (*Merops viridis*).

During a Christmas camp this season I came across a field where some twenty or thirty King Crows were busily engaged in catching butterflies; the day I first saw them, butterflies were numerous in this field, and it was easy to get undamaged specimens of *Terias silhetana*, *Terias laeta*, *Junonia lemonias*, *Tarucus theophrastus*, *Lampides elpis*, *Catopsilia pyranthe*, and some others which were not being caught in flight. Some three or four days later few King Crows were to be seen, the butterflies were much diminished in number, and nearly all those caught were damaged specimens. The birds perched on the tall dry Jowari stalks and made short flights on all sides, catching their prey sometimes on the wing, sometimes on the ground.

I could not say with certainty what butterflies were caught on the wing.

The King Crow and the Bee Eater are two of the commonest birds in this part of the country, and must cause a good deal of destruction in the course of a year.

ANNIE E. MCKAY.

India, February 21.

"Nature-Study" Exhibition.

WILL you kindly permit me, while thanking you for the attention which you have already directed towards the above exhibition, to state that it has now been arranged to hold it at the gardens of the Royal Botanic Society, Regent's Park, on July 23 and following days? It will be open to colleges and schools of every grade, and the exhibits will include all that bears upon Nature-study. Happily the project has secured very influential support, and has aroused considerable interest.

Sir John Cockburn, K.C.M.G., is chairman of the executive committee, and Mr. Charles Savile Roundell, of 7 Sussex Square, Brighton, is hon. treasurer.

I shall be happy to furnish full particulars, or to meet anyone, who may wish to see me personally, at any time by appointment either at the Botanic Gardens or in St. James's Street, S.W.

JOHN C. MEDD
(Hon. Sec. *pro tem.*).

Stratton, near Cirencester, March 19.

Sounds associated with Low Temperatures.

THE accompanying extract from a letter recently received from Norwich raises a question that I cannot answer. I have never experienced the fact named. Have any of your correspondents ever done so? W. H. PREECE.

"On February 18 the temperature went down to zero here. As my son walked about the sheds, he was struck by the whistling noise the ground made, which he says he has noticed each time such an extremely low temperature has occurred, and he reminded me how we had once noticed it together a great many years ago. Now what makes that whistling, and does it always accompany a zero frost?"

Proofs of Euclid I. 5.

I REGRET that in my letter of March 13 (p. 439, line 4) the letters A, B were inadvertently used by me instead of B, C.

I have tried Mr. Croome-Smith's proof (NATURE, March 20, p. 466) on a class of beginners, but it is difficult to convince them that, in the words of the professional conjurer, "there is no deception."

A non-mathematical friend has just written, pointing out that so long as we define a square as a four-sided figure having all its sides equal and all its angles right angles, it is somewhat inconsistent to trouble the beginner with proving properties of an isosceles triangle the truth of which he can readily see for himself at a glance. Either we should make him prove the properties of a square or we might just as well define an isosceles triangle as a triangle having two sides equal, and the angles opposite these sides equal. G. H. BRYAN.

THE NATIONAL PHYSICAL LABORATORY.

THE Prince of Wales, who was accompanied by the Princess, formally opened the National Physical Laboratory on March 19, in the presence of a distinguished company of men of science and others interested in national progress. In declaring the laboratory open, His Royal Highness said:—

I am glad that my first duty as a Fellow of the Royal Society should be to join with my distinguished brethren in opening this institution, the direction and administration of which have been entrusted to the Society by the Government. It is also a great pleasure to assist in the inauguration of what may fairly be called a new departure, for I believe that in the National Physical Laboratory we have almost the first instance of the State taking part in scientific research. The object of the scheme is, I understand, to bring scientific knowledge to bear practically upon our everyday industrial and commercial life, to break down the barrier between theory and practice, to effect a union between science and commerce. This afternoon's ceremony is not merely a meeting of the representatives of an ancient and world-renowned scientific society for the purpose of taking over a new theatre of investigation and research. Is it not more than this? Does it not show in a very practical way that the nation is beginning to recognise that if her commercial supremacy is to be maintained greater facilities must be given for furthering the application of science to commerce and manufacture? In the profession to which I am proud to belong there are, perhaps, special opportunities of gaining a certain insight into the general trade and commerce of the world and of comparing the commercial vitality of the different countries. And certainly abroad one finds an existing impression, which was confirmed by the experience of my recent and interesting colonial tour, that the superior technical and scientific knowledge of our foreign competitors is one reason why our hitherto preeminent position in manufactures and commerce is so considerably threatened. As a simple example I may quote the opinion of an expert authority in Australia, that the aniline dyes of Germany had given to a certain class of German-made goods a decided superiority over those of British manufacture. In Germany and America much valuable work has been carried out by the State. In this country the Government have provided these buildings and found machinery for the supply of light, heat and power. They are at present not inclined to spend more money upon equipping the laboratories. It is therefore to the liberality of the public that we must look, not only for money, but for presents in machinery and necessary appliances. Already the institution has benefited in the latter respect by gifts from Sir Andrew Noble, the Drapers' Company, Messrs. Willans and Robinson, Lady Galton, and others. The old-established Kew Observatory now forms part of the laboratory. Important and growing work is carried out in the testing of telescopes, binoculars, sextants and, more particularly, telescopic sights for the Navy. Most of the scientific outfit supplied for the Antarctic expedition was tested at Kew. The laboratory will also supply a want which is much felt for standardising and testing the many other forms of apparatus in daily use, while investigations will be carried out on points of importance to the manufacturer or the merchant from the solution of which valuable results may be expected to accrue. I am particularly pleased to know that it is possible that within the precincts of this laboratory there will be established a work of the utmost importance—namely, a tank after the design of the late Mr. Froude, in which the performance of a ship can be predicted from experiments on a model. At present there is such a tank at Haslar, which is fully occupied in Government work. The Institution of Naval Architects, impressed with the demand for this work, have proposed to raise the sum required to erect the tank and for the necessary appliances. But the funds at present at the disposal of the laboratory will require to be considerably supplemented if they are to undertake this much-needed work. No doubt the working expenses of the tank will ultimately be met by fees. But a difficulty may arise in tiding over the interval which must elapse before such fees are available. I am confident that, through the generosity of the public, the necessary means will be forthcoming to meet these difficulties and to secure that which is almost an essential to the shipbuilding industry of a country possessing the largest mercantile marine in the world. Before such an audience I have not presumed to speak of the value to science of this institution. Though the Navy has given many notable names to scientific theory, it is the practical results which naturally appeal more to the mind of the sailor, and I am sure you will accept this as my excuse for having ventured to make my few remarks upon the future of this institution from merely a utilitarian point of view.

At the close of the ceremony, in responding to the vote of thanks, the Prince of Wales announced that Sir William Armstrong, Whitworth and Co. had promised to subscribe 1000*l*. towards the funds of the laboratory; and he expressed the hope, which all of us share, that this excellent example will be promptly followed by other manufacturing firms. We give below some particulars of the work already instituted at the laboratory.

The opening ceremony took place in the engineering laboratory, in which about 900 guests were accommodated. This had been cleared for the occasion, and the only machines left in position were a shaping machine by Baker and Co., of Halifax, and a ten-ton testing machine. The latter is one of Messrs. Buckton's vertical machines. The stress is applied direct by means of a hydraulic ram worked off the main, in which there is about 100 feet of water pressure, so that no intensifier is necessary; the supply from a small cistern fixed to the wall is sufficient to bring the ram back when the pressure is relieved. The machine is intended primarily for experimental work in connection with the alloys research; for this it has conveniences which a more powerful instrument would not possess, while at the same time it may be useful in making accurate tests on small specimens; such tests the committee is prepared to undertake, though it fully recognises the desirability of erecting a large machine as soon as funds will permit. The usual accessories for torsion and bending tests are fitted; there is also a simple autographic gear.

The pressure pumps for the gauge-testing work supplied by Messrs. Schaffer and Budenberg were placed temporarily in an adjoining room. These are two in number; one is arranged to test simultaneously ten or twelve gauges up to a pressure of 600 lbs. to the square inch; the pressure is applied by a force pump and a screw plunger. In the other, a pressure of twelve tons to the square inch can be obtained easily. The indicator-testing apparatus given by Messrs. Willans and Robinson has not yet arrived. In the engine-room the 75 kilowatt Parsons' turbine was running, and proved an attraction to many visitors. The normal voltage of this machine is about 105. The room also contains a 10-kilowatt dynamo by Thomas Parker and Co., driven by a Crossley gas-engine and a motor generator set also by Parkers. By means of regulating resistances, the dynamo of this set can be made to run at voltages between 10 and 60. There are three storage batteries, each of about 55 chloride cells, in the Laboratory, and by running the generator in series with the main dynamo each of these can be charged. But in experimental work the cells are likely to be unequally used; the generator alone can then be used to charge groups of cells which require special treatment.

With regard to the physical part of the Laboratory, it must be remembered that the staff has only been in the building for a very short period, the electrical rooms were not ready for occupation until about ten days before the opening, and, further, that the funds at the disposal of the committee have sufficed to purchase only a limited equipment. The aim of the director has been to complete as far as possible the apparatus required for experiments which it is hoped to undertake at once; no apparatus has been bought without an express and immediate object in view. The thermometric department is perhaps the most completely fitted. The main laboratory has been divided into two by a partition of soft brick and glass. On the one side are the various furnaces and heating appliances, on the other the measuring instruments which it is desired to keep at a uniform temperature or to protect from fumes. The brick can easily be drilled to allow the passage of wires, tubes, &c.; through the glass the observer can see what is happening on the other side of the partition. Appliances were shown for standardising thermometric instruments from the temperature of liquid air up to 1000°C. or 1200°C. This laboratory is in the charge of Dr. Harker, who has shown much ability in arranging the various appliances.

For the liquid air there is a Hampson liquefier attached to a Brotherhood compressor, which is driven by a 5 h.p. motor by Laurence Scott and Co., of Norwich. For boiling-point observations and for calibration, the standard apparatus as used at Sèvres has been fitted. For temperatures between boiling point and 200° C. to 250° C. an oil bath has been constructed. This consists of a wide U-tube of copper having a junction across the upper part of the U. In the one limb is a stirrer driven by a small motor, in the other the thermometers are placed; thus a continuous stream of oil is driven rapidly past the thermometers. The whole is jacketed and heated by gas, and careful observations have shown that the temperature over the whole of the vertical column is remarkably uniform.

For temperatures up to about 600° C. there is a similar bath of iron containing a mixture in equal parts of the nitrates of potassium and sodium.

The higher temperatures up to nearly 1200° C. are obtained in an electric oven similar to that used by Messrs. Holborn and Day at the Reichsanstalt, and the director is indebted to President Kohlrausch for kind assistance in procuring the materials for this. The oven, which was the gift of Sir Andrew Noble, consists of a series of tubes of porcelain and fireclay carefully lagged with asbestos; round the innermost tube a nickel wire is coiled; this is heated by a current, and a remarkably steady and uniform condition of temperature is obtained; the regulation of the temperature is easy, and there are no fumes to contend with.

For success with the oven it is necessary that the electric supply should be uniform; a special battery of 56 cells has therefore been installed. This has been arranged in four groups of 14 cells each, and by means of a specially devised switchboard these can be combined in various ways to give the required current and voltage. This battery was the gift of Sir Andrew Noble, to whom also is due the gas thermometer which at present forms the standard of reference. For secondary standards, mercury thermometers will be used up to 250° or possibly rather higher; above this platinum thermometers, or possibly thermopiles, will be adopted. Among the exhibits were three thermal-junctions most carefully standardised by Prof. Holborn, which will form a link between the Laboratory and the Reichsanstalt; there was also a platinum thermometer in a quartz tube, very kindly given by Mr. W. A. Shenstone. A cathetometer set up temporarily against the wall attracted special notice.

At no great distance from the thermometric laboratory is the mercury pressure gauge. A glass column some fifty feet high has been fixed to the wall of the laboratory; alongside this is a steel scale, divided into millimetres, pounds per square inch, kilogrammes per square centimetre, and feet of water; thus gauges up to a pressure of 250 lbs. to the inch can be tested directly against the column. A lift erected close to the column enables the observer to read the height of the mercury. The pressure is applied by means of compressed air contained in a bottle connected both to the gauge and the mercury column. The bottle will be filled from the Brotherhood compressor which works the air liquefier. For standardising gauges between 250 and 400 lbs. pressure, a loaded piston apparatus—a gift from Messrs. Willans and Robinson—will be available; for pressures above this, apparatus has to be constructed.

The metallurgical department is housed in the old kitchen, in which there was an interesting exhibition of photographs of metallic sections and cooling curves, lent by Sir William Roberts-Austen. The apparatus for investigating cooling curves has yet to be bought, but a beautiful photomicrographical outfit by Zeiss was shown by Dr. Carpenter, who exhibited to a number of the guests the section of a steel rail magnified four hundred times; the pearlite and ferrite structures were clearly visible; the rail had been rolled cold and the grains were elongated by the rolling. The projection apparatus is very complete; the arrangements for cutting, grinding and polishing the sections are also ready; the polishing apparatus has been specially designed by Mr. J. E. Stead, and the laboratory is prepared to undertake the microscopic examination of sections for the railway companies or other users.

A room adjoining the microscopeis arranged for metrology, and here were set up a dividing engine by the Société Génevoise pour la Construction d'Instruments de Physique. This instrument was given by Sir Andrew Noble, and is a copy of that in use at the Bureau International, but without the automatic mechanism—this, however, can be added if funds permit. It will divide lengths of 1 metre or less. The room also contained a Whitworth measuring machine, a set of standard gauges, surface plates, &c. A set of screw gauges had most kindly been lent by

Messrs. Sir W. G. Armstrong, Whitworth and Co., who exhibited in addition Sir J. Whitworth's original measuring machine. A Pratt and Whitney measuring machine has not yet arrived. In an adjoining room, thanks to the courtesy of Sir F. J. S. Hopwood and Mr. Chaney, there was an interesting exhibit from the Standards Department of the Board of Trade. King Henry VII.'s yard and Queen Elizabeth's pints were shown in proximity to our modern standards.

The electrical rooms are three in number. One of these, in the basement, has a constant-temperature chamber attached, and here were the British Association standards of resistance; the coil "Flat" made by Matthiessen about 1864 and used by the original British Association Committee on Electrical Standards was shown to visitors, as well as some modern standards.

The main electrical laboratories, however, are far from complete; one of these, which is to be used for the fundamental units and standards, was occupied as a tea-room. In the other, Mr. Campbell had, in the ten days which had been available, set up some secondary standards in their permanent positions, while other apparatus was exhibited on tables in the middle of the room. A few antiquated scales of historical interest aroused some criticism. They were merely placed on the tables with the other apparatus to indicate that a galvanometer with some proper arrangement of lamp and scale formed part of the installation required.

The fundamental standard of electromotive force will be the Clark cell, while current will be measured by the drop in volts over a known resistance; but for secondary standards a Kelvin multicellular voltmeter of somewhat special construction, a set of Kelvin balances and some Weston instruments will be employed. The voltmeter is read on a long scale in the form of the arc of a circle some two metres in radius. Between 60 and 110 or 120 volts the scale is a very open one, some 5 cm. corresponding to one volt. Thus it is easy to read to the tenth of a volt. For use with the instrument a special resistance box containing ten coils has been wound by Mr. Campbell.

The first coil of 10,000 ohms resistance is divided into two parts. One of these has a resistance of 1500, the other of 8500 ohms; each of the others is 10,000 ohms. Each coil is of manganin, wound in sections, which are arranged so as to be non-inductive, and each coil will stand an E.M.F. of more than 100 volts. Thus 1000 volts may safely be applied to the whole. A current can be passed through the whole box and adjusted by means of external resistances until the drop between the first and second terminal just balances the E.M.F. of one Clark cell—14,340 volts—in series. In this case the drop across each coil after the first is 10 volts, and by connecting the voltmeter in turn to the proper terminals of the box its scale can be calibrated. When this has been done the instrument is ready for reading directly potential differences between 50 and 120 volts; below 50 the scale is too contracted. To measure voltages above 120 volts, the box is used; the total volts are put on between the end terminals; the box enables these to be subdivided to tenths, and a convenient number of tenths can be measured directly on the voltmeter scale.

In another corner of the room were the standard air condensers of the British Association; these, which consist of a series of concentric cylinders, have been described by Mr. Glazebrook in some of the reports of the Electrical Standards Committee; on a table near by was shown the apparatus for determining their capacity, a Wheatstone's bridge box of platinum silver coils by Elliott Bros. and a rotating commutator made by Pye and Son, of Cambridge, the speed of which is controlled by a stroboscopic arrangement viewed through diaphragms attached to a standard fork.

It is intended at once to set about constructing from these condensers standards of capacity for commercial use.

On another table was set up in a convenient form the apparatus for measuring by the ballistic method the permeability and hysteresis of an iron ring, while close by the latest pattern of Ewing's permeameter was on exhibition.

In the centre of the room were shown two resistance boxes by Wolff, of Berlin; one of these was a potentiometer box with a wide range of applicability, the other an ingenious modification of the Kelvin double bridge which is used extensively at the Reichsanstalt for the measurement of small resistances.

The commercial testing of iron and steel or of measuring apparatus, if undertaken on a large scale, will probably be carried out ultimately in a room attached to the engineering laboratory; most of the arrangements which have just been described are fitted rather for the construction and verification of secondary standards than for purely commercial testing.

A fourth wing of the building contains the chemical laboratory, which calls perhaps for no particular description; it was described as workmanlike by a very capable judge on the nineteenth, and that may suffice. A chemical laboratory is essential, but it is not desirable that it should be very elaborate.

The laboratory contained a large collection of glass vessels, flasks, burettes, &c., lent by Messrs. Gallenkamp; these were intended to illustrate one branch of the new work, the standardisation of such apparatus for which there seems a great opening. The vessels exhibited bore the stamp of the Reichsanstalt.

The system of electric wiring adopted requires a special notice. There are two distinct sets of circuits; one of these, connected to the lamps and to numerous plug points, is fed from the dynamo or the cells at a steady voltage of 100 volts. It is used for lighting and for the supply of power.

For the experimental work there is a separate battery of 55 cells. These are arranged in groups of 5, the first group being further subdivided; the positive poles of the cells are connected to a series of horizontal brass bars at the back of the main switchboard; the negative poles are connected to a series of isolated blocks, which, by means of switches on the front of the board, can be put into contact with the corresponding horizontal bars; the positive pole of each group is one bar lower than the negative pole of the same group. Thus if the switches are all closed the cells are in series; the top horizontal bar is negative, and there is a constant rise of 10 volts between each two consecutive bars. On the front of the board are a series of vertical bars, and from the tops of these the experimental circuits, of which there are thirty, lead away through fuses. These vertical bars can be plugged through to the horizontal bars at the back, and thus a series of voltages rising by steps of 10 volts can be distributed through the building.

The normal discharge rate of the cells is 50 amperes, but to obtain higher rates the cells can be connected in groups of five in parallel. To do this with all the groups, all the switches are opened; two specially heavy vertical bars are then connected by plugs, the one to all the positive poles, the other to all the negative poles of the battery. From these bars two circuits capable of taking 500 amperes lead away.

The switchboard, which is a modification of that at the Owens College Laboratory, was designed by Mr. G. A. Steinthal, of Bradford, in accordance with the suggestions of the director. Mr. Steinthal has carried out all the experimental wiring. The distributing wires are for the most part bare copper, and are carried on porcelain insulators. Some of these wires go directly to the various rooms, and are so arranged that it is possible in any room to obtain simultaneously at least two different voltages. Others of the distributing wires go to three subboards arranged in a similar manner to the main board; four circuits from the main board go to each subboard, and twelve subsidiary circuits leave it. In the main electrical laboratories there are five of these subcircuits, and to avoid magnetic action concentric wiring has been used in the section. Each board is fitted with a voltmeter, so that the voltage can be tested before connection is made with any instruments. Thus the electrical equipment, so far as it goes, is unusually complete. It should be noted, however, that provision is still required for alternating current supply and for voltages above 110 volts. Arrangements have been made by which the experimental battery can be put on to the lighting circuit, or run in series with the lighting battery to get 220 volts, but it is not anticipated that this will often be done. As soon as funds permit, the outfit will need supplementing in this respect.

It will appear from the above that there is much to be done before the Laboratory can be called complete; still, for many branches of its work it has the means to start, and its success in these will lead to increased opportunities for development.

THE SCENERY OF ENGLAND.[1]

IT is curious to reflect on the history of man's inquiry into the origin of the landscapes among which he has lived for so many thousand years, and to find how recent is his intelligent interest in the subject. Within the memory of many who are still alive and active, the present topography of the land hardly came within the scope of scientific investigation, and while the utmost energy and enthusiasm were displayed in unravelling the secrets of the rocks below the surface and thus reconstructing the geography and scenery of the successive eras of the geological past, only meagre attention was given to the causes which had brought about the existing features of that surface. The popular notion that everything remained as it had been from the beginning was known to be untenable and absurd; nevertheless, the subject failed to excite the interest of geologists as a body. Some of them were Wernerian tories, others Plutonist conservatives or Uniformitarian liberals; but whatever might be their geological creed, they were for the most part Gallios in this matter, never caring to set themselves seriously to consider how their familiar hills and valleys were in detail to be accounted for.

Yet the way had been shown to them generations before. It had been opened up by Lazzaro Moro and Generelli in Italy; by Ray and afterwards by Hutton and Playfair in this country; and by Guettard and Desmarest in France. Living on an island and accustomed to continual tales of the destruction wrought by the sea on the margin of the land, British geologists, largely influenced in later years by Lyell, had come to look upon the sea as the prime agent in the degradation of the terrestrial surface. They had no theoretical objection to depressing or uplifting the land to any extent that might be desired, in order to account by marine erosion for any particular topographical feature. While admitting the existence of what were called "valleys of denudation," they thought it much more probable that these hollows had been scooped out by violent inundations of the sea, or by ocean currents moving with great velocity over the submerged country, than that they could have been carved out by such seemingly feeble agents as the rivers that flow in them. The admirable demonstration given by Desmarest, as far

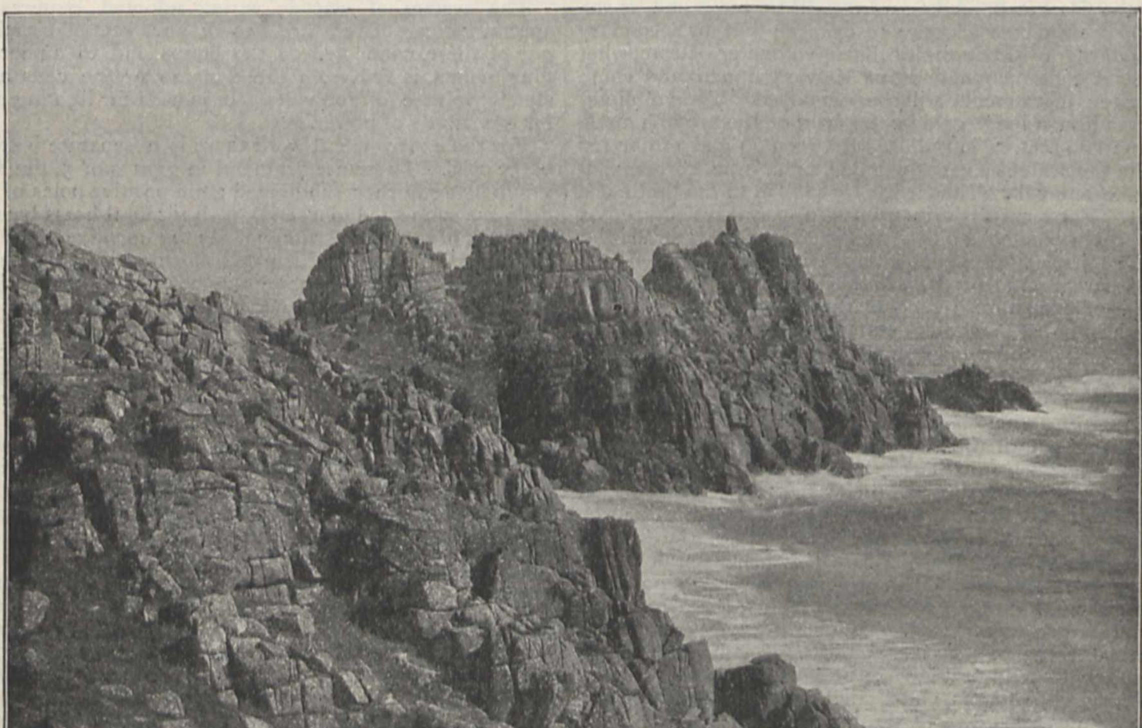


FIG. 1.—Granite Coast, Cornwall.

[1] "The Scenery of England and the Causes to which it is Due." By the Right Hon. Lord Avebury. Pp. xxvi + 534. (London: Macmillan and Co., Ltd.) Price 15*s*. net.

back as 1774, that a system of valleys, like that of Auvergne, had been carved out by running water in a series of rocks of varying powers of resistance, including even thick and wide sheets of solid lava, failed to impress the geological mind. The subsequent enforcement of the same lesson from the same region by Poulett Scrope in 1826, and three years afterwards by Lyell and Murchison, likewise roused no general interest. English geologists, while they admitted that such a process of land-sculpture might very well be allowed to have been effective in the heart of a foreign country, far from the sea and high above its level, remained true to their impression that, by invoking convulsions of the solid ground below and sufficiently destructive operations of the sea above, they could satisfactorily explain all that seemed to need explanation in the topography of the land. How deeply rooted this prejudice was is well shown in the memorable paper by Ramsay on the denudation of South Wales and the adjacent English counties, published in 1846. This great classic holds, and deserves to hold, an honoured place in geological literature, as the first concrete attempt to work out in some detail the denudation of a region with reference to its geological structure. Yet at that time, being as marine as the staunchest adherent of the old faith could desire, its author scouted the idea that rivers and streamlets had played any notable part in carving out the valleys of the country. With the naïve remark that "it is not to be expected that an unaccustomed eye should at first detect all the evidences of the former action of the sea on these lands," he affirmed that "we must either adopt the theory that the great features of the land have resulted from the ordinary action of the sea, or else revert to the hypothesis of great bodies of water violently rushing over the surface." These views continued to prevail for twenty years longer. Their last champion was probably the late Dr. D. Mackintosh, whose "Scenery of England and Wales" appeared in 1869.

But some years before that date the first step in the application of Hutton's teaching to the history of the valleys of this country had been taken by Beete Jukes, who broke new ground and opened the eyes of his brother geologists to the true nature of the problems of topography by the publication of his ever-memorable essay, "On the Mode of Formation of River Valleys in the South of Ireland," which was issued in 1862. The examples cited this time were not from a foreign country, but from our own islands, where they could be judged of and criticised in the light of all that was known of a similar nature in other parts of Britain. The process of time had fitted the soil of the geological mind for the seed, and it soon sprang up and bore fruit. Next year (1863) Ramsay showed in the first edition of his "Physical Geography and Geology of Great Britain" that his old faith was weakened, and that he was prepared to follow his friend and colleague in what was really a return to the Huttonian fold. At that time the Geological Survey was at work on the Weald under Ramsay's supervision, and had to face the problem of its denudation, which had been so often described and discussed and had so complacently been assumed to be a proof of the levelling action of the sea. For the first time in England a tract of country which was geologically mapped in detail was simultaneously subjected to a searching inquiry as to the history of its topographical features. The officers of the staff, after an exhaustive examination of the ground, were led to discard the doctrine of marine erosion and to adopt in its stead that of long-continued subaërial waste. They showed convincingly how this explanation reconciled all parts of the evidence, and how each new

FIG. 2.—Lower Fall, Aysgarth, Wensleydale, Yorkshire.

observation advanced and confirmed the deduction that the valleys which diverge from the Weald began to be eroded by the streams that flow in them when the drainage descended from the still existing dome of chalk, and that during the enormous time in which atmospheric degradation has been at work that dome has been completely removed, the rivers gradually sinking to lower levels, but still continuing to flow outward as at first. Ramsay proclaimed his conversion to these views in the second edition of his book, which was issued in 1864. Next year there appeared the detailed essay on the subject by Dr. C. Le Neve Foster and the late Mr. Topley, which established beyond all further doubt the potency of atmospheric decay and river-erosion in the sculpture of the surface of this country.

The Huttonian doctrine, though thus long in gaining acceptance, made rapid progress when once a few enthusiastic workers, drawn under the spell of its attractiveness, began to apply it to the interpretation of all parts of the British Isles. In England and Wales, in Scotland and in Ireland, it gained every year an increasing number of followers, many of whom, with the usual geological alacrity, have contrived to pile up quite a respectable mass of scientific literature devoted to its discussion and promulgation. This great phalanx of observers and writers on the subject has now to hail as its latest recruit Lord Avebury, who has given another proof of his versatility by a contribution of more than 500 pages to a discussion of the origin of the scenery of England and Wales. Encouraged by the favourable reception accorded to his volume on the "Scenery of Switzerland," he has been led to produce another on that of his own country. Paradoxical as it may seem, it is nevertheless true that the task he set before himself in the preparation of this work was in many respects more difficult than that of the earlier publication. Notwithstanding the complicated structure of the Alps, the story of the origin of their valleys and the sculpture of their great blocks of mountain is on the whole less complicated and obscure than that of the tamer English landscapes. In this country the problems of topography involve questions of higher antiquity and lead the inquiry into a domain where the evidence is less distinct and abundant, and where a larger demand is made for detailed knowledge of the geological structure and history of the ground.

Lord Avebury devotes his earlier chapters to an outline of the geology of the country, and gives a brief account of the various rocks from the oldest to the youngest. In dealing with the scenery, he begins at the coast-line and notes the distinctive characters of our shores with the causes to which their variations are due. With regard to the interior, after some general statements respecting the movements of the terrestrial crust and their effects, he discusses the distribution, structure and origin of the mountains and hills, citing numerous examples from different parts of the country. He then passes on to the consideration of the rivers, dealing first with the general history of a typical river and illustrating his subject by references to the various English and Welsh streams by which the successive features of that history are best displayed. From moving water he naturally turns to the lakes, and picks his way with great skill among the rocks and shoals of that much-debated subject. The influence of the rocks in determining variations in the character of the landscapes is rapidly treated in a single short chapter, which is followed by one that probably gave him as much pleasure to write as any part of the book, for it deals with the downs, wolds, moors and commons which have been so familiar and delightful to him all his life. The next two chapters are not unlikely to have more interest for the unscientific reader than the rest of the volume, seeing that they treat of the connection of certain topographical features with old systems of land-tenure and methods of agriculture. They show why parish-boundaries run as they do and what causes have often determined the sites of towns. We are led across the country from one interesting historical spot to another, and are finally brought back to London and set to think of the geological reasons that have fixed the position of the chief city of the empire. It might, perhaps, have been better had the book appropriately ended there, but a final chapter is added in which, quitting the scenery and history of the Thames valley, the reader is suddenly plunged into the "nebular theory" and the tetrahedral collapse of the globe.

In his preface the author expresses a hope that the book may prove half as interesting to read as he has found it to write. Every reader must recognise the enthusiasm with which Lord Avebury has followed out his self-imposed task in a field which he had not made specially his own. He has brought together in readable compass a summary of what has been done in the investigation of the history of the scenery of England. Every here and there his narrative glows with the fervour of a true naturalist, as where he describes the shore-life of our coast-line with a minuteness which shows how closely he has observed, and with a breadth that brings the whole scene before us, or where he depicts the charms of the downs, noting their wild flowers one by one, and carrying us with him over their breezy crests, past green barrow and grey standing-stones. His book will doubtless do good service in attracting more general interest to one of the most fascinating branches of geology.

One feature of the volume gives it a special attraction. It is profusely provided with illustrations from photographs of English scenery, chiefly selected from the great collection which is gradually being gathered together by a committee of the British Association. We give two of them in this article, by way of examples (Figs. 1 and 2). Most of them have never before been published. But, beside the charm of novelty, they possess the still greater merit of having been taken, either by geologists or others, for the express purpose of preserving a record of interesting geological features. Those chosen for this volume have been excellently reproduced, and the printing of them is perhaps as near perfection as can be secured for illustrations that are printed with the general body of the type. The name of Messrs. Clark is a sufficient voucher for the beauty of the typography. But how did their reader or pressman allow the map (Fig. 183) to appear upside down?

Lord Avebury has not adopted the topographical nomenclature which our cousins on the other side of the Atlantic have devised and seem to be so proud of. Like other writers in this country, he has been able to treat his subject in plain English words, without recourse to a set of uncouth terms which are as unnecessary as they are undesirable.

The history of the landscapes of England, notwithstanding all that has been published on the subject, still presents many difficult problems for solution. Though Ramsay in his later papers so ably led the way, one great cause of stumbling to many of the workers in this field of inquiry still arises from their inability to realise the vastness of the denudation of the country within Tertiary and recent times. They shrink from the boldness of covering hundreds and thousands of square miles of ground with formations of considerable thickness, every vestige of which has disappeared. Yet it is only by conceding the former existence of such formations that they can possibly explain the present topography of the country and lines of drainage. The mere existence of an area of Palæozoic formations at the surface, especially, too, where it forms high land, ought to be regarded as in itself a proof that, for a vast period of time and until a comparatively late date, that area must have lain under a covering of later rocks. It was over this vanished covering that the present drainage system began to be traced, and the channels originally chosen by the streams that first flowed over it still, on the whole, keep to the same courses, though they have now cut their way down into the older rocks. The most helpful line of investigation that can at present be pursued in this subject is to be found in the search for actual or probable evidence of the extent of the denuded formations. The recent discovery by the Geological Survey of masses of Rhætic, Liassic and Chalk strata in a Tertiary volcanic vent in the Isle of Arran, which proves the former extension of these formations into the west of Scotland, is an example of the unexpected way in which the most important evidence may at any moment be discovered. But even if no such evidence should be forthcoming, it is impossible to contemplate the prodigious denudation of the country even among solid massive rocks like the lavas of the west of Scotland without the profound conviction that since Tertiary time hundreds of feet of rock have been removed from the surface, and that it is impossible to comprehend the history of our landscapes without taking this momentous fact into account.

THE ROYAL SOCIETY AND THE PROPOSED BRITISH ACADEMY.

THE following letter on this subject appeared in the *Times* of March 20 :—

To the Editor of the TIMES.

SIR,—In the references which have been recently made to the early history of the Royal Society, the charters of King Charles II. have frequently been remarked upon, and also the subject-matter of the communications published by the *Philosophical Transactions* from time to time. It has been conceded by many who have given attention to the matter that the charters of King Charles II. intended that the then newly-founded Society should take cognisance, not only of observational and experimental science, but also of those philosophical, historical and philological subjects for which, on the ground that they lack representation to-day, King Edward VII. has been petitioned to grant a charter enabling some new body to look after their interests. It has also been conceded that the early practice of the Royal Society was in accordance with the suggested intention referred to above, so far as the communications made to it enable us to form a judgment.

In a previous letter on this subject, which you were good enough to insert in the *Times* of January 29, I pointed out that a committee specially appointed by the Council of the Royal Society to consider the matter had reported, after consultation with high legal authorities, that the inclusion of the subjects within the scope of the Royal Society, for the general organisation of which it is now proposed to found a new Academy, is within the powers conferred on it by the charters of that Society. I venture to give two extracts from the first charter granted by King Charles II. which alone seem to establish this conclusion. If you will permit me, I will reproduce them here :—

> Charles II., by the grace of God King of England, Scotland, France and Ireland, Defender of the Faith, &c., to all to whom these present Letters shall come, greeting.
>
> We have long and fully resolved with Ourself to extend not only the boundaries of the Empire, but also the very arts and sciences. Therefore we look with favour upon all forms of learning, but with particular grace we encourage philosophical studies, especially those which by actual experiment attempt either to shape out a new philosophy or to perfect the old. In order, therefore, that such studies, which have not hitherto been sufficiently brilliant in any part of the world, may shine conspicuously amongst our people, and that at length the whole world of letters may always recognise us not only as the Defender of the Faith, but also as the universal lover and patron of every kind of truth : Know ye, &c.

Of the "Fellows" it is written :—

> The more eminently they are distinguished for the study of every kind of learning and good letters, the more ardently they desire to promote the honour, studies and advantage of this Society . . . the more we wish them to be especially deemed fitting and worthy of being admitted into the number of the Fellows of the same Society.

Of course it would have been very much more satisfactory if the committee, instead of enunciating pious and legal opinions as to what the charters enabled the Society to do, as abstractedly as if the Society had never existed, had, seeing that action under the charters had been going on for nearly two centuries and a half, told us what the Society had really done year after year in the matter of choosing men for election into the Society. In this way sure proof could be obtained of the general opinion of what the charters empowered and enjoined the Society to do, not only at the time they were conferred, but at subsequent dates. This course, which obviously is the only satisfactory way of arriving at a conclusion on the questions at issue, was, however, not open to the committee ; for a complete list of the officers, Fellows and foreign members elected in each year from the foundation of the Society was not generally available.

This gap in our knowledge of the actual life of the Society has recently been filled, and we can now learn the kind of work for which the Society considered itself responsible by the men it elected to do it in its early days, and especially by those who were elected to fill the various offices. It will be obvious that a complete inquiry of this nature is a matter involving considerable time and labour ; but in the present state of the question raised by the proposition for a new British Academy it is of such high importance to know the facts that I have not hesitated to try to get at them, however imperfectly ; my inquiry being limited as much as possible, this has been done by passing over all doubtful cases and considering chiefly the first century of the life of the Society, that is from 1663.

The general result of this limited inquiry may be stated as follows :—

I begin with the presidents. Some were appointed on account of their rank, others on account of their contributions to observational or experimental science, among them Wren, Newton, the Earl of Macclesfield, and others. But besides these we have Sir John Hoskins, "a most learned virtuoso as well as a lawyer," according to Evelyn ; Samuel Pepys, of diary fame ; Martin Folkes, an antiquarian "under whom the meetings were more literary than scientific" ; Sir James Burrow, an antiquarian, also a lawyer ; and James West, another antiquarian and collector of coins, and given to "black letter lore." If we pass the first century, we find Sir John Pringle, a learned physician and professor of metaphysics and moral philosophy, elected in 1772, and Davies Gilbert in 1827, who, although addicted to science, was chiefly an antiquarian and historian.

Among the treasurers we find one of the first appointed Abraham Hill, given as much to moral as to natural philosophy ; Roger Gale, an archæologist and numismatist ; and, again passing the first century, Wm. Marsden (1802), an Oriental scholar, and Samuel Lysons (1810), an antiquarian and an artist.

We next come to the secretaries. The most remarkable thing about these officers is that between 1663 and 1765, of the twenty-nine elected no less than sixteen were doctors of divinity, medicine or law ; and, so far as the inquiry has gone, the "Dictionary of National Biography" shows that they were not merely professional men, but scholars first and writers afterwards. The secretary elected in 1776 was Joseph Planta, the librarian of the British Museum ; while in 1812 Humphry Davy was followed by Taylor Combe, an archæologist and numismatist.

The office of foreign secretary was created in 1723. Of the eight appointed down to 1772, four were doctors of medicine, and they were selected possibly for the same reason as their colleagues among the secretaries. Maty, who was elected in 1772, was the assistant librarian in the British Museum.

The enormously wide area of knowledge from which the officers of the Society were drawn during the first century is in sharp antithesis to the narrow ground of award of the Copley medal, which was first conferred in 1731. The grant of this medal is limited to the author of the most important discovery or contribution to science by experiment or otherwise; and the greater the divergence between the officers' and Copley medallists' lists, the less, naturally, was the limitation of the Fellowship to those interested alone in experiment or observation.

We next come to the Fellows of the Society. The following lists are based upon a rapid reconnaissance of those who occur early in the alphabetical order, using Hole's "Brief Biographical Dictionary" as a means of determining their identity. The names of many Fellows are absent from Hole, and there are some incertitudes, besides which Hole's definitions are very terse. The lists, however, are given for what they are worth; and there can be little doubt that they will soon be replaced by complete and authoritative lists officially compiled. It is important that the Lords of the Privy Council should possess such documents to assist them in the important inquiry with which they are charged; and we may hope that this eagerness to possess is only equalled by the anxiety of the Royal Society to provide them if their compilation be in the interests of truth :—

Archaeologists and Antiquarians.	
Ames, Josh.	1743
Amyot, Thos.	1824
Ashmole, Elias	1663
Astle, T.	1766
Ayloffe, J.	1731
Baker, G.	1762
Brander, G.	1754
Bridges, J.	1708
Churchill, Winston	1664
Gale, R.	1718
Gale, T.	1677

Writers.	
Askew, Ant.	1749
Barrington, Daines	1767
Bathurst, Ralph	1663
Becket, Wm.	1718
Bentley, R.	1695
Birkenhead, J.	1663
Bowlden, T.	1781
Brocklesby, R.	1746
Brown, R.	1811
Bruce, J.	1791
Burnet, T.	1748
Burney, C. (Music)	1773
Cadogan, W.	1752
Chandler, J.	1734
Edgeworth, R. L.	1781
Egerton, F. H.	1781
Farmer, R.	1791
Green, T.	1798

Historians.	
Abel, Clarke	1819
Barnes, Joshua	1710
Bates, G.	1663
Beaufort, Louis de	1746
Bernard, C.	1696
Birch, T.	1734
Clarke, J. G.	1792
Coxe, W.	1782
Duclos, C.	1764
Edwards, B.	1794
Ellis, G. A.	1816
Gillies, J.	1789

Philologists.	
Colebrooke, H. T.	1816
Dickenson, E.	1677

Poets.	
Akenside, Mark	1753
Browne, J. H.	1749
Byron, Lord	1816
Denham	1663
Dryden, J.	1663
Ellis, G.	1797

Travellers.	
Bruce, James	1776
Brydone, P.	1773
Carteret, P.	1664
Chardin, J.	1682

Lawyers.	
Adair, James	1788
Aland, J. F.	1711
Arden, R. P.	1788
Dalrymple, J.	1796

Although the matter has not as yet been inquired into, there is already ample evidence that the foreign members were selected with the same catholicity as the ordinary Fellows. Thus Sorbière, an eminent French *littérateur*, was elected in 1663 (the first year); the Italian historian Gregorio Leti was elected in 1681; and the French historian Michael Le Vassor in 1701.

It does not seem possible that any unprejudiced mind, after a perusal of the above statements, limited though they are to a point of time, and, in the case of the Fellows, to a few letters of the alphabet, and inaccurate as they may well be here and there, can deny that the reconnaissance affords valuable evidence that the action of the Royal Society for the first century after it had received its charters was as broad as the charters themselves. The Society tried to do, and succeeded in doing, the duty which the charters imposed upon it.

We learn from the above statements that for the period over which my hasty inquiry has gone, Britain possessed a general organisation of learning as complete, though not so detailed, as that of the Institute of France or any other foreign academy to-day. King Charles II. had, in fact, in his charters, and the Royal Society had, in fact, in its action upon them, anticipated the work of Napoleon by very nearly a century and a half; the portals of the Royal Society and of the Institute of France were equally wide, and wide enough to admit the most illustrious men produced in each country.

If I have erred in any way in reading the facts or in drawing conclusions from them, I sincerely trust that someone with more leisure and knowledge than I will discover where I have gone wrong and at once put the matter right. I am the more anxious that this should be done because I gather from the petition of the Royal Society Council to King Edward VII., which was printed in the *Times* of February 27, that the condition of things which the facts reveal is either unknown to the Council or regarded by them as a matter not worth mentioning.

In that petition His Majesty is informed that the President and Council are of opinion that the studies which it has been shown were fully provided for by King Charles II.'s charters to the Royal Society, and "taken care of" for, at all events, the first century to which my inquiry was limited, "ought to be taken care of by some academic organisation, and that this should be effected, not by the Royal Society taking charge of these studies, but by the establishment of some other body."

I submit, Sir, that the view that a complete inquiry should be made before any step be taken towards creating a new body to do what the charters of King Charles II. enjoined and empowered the Royal Society to undertake is vastly strengthened by the facts now brought to light, which show us what the Royal Society actually did.

This inquiry was thus referred to in the petition to the King, dated February 14, which was signed by many eminent representatives of the intellectual, industrial and other forces of the Kingdom :—

> We Your Petitioners humbly pray that Your Majesty may be graciously pleased to cause an inquiry to be made with a view of instituting a general and formal organisation of all the studies depending upon scientific method now carried on similar to that inaugurated for the philosophical studies of the seventeenth century by the charters of His Majesty King Charles II.

I, am, Sir,
Your obedient servant,
NORMAN LOCKYER.

Athenæum Club, March 11.

ANNOUNCEMENT OF NEW MAMMALIAN REMAINS FROM EGYPT.

THE discovery of ancestral Proboscidean and other remarkable mammalian forms in the Egyptian desert has already been noticed in NATURE (vol. lxiv. p. 582). Dr. C. W. Andrews's preliminary descriptions of the remains show that the deposits are of deep interest to palæontologists and other students of mammalian morphology and distribution. Mr. H. J. L. Beadnell now announces, in a pamphlet of two pages of text, illustrated by six plates, that explorations of the desert bounding the

Fayum depression have led to the discovery of several new creatures. "The most important of these," he says,

FIG. 1.—*Arsinoitherium Zitteli*, Beadn. Side View.

"is a large, heavily built, ungulate, about the size of a rhinoceros, and for which the writer proposes the generic

FIG. 2.—*Arsinoitherium Zitteli*, Beadn. Back View.

name Arsinoitherium, from Queen Arsinoe, after whom the Fayum was called in Ptolemaic times, the species being *A. Zitteli*, in honour of the eminent geologist, who may be regarded as the pioneer of geology in Egypt, and whose work when attached to the Rohlfs Expedition of 1873–74 is well known to all geologists." The accompanying illustrations, reproduced from the paper, show a side view (Fig. 1) and a back view (Fig. 2) of the type specimen.

BRYAN DONKIN.

BY the death of Mr. Bryan Donkin at Brussels on March 4 the engineering profession has lost one of its members who devoted himself with more than ordinary assiduity to the scientific side of his calling. The name of Bryan Donkin was eminent in the world of mechanical engineering for the whole of the last century. The late Mr. Donkin succeeded, in due course, to the management of the business which his grandfather, the first Bryan Donkin, had founded in 1803 for the manufacture of paper-making machinery; a new process for producing continuous rolls having been then recently introduced. Bryan Donkin, jun., as the subject of our memoir was known until quite recent times, was born in 1835, and was educated at University College, London, and at the École Centrale des Arts et Métiers in Paris, where he was for two years. After that he was apprenticed to his uncle at the Bermondsey works, his father, John Donkin, having died at a comparatively early age. In 1859 he went to St. Petersburg to superintend the erection of a large paper mill which was being established under the Imperial Russian Government for the manufacture of bank notes and State papers. He returned to this country and in 1868 became a partner in the Bermondsey firm. In 1889 the business was turned into a limited company, of which Mr. Donkin was chairman.

It was not, however, as the head of a manufacturing business that Mr. Bryan Donkin was best known in engineering circles, but as an experimenter and a student in thermodynamics and a reader of papers before technical societies. His first important work was undertaken in conjunction with Mr. Farey, who was also a partner in the Bermondsey firm. The latter had invented a steam-engine, which was known by his name, and it was determined that a complete test should be made to ascertain its efficiency. One of these engines had been erected to drive a paper mill in Devonshire, and the method of testing by measuring the heat discharged with the condensing water was adopted. The principles then followed are now well known, but thirty years ago scientific testing was a very rare thing among engine makers. The temperature of the water was naturally not difficult to ascertain, but to measure the volume with accuracy was a formidable task. How this was done by means of the notched weir and the application of a simple hydraulic law is too familiar to all engineers to need describing afresh.

Mr. Donkin carried on an extensive correspondence with continental engineers; probably he was more closely in touch with foreign scientific experts in the field of steam engineering than any of his compatriots. He devoted a great deal of attention to the use of superheated steam, and in the course of some experiments he devised an instrument he designated the "steam revealer." It consisted essentially of a glass vessel into which steam from the engine cylinder was admitted. By observing whether the steam was transparent or was clouded by the presence of watery vapour, it was possible to estimate if the steam were either superheated or saturated, or whether liquefaction had set in. A paper on this subject was read by its inventor before the Institution of Mechanical Engineers in October, 1900. Of late years Mr. Donkin devoted a good deal of attention to internal combustion motors. A book on "The Gas

Engine," which was from his pen, was published by Messrs. Griffin and Co. He also translated Diesel's work, "The Theory and Construction of the Rational Heat Motor." During the whole of his career he was constantly engaged in experiments of various kinds, one of the principal series being the tests he made, in conjunction with Prof. Kennedy, on the steam boiler. In 1898 a work which he had written on the subject was published by Messrs. Griffin and Co.

Mr. Donkin was a member of the Institution of Civil Engineers, from which society he received the Watt medal and Telford and Manby premiums; a vice-president of the Institution of Mechanical Engineers, and a member of various other scientific and technical societies.

NOTES.

M. YERMOLOFF has been elected a correspondant of the Section of Rural Economy of the Paris Academy of Sciences, in succession to the late Sir J. B. Lawes.

IN connection with the survey of British lakes provided for by the Pullar Trust, Sir John Murray has rented Rannoch Lodge, standing at the west end of Loch Rannoch, from now until the commencement of the shooting season. In the first week of April the following gentlemen will join him and will be associated with him in the work, viz., Mr. R. M. Clark, Aberdeen, Mr. T. N. Johnston, Edinburgh, Mr. James Parsons, London, and Mr. James Chumley, Edinburgh. Other appointments will be made later in the season. Sir Robert Menzies, who has taken a great interest in these investigations, and has placed boats, &c., at Sir John Murray's disposal for carrying on the work, has said that all Highland proprietors should render any assistance in their power to the survey by offering the use of boats. It is intended to include within the scope of the survey, in addition to the systematic physical and biological investigations, observations regarding the oscillations in the level of the water (phenomena called "seiches" by Prof. Forel) by means of self-registering "limnographs," which will be set up on the shores of the larger lakes. The first limnograph is now in process of construction in Geneva under the personal supervision of Prof. Ed. Sarasin, of Geneva. It will be remembered that Mr. Laurence Pullar, of Bridge of Allan, has set aside funds to aid in carrying out this survey, as a memorial to his son, the late Mr. Fred. P. Pullar, who was engaged (in collaboration with Sir John Murray) in a systematic survey of the Scottish lakes at the time of his accidental death in February of last year.

MR. J. HUTCHINSON, F.R.S., went to South Africa recently to study the local diffusion of leprosy there. The *Times* announces that he has now returned; and the conclusion to which he has arrived is that the primary cause of the disease is the use as food of badly-cured salt-fish. Whilst believing that this has been by far the chief agent in its diffusion, Mr. Hutchinson thinks he has obtained conclusive evidence that the malady may, in very exceptional circumstances, be communicated from person to person. He does not believe that it is either infectious or contagious in the proper sense of these words, but that it may be communicated by eating food contaminated by a leper's hands. The measures suggested for the prevention of the disease are, first (and by far the most important), the legislative control of the fish-curing establishments; secondly, the diffusion of information as to danger of communication; and thirdly, the establishment of small isolation homes into which lepers should be induced to go during the stage involving risk.

IT is stated that Prof. E. von Behring intends to give the amount of the Nobel prize recently awarded him (8400*l*.) to the Prussian State for the permanent endowment of the Institute of Experimental Therapeutics founded by him in the University of Marburg. The gift is to be devoted to the prosecution on a large scale of the researches on serum initiated by Prof. Behring. The *British Medical Journal* appropriately recalls the fact that several years ago Prof. von Behring gave the half of a French prize awarded to him, equivalent to a sum of 1000*l*., in furtherance of serum research.

A NEW city branch of the Imperial Institute will be opened early in May for the display, to merchants, manufacturers, &c., of raw and manufactured products received, from time to time, from the colonies and from India, and for which it is desired to find openings in the British markets. Curators and other members of the Imperial Institute staff will attend at the office at stated times and by special appointment, to deal with inquiries and to assist in establishing or facilitating business relations with mercantile houses, &c., in the colonies and in India. The city branch will be in constant communication, by telephone and messengers, with the Imperial Institute, South Kensington.

EARLY in April, students of the Institution of Electrical Engineers will visit the Newcastle-on-Tyne district and inspect several works there. Among the places to be visited are the works and substations of the Newcastle Electric Supply Co. and of the Sunbeam Electric Lamp Co., the Elswick Works of Sir W. G. Armstrong, Whitworth and Co., the three-phase tramway system at Stockton-on-Tees, and the works of Messrs. Palmer's Shipbuilding and Iron Co.

WE are informed that at the meeting of the Connecticut Academy of Sciences on February 12, Prof. A. E. Verrill exhibited several remarkable photographs in natural colours taken direct from nature by a new process, just invented by Mr. A. Hyatt Verrill, of New Haven. One of these was a Bermuda landscape, in which the beautiful blue and green tints of the water, as well as the soft, creamy colour of the old stone Walsingham residence and the natural grey of the rocks, were well brought out. Three other plates were copies of water-colour drawings of groups of bright-coloured Bermuda fishes, taken from life by Mr. Verrill. The photographs were on paper, and were said to have been obtained by a purely photo-chemical process.

THE report of the council of the Scottish Meteorological Society, read at the general meeting of the Society on March 20, announces that the second volume of the Ben Nevis observations is approaching completion. This is the first of the three volumes, for the printing of which the Royal Societies of London and Edinburgh have each voted 500*l*. It contains the observations made at the Ben Nevis and Fort William Observatories from January 1888 to December 1892, and discussions connected with them. One of these discussions is by Mr. J. Aitken, F.R.S., on the dust of the atmosphere as observed on Ben Nevis and at various places in Scotland. For several years experiments with kites for meteorological purposes have been carried on near Edinburgh by Mr. John Anderson. He has now obtained a complete outfit, including an oil-engine of two and a quarter (2¼) horse-power. It is proposed to test this kite, which in some respects has new features to recommend it, very thoroughly in the early summer. The outfit will be handed over to the ship of the Scottish Antarctic Expedition for use in the South Polar regions.

WE have received a reprint of a letter from Prof. A. Agassiz to Prof. E. S. Dana, dated Colombo, January 29, in which Prof. Agassiz announces the return of his expedition from an exploration of the Maldives, extending over several weeks. The general form of the plateau on which the atolls are situated has been determined and the channels between the lagoons carefully studied. The principal atolls in the middle of the group are separated by shallow water, but towards the south the depths increase to nearly a thousand fathoms. Atolls are found in all stages of formation, including specimens of greater simplicity than have been found anywhere except on the Yucatan plateau. A preliminary report of the work will be issued as soon as the charts are completed.

IN a paper published by the Amsterdam Academy of Sciences, Prof. Eugene Dubois discusses the supply of sodium and chlorine by rivers to the sea. A large number of analyses of river-water are dealt with, and Prof. Dubois arrives at the conclusion that Sir John Murray's estimate of the amount of sodium delivered by rivers is much too high. The point is of special interest in relation to the attempts of Prof. Joly and others to estimate the age of the earth from chemical denudation. Prof. Dubois' results seem to indicate a period of the same order as that obtained by Lord Kelvin—twenty-four millions of years.

MR. J. BARCLAY, Birmingham, asks for an explanation of an effect he has observed, produced by refraction of air. While looking at a bookcase through the heated air rising from the chimney of a lighted lamp, the line of sight being a few inches above the top of the chimney, he noticed that one of the volumes appeared to project in front of the row in which it stood. Mr. E. Edser, to whom the observation has been referred, writes in reply:—"The illusion is obviously due to the refraction of light by a cylindrical column of heated air, which acts as a divergent cylindrical lens. The refractive index of the air of the room may be taken, roughly, as equal to 1·0003. If the heated air rising from the chimney of the lamp has a temperature of 300° C., its refractive index would, roughly, be equal to 1·00015. At the interface between the cold and heated air, the effective refractive index would be equal to 0·99985. Assuming the lamp chimney (and therefore the column of heated air) to have a diameter of 1 inch, then the focal length of the cylindrical lens would be 0·00015. The distance of the book from the lamp was about 8 feet, or (say) 100 inches. Seen through the column of heated air, the distance v of the book from the lamp is given by the equation $1/v - 1/100 = 0{\cdot}00015$, from which v is found to be 99 inches. The book thus appears about an inch in front of its true position, as observed by Mr. Barclay."

WE congratulate our Norwegian contemporary, *Naturen*, on having completed the first quarter of a century of its struggle for existence in a country of only two and a quarter millions of inhabitants. It is published in Bergen, where it was founded in 1877 by Dr. Hans Reusch, then an assistant in the Geological Survey of Norway, of which he is now director. In spite of many difficulties, *Naturen* gradually gained ground at a time when old and excellent journals such as *Tidskrift for populaere fremstillinger* and *Naturen og mennesket* (both published in Denmark) were discontinued. In 1881 Dr. Reusch went abroad for some years and handed over *Naturen* to Herr Carl Kraft, who conducted it on the same lines and against the same difficulties until 1886. In January 1887 the journal became the property of the Museum in Bergen, which continued its publication under the editorship of its director, Dr. I. Brunchorst, and in 1893 it received a yearly Government grant of Kr. 1000 (= 55*l.* 10*s.* 3*d.*), on condition that 400 copies are supplied monthly at half price to State schools and public libraries, so that poorly paid teachers and others in remote districts may have access to its pages. In its first number for 1902, in which it celebrates the commencement of the twenty-sixth year of its existence, we are presented with the portraits of its first two editors. The number also contains articles by the three contributors to its first number in 1877, viz. Dr. H. Reusch, Herr I. Sparre Schneider and Prof. Geelmuyden. We wish the journal a long and prosperous life.

IN a lecture lately delivered before the Norwegian Geographical Society by Captain R. Amundsen, the author gave an account of the proposed exploring expedition to the magnetic North Pole. Captain Amundsen was first officer of the *Belgica*, which sailed for the Antarctic in August 1897 with the view of determining the exact locality of the magnetic South Pole, and it was while that ship lay fixed in the drift-ice west of Graham Land that the idea was conceived of exploring the magnetic North Pole. For the contemplated expedition, the *Gjöa*, one of the strongest and best sailing-vessels of the Arctic fleet, has been purchased at Tromsö. In 1831, Sir James Clark Ross reached a position where the dipping-needle was only deflected one minute from an absolutely vertical position, but the question has been raised whether the magnetic pole is actually only a point or whether the peculiarity of the needle assuming a vertical position extends over a large area, and, further, whether the magnetic pole changes its position. With the object of solving these two questions, Captain Amundsen will sail in the spring of 1903. The *Gjöa* is to be fitted with a petroleum engine and will carry a crew of seven men. A travelling magnetometer is under construction at the Deutsche Seewarte, and will resemble that used on board the *Fram*. A dipping-needle is being constructed in London, and will be examined at the observatory of the National Physical Laboratory. It is proposed to take magnetic observations as frequently as practicable, to leave the ship either at Matty Island or King William Land, and as soon as the severest part of the winter is over to continue the journey with the sledges to the place on Boothia reached by Ross.

WE have received a copy of Mr. C. E. Stromeyer's paper on explosions of steam pipes due to water-hammers, read before the Manchester Literary and Philosophical Society. The paper deals both with the causes of these explosions and with the forces which come into play when they occur. At the meeting Mr. Stromeyer made two sets of experiments with water in glass pipes. The first illustrated those accidents which are caused when the steam pipes are so arranged that water may find a lodgment over the boiler stop valve. When opening this valve, the steam pressure shoots the plug of water along the pipe until it strikes and shatters the engine stop valve, if this happens to be left partly open. The other experiment showed that if near the boiler stop valve there is an L pipe in which water can lodge while steam is in the main pipe above the vertical leg, then by draining away this water, which has, of course, to be done before starting the engine, steam is admitted to the horizontal leg and most violent steam-hammer blows occur, which have been the cause of many explosions. In the theoretical part of the paper, Mr. Stromeyer gives a proof that the velocity of a pressure wave is the same as the velocity of sound, which has an important bearing as showing that both undulatory and angular sound waves travel with the same speed. Then as regards the pressure exerted by an elastic body like water when it suddenly comes to rest, he explained that a pressure wave travels from the front end of the water column to the back end, and that the back end, or in fact any part of the water column, continues to move forward with its original velocity as long as it does not feel the wave of pressure. The arrested (pressed) water column is, therefore, shorter than the moving one. The ratio of the amount of shortening to total length is the ratio of original velocity (V) of the whole column to the pressure velocity (W). By multiplying this ratio by the elasticity of water (E) we get the pressure $P = E\,\frac{V}{W}$. Thus a plug of water only 6 inches long propelled through a distance of only 2 feet under a pressure of 15 pounds would on being suddenly arrested exert a pressure of 6400 pounds.

OUR contemporary the *Electrical Review* of New York celebrated on February 15 the twentieth anniversary of its publication. The greater part of a special issue is devoted to retrospective articles on the development of the different branches of the industry during the past twenty years. A facsimile reproduction of the first page of the first number shows that the original title of the journal was the *New York Review of the Telegraph and Telephone*, which sufficiently indicates the position of electrical engineering at that time. In 1882 the incandescent lamp was only just developed to a practical article; towards the end of the year the first central generating station was opened by Mr. Edison in New York. The first attempts at electric traction were just being made, and industrial electrochemistry had not advanced further than electroplating and a little copper refining. It has become, perhaps, hackneyed to remark on the rapid development of electrical engineering, but it is pleasant to be reminded occasionally in so striking a fashion how very great the rapidity has been. One of the most interesting features of the issue under consideration is the reproduction of engravings from early numbers showing some of the first commercial machines, and the comparison of these with the process blocks of the enormous engines and dynamos now in use. Altogether we can congratulate the paper on a very attractive and instructive number.

OWING to recent excavations in Hull, a large number of seventeenth century tobacco pipes have been discovered; these have been figured and described by Mr. T. Sheppard, the curator of the Hull Museum, in one of the useful penny guides, to another of which, on an ancient model of a boat, we drew attention a short time ago. This handbook will prove of value, as little is known about early clay pipes and their makers.

IN the thirty-fifth report on the Peabody Museum of American Archæology and Ethnology of Harvard University, we have a very satisfactory record of the research and field work accomplished during the year 1900–01. There were seven expeditions during that period to various parts of North and Central America for the purpose of studying languages, customs and archæology, and one graduate has done some valuable work in Syria. The collections have increased so greatly that the existing museum accommodation is quite inadequate; doubtless this will soon be remedied, as wealthy Americans are always ready to help deserving institutions that do their best.

WE have often drawn attention to the valuable *Bulletins* of the Madras Government Museum, and the current number (vol. iv. No. 2) fully sustains the reputation of the series. Mr. Edgar Thurston demonstrates an unexpected occurrence of brachycephaly among certain Dravidian tribes in the Bellary district of the Madras Presidency, where 37·8 per cent. (among 419 subjects examined) have a cephalic index of above 80, the average being 78·9 as opposed to an average index of 73·8 in the southern districts of the Presidency. We are pleased to find that Mr. Thurston will now study this problem. Mr. T. Ranga Rao is the author of an interesting paper on the Yánádis of the Nellore district (see p. 437), which was written as a thesis for the M.A. degree examination of the Madras University; in this recognition of ethnology the Madras University is in advance of those in the mother country. Among the "Miscellanea" are notes on the couvade, albinos, earth-eating, weighing beams, and other matters of interest pertaining to the ethnology of southern India.

NO. 6 of the *Sitzungsberichte* of the Vienna Academy for 1902 contains an abstract of the third part of Franz Baron Nopesa's work on the dinosaurian remains from Siebenburgen. This fasciculus is devoted to the description of the skull of the iguanodont known as Mochlodon, and also of dermal plates described under the name of Onychosaurus. In a second communication the author discusses certain European Cretaceous armoured dinosaurs, such as Struthiosaurus, Acanthopholis and Polacanthus, which he believes to be closely related to the remarkable horned Ceratopsidæ of North America.

IT is most satisfactory to learn, from an article contributed to the March number of the *Zoologist* by Mr. John Gurney, that spoonbills are making the mud-flats of Breydon Broad, Norfolk, their regular summer resort, from two to four of these beautiful birds having frequented this locality from the early part of April till the end of July. An avocet was also seen there on one occasion. These gratifying results are entirely due to protection; but Mr. Gurney adds that "unless the Breydon Wild Birds' Protection Society receives more pecuniary support than it has had in the past, it will be unable to continue to carry on its good work." In a rich county like Norfolk there ought to be no difficulty in obtaining the necessary funds. Out of the fifteen Spanish bustards turned down near Thetford in 1900, only two pairs remain, and these wandered on one occasion nearly as far as Newmarket. Among rare birds recorded in Norfolk during the past year, Mr. Gurney mentions the golden oriole, orange-legged hoby, woodchat, roller, Tengmalm's owl and Caspian tern.

IN his address to the thirteenth annual meeting of the Association of Economic Entomologists, held at Denver, Colorado, in August last (of which a report appears in *Bulletin* No. 31 of the Entomological Division of the U.S. Department of Agriculture), Mr. G. P. Gillette took for his subject the life-history of the codling-moth. One of his objects was to show the imperfection in our knowledge of the history of even the most common insects; and since, next to the "two-lined locust," the codling-moth is the species which occasions the greatest loss to cultivators in Colorado, the importance of a full knowledge of its habits can scarcely be overrated. Until quite recently, entomologists held the belief that the moth lays its eggs in the calyces of apples; the fruit-growers knew this to be an error, and in consequence have, unfortunately, somewhat lost confidence in the work of the Division. A special subject of investigation has been the number of broods annually produced by this insect. In Colorado, where the species is definitely known to be double-brooded, the habits of the moth are probably very different from those in the more eastern districts, and one of the main objects was to determine whether in the warmer parts of the country, where more tender fruits are grown, the annual number of broods might not be greater.

MESSRS. BLACKIE AND SON contemplate a re-issue of Kerner's "Natural History of Plants," a work which in its English form is identified with the name of Prof. F. W. Oliver. The new edition, which will be issued at a considerably reduced price, will be substantially a reprint of the original English edition, with a few necessary alterations and corrections.

THE "Class List and Index of the Periodical Publications in the Patent Office Library," lately published by the Patent Office (Bibliographical Series, No. 5), is a well-arranged catalogue of journals, reports and other periodical publications of interest to students of pure and applied science. The reports of scientific and polytechnic societies and the scientific and technical journals are subdivided locally; they are also classified according to subjects. There are in the list 2563 works, distributed under 356 classes and representing about 39,680 volumes.

TWO catalogues of scientific apparatus which have recently been received show that the needs of teachers and investigators of physical science are well supplied by instrument makers. One of the catalogues shows apparatus made by Messrs. J. J. Griffin and Sons for the purposes of instruction in sound, light and heat in schools and colleges. Among the new and ingenious devices contained in the catalogue we notice simple apparatus for the determination of the coefficient of linear expansion, the determination of relative conductivities, and a model theodolite. To make the catalogue of permanent use in the laboratory, tables are given of physical constants frequently required, and of logarithms, anti-logarithms and trigonometrical functions. The new catalogue of physical and electrical apparatus made by the Cambridge Scientific Instrument Company contains many instruments of precision not found in the lists of other instrument makers. For instance, a comparator and cathetometer combined, which can be used in a vertical or horizontal instrument, is described in the catalogue, and also geometric tripod stands, which can be so arranged as to form a stand of any desired height. Both these appliances were designed by Prof. C. V. Boys, and have not been illustrated previously. Other noteworthy instruments are a chronograph for laboratory use and the "Cambridge" standard coils, which are wound with bare platinum silver wire round a stout mica frame supported by a brass carrier. The coils are contained in a glass case with an ebonite top and are immersed in insulating oil. This arrangement ensures the coil being at the true indicated temperature, as there is no lagging due to paraffin wax or silk covering.

THE additions to the Zoological Society's Gardens during the past week include a Wedge-tailed Eagle (*Aquila audax*) from Australia, presented by Mr. Aubrey Richardson; two Spotted Turtle Doves (*Turtur suratensis*), a Barred Dove (*Geopelia striata*) from India, presented by Mr. L. Ingham Baker; a Common Bluebird (*Sialia wilsoni*) from North America, presented by Miss L. B. Dyar; five Prjevalsky's Horses (*Equus prjevalskii*) from Northern Mongolia, an Egyptian Jerboa (*Dipus aegypticus*) from North Africa, a Raven (*Corvus corax*), a Lapwing (*Vanellus vulgaris*), European, a Red-fronted Amazon (*Chrysotis vittata*) from Porto Rico, a Lesser Sulphur-crested Cockatoo (*Cacatua sulphurea*) from Moluccas, two Californian Quails (*Callipepla californica*) from California, five Yellow-winged Sugar-birds (*Coereba cyanea*), three Brazilian Tortoises (*Testudo tabulata*) from South America, a Long-necked Chelodine (*Chelodina longicollis*), a Bearded Lizard (*Amphibolurus barbatus*), a Gould's Monitor (*Varanus gouldi*), a Lace Monitor (*Varanus varius*) from Australia, twenty-four sharp-headed Lizards (*Lacerta dugesi*) from Madeira, deposited.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN APRIL.

April 2. 4h. Saturn in conjunction with moon. Saturn 5° 15′ S.
3. 9h. Jupiter in conjunction with moon. Jupiter 5° 53′ S.
4. 8h. 46m. Minimum of Algol (β Persei).
8. Sun eclipsed, invisible at Greenwich.
9. 15h. 51m. to 20h. 35m. Transit of Jupiter's Sat. IV.
10. Saturn. Outer minor axis of outer ring = 13″·96.
10. 16h. Ceres in conjunction with moon (Ceres 0° 23′ N.).
11. 9h. 36m. to 10h. 15m. Moon occults δ^3 Tauri (mag. 4·2).
12. 11h. 23m. to 12h. 11m. Moon occults 119 Tauri (mag. 4·6).
14. 12h. 36m. to 13h. 9m. Moon occults 68 Geminorum (mag. 5·0).
15. Venus. Illuminated portion of disc = 0·435, of Mars = 1·000.
15. 11h. 47m. to 12h. 17m. Moon occults 27 Cancri (mag. 5·6).
21. 11h. 46m. to 12h. 52m. Moon occults α Virginis (mag. 1·2).
22. 5h. 0m. to 8h. 45m. Moon eclipsed, partly visible at Greenwich. Moon rises at 7h. 5m, totally eclipsed.
23. 12h. Mercury in conjunction with Mars. Mercury 0° 40′ S.
23. 12h. 30m. to 16h. 12m. Transit of Jupiter's Sat. III.
24. 10h. 28m. Minimum of Algol (β Persei).
25. 10h. 53m. to 12h. 7m. Moon occults B.A.C. 5580 (mag. 5·7).
25. 12h. Venus at greatest elongation, 46° 12′ W.
26. 10h. 51m. to 15h. 40m. Transit of Jupiter's Sat. IV.
28. 16h. 20m. to 17h. 44m. Moon occults ρ^1 Sagittarii (mag. 3·9).
29. 14h. Saturn in conjunction with moon. Saturn 5° 20′ S.

ORIGIN OF DISTURBANCE IN CORONA, MAY 17-18, 1901.—*Bulletin* No. 18 from the Lick Observatory is devoted to the discussion of more detailed examination of the photographs obtained during the total solar eclipse in Sumatra, which showed evidence of a marked disturbance in a certain region of the corona. A set of positives on glass from solar negatives taken at Dehra Dûn, India, for the Solar Physics Committee, have since been received from the Astronomer Royal, giving exact records of the solar surface on May 17, 18, 19, 20, 21, 22, 26 and 28, 1901. The photographs of May 17 and 18 show no evidence of spots or other active features, but that for May 19 shows a medium-sized spot just passed into view round the east limb. On the 20th, this is seen to be followed by a group of smaller spots, surrounded on all sides except the west by a large area of faculæ. This group of small spots shows conspicuous changes from day to day.

The positions of the spot on the plates of May 19 and 28 were measured, and from the reduced values its probable position on the day of eclipse was computed. It would be on the opposite side within 4° of the limb. The position angles of the spot as projected on the limb and the apex of the coronal disturbance are practically identical. As, moreover, both the sunspot and the coronal disturbance appear to have had the same latitude, it can hardly be doubted that this unusual appearance in the corona was in reality immediately above the group of sunspots and faculæ, and that it had its origin in the same disturbance of the solar surface. In view of this conclusion, an attempt was made to determine if any measurable displacement of any of the coronal masses had occurred during the interval of about five minutes, but no certain indication of such motion could be detected. In this connection, however, the interval of one and a half hours between the times of eclipse in Mauritius and Padang should render a comparison of the negatives secured at the two stations valuable.

FOUCAULT'S PENDULUM.—An interesting announcement is made in the March number of the *Bulletin de la Société Astronomique de France* to the effect that a movement is being started among the astronomical authorities in Paris to arrange for the repetition of Foucault's famous experiment at the Panthéon, which was interrupted in 1851. No definite arrangements are yet settled, but it is hoped this majestic demonstration of the rotational movement of the earth will be successfully installed with all the advantages of modern refinements in instrumental construction.

A CONVENIENT TERMINOLOGY FOR THE VARIOUS STAGES OF THE MALARIA PARASITE.[1]

I HAVE found it necessary in labelling a series of models of the malaria parasite in the Central Hall of the Natural History Museum to use as simple and clear a terminology as possible. I think that this terminology will be found useful by others who are perplexed by such terms as "sporozoites," "blasts," "ookinetes," "schizonts," "amphionts" and "sporonts"—terms which have their place in schemes dealing with the general morphology and life-history of the group Sporozoa, but are not, as experience shows, well suited for immediate use in describing and referring to the stages of the malaria parasite.

It is necessary to treat the malaria parasite from the point of view of malaria; that is to say, to consider its significant phases

[1] By Prof. E. R. Lankester, F.R.S. Read before the Royal Society o March 6.

to be those which it passes in the human blood. In reality its mature condition and most important motile, as well as its most prolific reproductive, phases are passed in the body of the mosquito.

(1) The malaria-germ which is brought by the stab of the Anopheles into the human blood-vessels is a reproductive particle, a *spore*. It is needle-like in shape, and might be named in reference to its form (*e.g.* oxyspore or raphidiospore), but the most important fact about it for description and comparison is that it has been formed *outside* the human body, and is introduced as a strange element into the human blood by the agency of the mosquito. I therefore call it the EXOTOSPORE.

(2) The Exotospores (probably as many at a time as forty or fifty) enter the blood by the agency of the mosquito's stab and immediately penetrate, each one, a red corpuscle. The history of this process has not been observed. As soon as it has entered a red corpuscle the exotospore loses its needle-like shape and becomes amœbiform. I apply to it the name I proposed some years ago for similar amœbiform spores in other Protozoa, namely, AMŒBULA ("Encyclopædia Britannica," article "Protozoa").

(3) The Amœbula exhibits amœboid movements within the red corpuscle, enlarges and finally breaks up into spherical spores, which are liberated with destruction of the red corpuscle. It seems to me unnecessary to have a special name for the star-like or other condition of the Amœbula when in course of breaking up into spores; but the spores so produced require a special name which shall emphatically distinguish them from the Exotospores. I call them the ENHÆMOSPORES, in reference to the fact that they are produced by a process of division which occurs *in* the blood of the malaria-stricken human being.

(4) The Enhæmospores penetrate fresh red blood-corpuscles, and after a certain growth as amœbulæ break up into a new crop of Enhæmospores, by which the infection of the red corpuscles is extended. This process appears to go on for several generations and for a varying duration of time. But owing to conditions and at a period of the infection which has not been precisely ascertained, some (or all?) of the amœbulæ derived from Enhæmospores cease to break up into spores. Instead of carrying out that process they enlarge, and in the case of the æstivo-autumnal parasite (*Laverania praecox*) become sausage-shaped or, as it has been termed, crescent-shaped. This change of form is accompanied by a destruction of the red corpuscle and the formation of granules of dark pigment within the parasite. It seems best to term this phase the "CRESCENT" or "CRESCENT-SPHERE," the latter term being applicable to those species in which the form is not markedly crescentic.

(5) The crescents or crescent-spheres remain quiescent in the human blood. They are, however, of two different natures—male and female. It is not possible to distinguish with any certainty the male from the female crescents whilst they remain in the human blood-vessels. But it is these bodies which are destined to be swallowed by the Anopheles mosquito and to carry on further the life-history of the parasite.

The crescents are therefore the sexual phase of the parasite. When the crescents are swallowed by a mosquito (of an appropriate species), they undergo two different modes of development, determined by the fact of their sex. Both sexes become spherical, and may now be called respectively "EGG-CELL" and "SPERM-MOTHER-CELL."

From the periphery of the SPERM-MOTHER-CELL, now floating in the mosquito's stomach, there are developed with surprising rapidity six or seven SPERMATOZOA, which for a time remain attached to the residual mass (or SPERM-BLASTOPHOR) of the sperm-mother-cell. Complete cytological study of this development is still wanting, but it appears that the spermatozoa are true spermatozoa, like those of the higher animals, and have the same relation to the mother-cell from which they develop as is the case in such an animal as the earth-worm.

The EGG-CELL, now also floating in the mosquito's stomach, apparently gives rise to one, and possibly to two, polar bodies, but the observations on this point are, as yet, insufficient.

Fertilisation of the egg-cell now takes place in the gnat's stomach. A single spermatozoon penetrates and fuses with each egg-cell.

The fertilised egg-cell is spoken of as a "zygote"; it is also described as the sexually produced embryo.

(6) The ZYGOTE or SEXUALLY PRODUCED EMBRYO remains unicellular, but increases in size and becomes pyriform. It exhibits active movements of expansion and contraction in the line of its long axis, and also a quick movement of its narrower end alternately to either side. This is the largest growth of the individual cell attained to in the series presented by the life-history of the malaria parasite. It has been called "vermiform" and "vermicule" (Ross), and I adopt this name for it, viz. the VERMICULE. The vermicule is the dominant individual form in the history of the malaria parasite, endowed with greater size, power and activity than other phases. It corresponds, not only in this respect, but also in its position in the life cycle, to the large often active cells of the Gregarinidea, which I proposed some time ago to call the Euglena-phase ("Encyclopædia Britannica," article "Protozoa").

It is worthy of note that in the size and activity of the vermicule, the Hæmaosporidia—the order of Sporozoa which embraces the malaria parasite—come nearer to the Gregarinidea than they do to the Coccidiidea, though in the existence of a sexual generation absent in Gregarinidea they agree with the Coccidiidea.[1]

The vermicule now pushes its way through the tissues of the gnat's stomach and in the blood sinuses outside the stomach becomes spherical. It enlarges and nourishes itself on the insect's blood, and forms a spherical CYST, or structureless transparent envelope. This cyst is destined to enlarge, with vast increase of its living contents.

The living cell within the cyst breaks up by a definite process to form eventually an immense number of exotospores, the stage with which the present description commenced. The CYST would most conveniently be called a "sporocyst," since, as so often happens in Protozoa, it is formed purely and simply in relation to the quiescence of the organism and its division into numerous reproductive spores. Unfortunately, the word "sporocyst" has been employed recently by writers on the Sporozoa for the small capsules containing one or two to eight elongated spores which used to be called "pseudonaviculæ," and are formed *within* such larger cysts as that now in question. The word "cyst" should have been reserved for the larger more general protective envelope, and the "pseudonaviculæ" might have been called "sporo-thekæs." In any case, I think we may call the cysts in which the vermicules of the malaria parasite enclose themselves "SPORE-CYSTS" or "SPORE-FORMING CYSTS." The name "oocyst," applied to them by some writers, is simply misleading.

(7) The spore-cysts lying outside the stomach wall of the mosquito bathed in the insect's blood receive abundant nourishment. The single-celled vermicule enclosed undergoes rapid changes; it increases greatly in volume and breaks up by normal cell division (? the earliest steps have yet to be studied) into a number of SPORE-MOTHER-CELLS. In the process of this division and the later stages of the final development of the "spores" (exotospores), the "spore-forming cyst" increases in size to twenty times its initial diameter.

The spore-mother-cells are set closely together in the cyst; they are of polygonal shape, owing to pressure, and each has its nucleus. Finally they give rise, each spore-mother-cell, to a crop of filiform spores (exotospores) which have the same relation to the spore-mother-cell as spermatozoa have to a sperm-mother-cell, viz., they form on the outside of the spore-mother-cell as outstanding processes, carrying away all the chromatin of the mother-cell and leaving in the centre or to one side a "residuary body," a "spore blastophore" similar to the "sperm-blastophore" of spermatozoon-development.

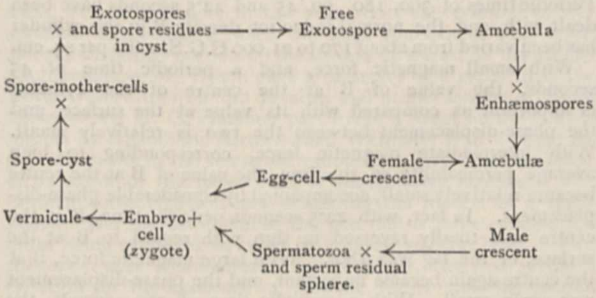
Thus we are brought back to the needle-like exotospores with which we started.

The spore-holding cysts burst and liberate the exotospores into the blood of the mosquito. Thence they readily pass into the ducts of the salivary gland, and so are conveyed by the mosquito's stabbing beak into human beings. A point in this connection is the definite ejection by the mosquito of the secretion of its salivary gland into the punctured wound which it makes in the human skin. There can be no doubt that such an ejection takes place. The leech ejects a secretion on to the wound caused by its bite which has the property of preventing the coagulation of the blood. It is possible that the mosquito and other blood-sucking flies may use the salivary secretion for the same purpose. It is obvious that unless there were some injection into the wound on the part of the fly, the chances of

[1] A sexual phase has been described in the Gregarine Stylorhynchus by Léger since this paper was written. It occurs at an unexpected point in the cycle: two encysted full-grown "Sporonts" are stated to produce the one egg-cells the other spermatozoids.

infection of the bitten animal by the parasites carried by mosquitoes or tzetze fly would be very small.

Our cycle of forms with the names here made use of may be written as below. The sign × is used to indicate fissile multiplication, and + to indicate fusion, while → merely indicates continuity.



I also give a list of the names here used with reference to the occurrence of the forms indicated in man or in gnat and an indication of the corresponding stages in a Gregarina and a Coccidium. In the column belonging to Coccidium I have employed the generalised physiological nomenclature accepted by special students of the Sporozoa (Schaudin, Lühe, &c.).

Malaria.	Coccidium.	Gregarina.
1. Exotospore, free in human blood ... ("Blast" of some authors.)	Sporozoite ...	Sporozoite. (Filiform young.)
2. Amœbula, in red corpuscles ...	Schizont ...	Amœbula.
3. Enhæmospore, ditto, and in blood ...	Merozoites, formed by schizogony.	
4. Crescent, in human blood ...	Gametocytes ...	
a. Male ...	Microgametocyte ...	
b. Female ...	Macrogamete ...	Schizogony rare; sexual stages NOT OBSERVED and probably WANTING.
5. Sperm-mother-cell, in gnat's stomach ...	Microgametocyte ...	
6. Egg-cell, in gnat's stomach ...	Macrogamete ...	
7. Spermatozoon, in gnat's stomach ...	Microgamete ...	
8. Zygote or embryo-cell, in gnat's stomach ...	Young oocyst (sporont) ...	
9. Vermicule, in gnat's stomach ...	WANTING ... (Called "ookinete" or "kinetosporont" in the nomenclature of this column.)	Full-grown motile "gregarine." (Euglenoid phase.)
10. Spore-cyst, in blood-sinus outside gnat's stomach	Older (but not larger) oocyst or sporont	Cyst enclosing one or two full-grown sporonts.
11. Spore-mother-cells in cyst, in blood-sinus outside gnat's stomach ...	Sporoblasts (sporogony) ...	Sporoblasts. (? Conjugation in *Lankesteria Ascidiae.* Spermatozoa and ova in Stylorhynchus.)
12. Exotospores in cyst, in blood-sinus outside gnat's stomach ...	Sporozoites enclosed in small groups in sporocysts within the bigger oocyst.	Sporozoites enclosed in capsules, called "pseudonaviculæ" or "sporocysts."
21. Free exotospores, in gnat's salivary duct ...	Free sporozoite ...	Free sporozoite.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE proposals of the Government with respect to education in England and Wales were described in the House of Commons by Mr. Balfour on Monday, and after a discussion, leave was given for the introduction of the Government Education Bill. It is proposed that in future there shall be one authority for education, primary, secondary, and technical; and that this authority, being responsible for a heavy cost to the ratepayers, shall be the rating authority for the district. Explaining the broad outlines of the measure, Mr. Balfour stated that the education authority will be the county council in counties and the borough council in county boroughs. They will work through committees appointed under schemes which will have to be approved by the Education Department. A majority of a committee at least is to be appointed by the council. The other members are to be nominated, and to be persons experienced in education. Wales, which has a secondary education authority already, is to be permitted either to retain that authority or to substitute for it the authority proposed in the Bill. With regard to secondary education, the provisions of the measure are practically identical with those embodied in the Bill of last year. County councils and borough councils are to have a 2*d.* rate to work upon, and as in many places that will be insufficient, power will be given to have that limit raised by provisional order. Boroughs already possess a certain jurisdiction over technical education, and have a rate of 1*d.* to work upon. It is not proposed to deprive any borough with a population above 10,000, or any urban district with a population above 20,000, of that jurisdiction. The councils of these boroughs and urban districts may, if they choose, become the absolute authority over primary education. They would retain their existing powers over technical education, and would become the authority for secondary education concurrently with the county council. But whether the schools in a district are voluntary or rate erected, the local educational authority created by the Bill will in future be the absolute master over all secular education. London is excluded from the operation of the Bill. The adoption of the elementary education portion of the measure would, for a time, be optional.

MR. H. BRERETON BAKER, M.A., late scholar of Balliol College, Oxford, has been elected by the governors of Dulwich College to be headmaster of Alleyn's School, Dulwich. Mr. Baker, who has had several years' scholastic experience as senior science master in Dulwich College, is well known as a chemist of real distinction, whose important papers in the *Philosophical Transactions* and the *Journal* of the Chemical Society on the remarkable influence of traces of moisture in facilitating chemical action have attracted well-deserved attention. Physical science has long formed a prominent part of the course at Alleyn's School, which possesses physical and chemical laboratories that are probably not surpassed by those of any school in the country. It will be a matter of interest to scientific men that at least one school in the kingdom should be, not only well provided with laboratory accommodation, but should have at its head a man of acknowledged scientific reputation.

SIR PHILIP MAGNUS will preside at a public meeting to be held in connection with the conference of the National Association of Manual Training Teachers at Manchester on Easter Tuesday, April 1.

THE Government of India has had under consideration the improvement of the existing system of education of Europeans and Eurasians, and the Local Governments have been asked for an expression of their views upon the subject. Meanwhile (says the Allahabad *Pioneer Mail*) a small committee of educational officers has been appointed to examine and revise the Bengal Code of Regulations for European Schools, in the hope that it may be found possible to render it suitable for adoption throughout India. The Secretary of State has accepted the proposal of the Government of India to create an appointment of Director-General of Education in India, and Lord George Hamilton has selected Mr. H. W. Orange to fill the post.

At a meeting of the Edinburgh Mathematical Society on March 14, the following resolutions in regard to the teaching of elementary mathematics were agreed to:—(1) That the primary object in teaching elementary mathematics is to afford a mental training to the pupil. The commercial, technical or professional applications of the subject are of secondary importance in general education. (2) That there should be no undue haste to begin the study of the calculus with a view to its practical applications. (3) That pupils should not be encouraged in the unscientific practice of placing dependence on rules or formulæ which they do not understand. (4) That, in teaching any branch of mathematics, concrete illustrations and verifications including experimental, graphical and other methods should, wherever practicable, accompany theory. (5) That in examinations particular methods of solution or demonstration should not, as a rule, be demanded, *e.g.*, the use of algebra should not be prohibited in answering questions in arithmetic or geometry. (6) That there should not be imposed upon schools in any branch of mathematics a syllabus which does more than indicate the order in which the main divisions of a subject are to be taught.

Dr. D. C. Gilman's reminiscences of the foundation and early days of the Johns Hopkins University, given in the current number of *Scribner's Magazine*, contain several interesting particulars concerning men connected with it. Johns Hopkins left his fortune to be divided between a university and a hospital, the two to be united in the promotion of medical science. As the capital for the university was thus provided by a single individual, there were no bodies to interfere with its plans, and no public or treasury to conciliate. Given the idea and the funds, all that had to be done was to produce the plan of an institution which should aim at having national influence, and should take to Baltimore, as teachers and students, the ablest minds that could be attracted there. Rowland was an assistant instructor in the Rensselaer Polytechnic Institute when Dr. Gilman heard of him from General Michie, and the following conversation occurred:—"What has he done?" I said. "He has lately published an article in the *Philosophical Magazine*," was his reply, "which shows great ability. If you want a young man you had better talk with him." "Why did he publish it in London," said I, "and not in the *American Journal?*" "Because it was turned down by the American editors," he said, "and the writer at once forwarded it to Prof. Clerk Maxwell, who sent it to the English periodical." When Dr. Gilman had seen Rowland and reported upon his rare powers to the trustees in Baltimore they said at once, "Engage that young man and take him with you to Europe, where he may follow the leaders in his science and be ready for a professorship." This was done; and the result is well known. Huxley gave the inaugural address, but he had to deliver it from memory, as he could not read the flimsies with which the reporters to whom he had dictated the lecture on the previous day had provided him. After this opening without music, prayer or other benediction came the storm of indignation from the religious papers. Referring to the opening, a Presbyterian minister wrote to a friend:—"It was bad enough to invite Huxley. It were better to have asked God to be present. It would have been absurd to ask them both. I am sorry Gilman began with Huxley. But it is possible yet to redeem the University from the stain of such a beginning." It took some years for the prejudice to wear away, but eventually the idea of an undenominational university controlled by laymen was accepted as reasonable, and Johns Hopkins' foundations became renowned as places of freedom and progress.

SOCIETIES AND ACADEMIES.

London.

Royal Society, January 30.—"The Distribution of Magnetism as Affected by Induced Currents in an Iron Cylinder when Rotated in a Magnetic Field." By Ernest Wilson, Professor of Electrical Engineering, King's College, London. Communicated by Sir W. H. Preece, F.R.S.

One object of this research was to investigate the effect which induced currents have upon the distribution of magnetism in an iron cylinder when rotated about its longitudinal axis in a magnetic field, the direction of which was normally at right angles to the axis of rotation. The variables dealt with were the total flux of magnetism between the poles of the magnet, and the speed of rotation of the cylinder. By threading insulated copper conductors through holes drilled in a plane containing the longitudinal axis, E.M.F.'s due to the rate of change of induction at different depths have been observed, and therefrom the intensity of induction has been found. The cylinder had a diameter of 25·4 cms., and its length was 25·4 cms. It was rotated by aid of a worm and worm wheel. Periodic times of 360, 180, 90, 45 and 22·5 seconds have been dealt with, and the normal induction density B in the cylinder has been varied from about 170 to 21,000 C.G.S. units per sq. cm.

With small magnetic force, and a periodic time of 45 seconds, the value of B at the centre of the cylinder is important as compared with its value at the surface, and the phase-displacement between the two is relatively small. With intermediate magnetic force, corresponding to high average permeability in the iron, the value of B at the centre became relatively small, accompanied by considerable phase-displacement. In fact, with 22·5 seconds periodic time, B at the centre was totally reversed in sign with regard to B at the surface, or the lag was 180°. With large magnetic force, B at the centre again became important, and the phase-displacement was again small. With a periodic time of 360 seconds, the disturbances above described still existed, but they were small. Similar effects to the above were observed in the case of an iron cylinder subjected to alternating magnetic force.

The conclusion was that with an alternating magnetic force applied axially to a cylinder of given diameter, the effects were more severe than in the same cylinder (of length equal to diameter) when rotated in a magnetic field as above described at the same frequency, and for corresponding values in the surface induction density. The results of these experiments were applied to similar cylinders of different dimensions by an application of the law of squares. The effects of induced currents in the armature of a certain class of induction motor were dealt with. It is shown that plates of iron 0·1 cm. thick experience no serious deviation from uniform distribution when rotated in a magnetic field, the direction of which was in the plane of the plate, at frequencies lower than about 180. Referring to Lord Kelvin's computation that the earth's magnetism is travelling round the earth in the direction of the sun with a periodic time relatively to the earth of 960 years, it is pointed out that in a cylinder similar in all respects to the one experimented upon, but having a diameter equal to that of the earth, a periodic time of 960 years would produce similar magnetic and electric events as would be observed in the above cylinder if it could be rotated with a periodic time nearly two million times as fast as the fastest speed in these experiments. On the other hand, with a cylinder 0·0000001 cm. diameter, 7×10^{14} revolutions per second would be required to produce the disturbances observed in these experiments.

March 6.—"The Differential Equations of Fresnel's Polarisation-vector, with an Extension to the Case of Active Media." By James Walker, M.A. Communicated by Prof. Clifton, F.R.S,

In many problems of optics we require the differential equations that the polarisation-vector has to satisfy, and the surface conditions that subsist at the interface of different media. These may be deduced from the principle of interference combined with the experimental laws of the propagation of light, without making any assumption respecting the character of the ether and the nature of the luminous vibrations. In crystalline media, Fresnel's theorem of the ellipsoid of polarisation affords the required relations between the wave-velocity and the directions of the wave-normal and of the polarisation-vector; in the case of active media, extensions of this theorem lead to similar equations giving the wave-velocity in terms of the direction-cosines of the wave-normal and the complex direction-cosines of the vector of a stream of elliptically polarised light. The differential equations are then deduced by applying the principle of interference. The surface conditions are obtained by assuming that the transition between two media takes place by a rapid continuous change of their properties and that the differential equations hold within the region of variation.

Royal Astronomical Society, March 14.—Dr. J. W. L. Glaisher, president, in the chair.—The secretary read a paper by Dr. Mitchell, of New York, on the flash spectrum at the Sumatra eclipse of May, 1901. Mr. Fowler gave reasons for doubting the correctness of Dr. Mitchell's view that the flash spectrum represents the upper portion of the layer of gas which, by absorption, gives the Fraunhofer lines.—A paper by Prof. Barnard on Nova Cygni, 1876, was partly read.—Mr. Maw presented a series of double star measures made by him in the years 1899-1901.—The Astronomer Royal presented a paper on new variable stars found at the Royal Observatory during the measurement of plates for the Astrographic Catalogue, and also a series of measures of double stars made at Greenwich with the 28-inch refractor. Prof. Turner described an instrument for rapidly comparing two star plates of the same region, and Mr. Lewis spoke upon the orbit of δ Equulei.—Mr. Maunder gave an account of a paper from the Royal Observatory on the mean areas, &c., of sun-spots in the year 1901, and referred to the apparent connection between the large sun-spot of May 1901 and the disturbed portion of the corona as shown on the eclipse photographs.—Mr. Dyson gave a summary of a paper from the Royal Observatory on the parallax and proper motion of Nova Persei.—Mr. H. C. Plummer partly read a paper on the images formed by a parabolic mirror.—Mr. Whittaker read a paper on periodic orbits in the restricted problem of three bodies, being an extension of the paper read at the January meeting. The problem considered was that of finding the motion of a small planet under the attraction of the sun and a large planet, the latter being supposed to move in a purely circular orbit. Two theorems were communicated in the paper, the first giving a criterion for the existence of periodic orbits and the second being concerned with the value of an integral taken over the orbit.—A note by Mr. Fourcade was read, on Prof. Turner's recent paper on photographic surveying.

Mathematical Society, March 13.—Major P. A. MacMahon, F.R.S., vice-president, and subsequently Lieut.-Col. A. Cunningham, R.E., in the chair.—The Rev. J. Cullen read a paper on the solutions of a system of linear congruences. The object of the paper is to give a graphical process for obtaining the solutions of a system of linear congruences under a given limit; and the scope of the paper consists in establishing and explaining four simple rules to be employed in applications of the process; the process yields new results in the resolution of high numbers, having factors of unknown form, into sums of squares.—Mr. G. H. Hardy communicated a paper on the theory of Cauchy's principal values. This paper is the third of a series concerned with the interpretation, and the use in analysis, of such divergent definite integrals as have in Cauchy's sense a principal value; it deals in particular with the possibility of differentiation and integration under the sign of the principal value, and gives sufficient criteria for the validity of the interchange of order of the limiting operations involved; the theory is illustrated by numerous examples of the calculation of definite integrals by processes which had not previously been proved to be valid.—Mr. R. Hargreaves read a paper on algebraic relations between zonal harmonics of different orders. The coefficients in any sequence equation connecting zonal harmonics are rational functions of the orders of the harmonics, and these functions also are connected by sequence equations; the latter equations are developed systematically.—Dr. F. S. Macaulay made a preliminary communication of some results in the theory of elimination. He showed how to express the resultant of any number of homogeneous equations in any number of variables as a quotient of two determinants.—The following paper was communicated from the chair: Mr. J. Buchanan, on quadrature formulæ. The formulæ are obtained by the use of methods of interpolation based upon central differences.

Entomological Society, March 5.—The Rev. Canon Fowler, president, in the chair.—Mr. L. B. Prout exhibited, on behalf of Mr. J. P. Mutch, *Vanessa* (*Eugonia*) *polychloros*, L., a ♀ bred by Mr. H. Baker from pupa from Stowmarket, Suffolk, the ground-colour much darkened and the black markings somewhat enlarged; *Chrysophanus phlaeas*, L., an aberration (captured in the Isle of Wight, August, 1901) much suffused with dark colour, especially at outer margin and on hindwings, only a very small patch of the red colour remaining at the inner angle of the latter; *Agrotis puta*, Hb., a perfectly halved gynandromorphous example, and *Noctua sobrina*, Gn., an aberrant specimen with white antennæ and a somewhat hoary appearance on the forewings, taken in East Aberdeenshire, August, 1900.—Mr. A. Bacot exhibited a series of *Malacosoma castrensis* and a series of *M. neustria* for comparison with a hybrid brood, resulting from a pairing between a male *neustria* and a female *castrensis*. This was the first time any exhibition of experiments of the kind had been made before the Society by British investigators, though Mr. Merrifield had shown a number of crosses bred by Herr Standfuss. The sexes, as exhibited, were very clearly distinguishable, and there was not much tendency to gynandromorphism, though of sixty or seventy specimens almost every ♀ showed some signs of ♂ coloration.—Mr. O. E. Janson exhibited a pair of *Stephanocrates dohertyi*, Jord., a Goliath beetle discovered by the late W. Doherty in the highlands of British East Africa.—Dr. T. A. Chapman exhibited cocoons of a Limacodid moth from La Plata, with empty pupa-cases of a dipterous parasite of the genus Systropus. The resemblance between the two pupa cases is, however, not merely of appearance, but functional also. The moth-pupa, *i.e.* the moth itself inside the pupa-case, almost certainly by inflating itself with air, to secure greater size and a stiffened epiderm as a basis of muscular action, exerts an end-to-end pressure within the cocoon, and so forces off a lid. The Systropus breaks off a similar lid, no doubt by similar end-to-end pressure to that exerted by the moth, Diptera having highly developed the habit of inflating themselves with air, at emergence from the pupa. This pupa also has a beak very like that of the Limacodid, but even stronger and sharper.—Mr. J. E. Collin, in further illustration of Dr. Chapman's remarks, exhibited specimens of *Systropus*, sp. ? from Buenos Ayres, parasitic on a Bombycid Lepidopteron (*Limacodes ?*). This, he said, was possibly the same as Dr. Chapman would have reared from his cocoons. The species was apparently undescribed, but most allied to *S. brasiliensis*, Meg.—Prof. E. B. Poulton, F.R.S., read a paper entitled "Five years' observations and experiments (1897-1901) on the bionomics of South African insects, chiefly directed to the investigation of mimicry and warning colours," by Guy A. K. Marshall, with appendices containing descriptions of new species, by W. L. Distant and Colonel C. T. Bingham.—Mr. Malcolm Burr contributed a monograph of the genus *Acrida* with notes of some allied genera and descriptions of new species—Dr. D. Sharp, F.R.S., contributed three papers by Mr. R. C. L. Perkins, respectively entitled: (*a*) Notes on Hawaiian wasps, with descriptions of new species"; (*b*) "Four new species and a new genus of parasitic Hymenoptera (Ichneumonidæ) from the Hawaiian Islands"; and (*c*) "On the generic characters of Hawaiian Crabronidæ: four new genera characterised."

Geological Society, March 12.—Sir Archibald Geikie, F.R.S., vice-president, in the chair.—The crystalline limestones of Ceylon, by Mr. Ananda K. Coomára-Swámy. The crystalline rocks of Ceylon may be divided into three series: (1) The older gneisses; (2) the crystalline limestones; (3) the granulites (charnockite series)—pyroxene-granulite, leptynite, &c. A local subdivision of this series is the Point de Galle group—wollastonite-scapolite-gneisses, &c. The crystalline limestones of Ceylon are intimately associated with the banded pyroxene- and acid granulites (charnockite series). They form bands with outcrops from a few feet to more than a quarter of a mile in width, interbedded with the granulites. The limestones themselves have a banded structure (foliation) parallel to that of the granulites and to the boundaries. Although the relation of the granulites to the limestones is on the whole intrusive, the two rocks in their present condition are essentially contemporaneous, and seem alike to have consolidated from a molten magma. The calcite occurring in the granulites near the contact has all the appearance of an original mineral. The foliation of the limestones is regarded as a sort of flow-structure, and corresponds with that of the granulites to which it is always parallel. That the foliation does not result from the action of earth-movements on a solid rock is shown by this, that the very minerals whose variable distribution is one of its chief causes have certainly not been affected by deforming earth-movements, nor are they such as to have been produced by these; moreover, in this respect a distinction cannot be made between the limestones and granulites, which would necessarily have suffered alike had they been subjected to deforming strains since the consolidation of the latter. The original nature of the limestones is less evident; they may have been sedimentary or tufaceous, and, if so, subsequently softened and metamorphosed; or possibly *ab initio* truly igneous rocks, and related to the charnockite-magma. Reasons for and against these views are given. The relations between the crystalline limestones and nepheline-syenites of Alnö have suggested to Prof. Högbom that perhaps the limestone may have been a product of the nepheline-syenite magma there. The author feels sure that the crystalline limestones of Ceylon have not arisen by the alteration of the basic lime-silicates of the pyroxene-granulites.—On Proterozoic gasteropoda which have been referred to Murchisonia and Pleurotomaria, with descriptions of new subgenera and species, by Miss

Jane Donald. Many of the Palæozoic shells referred to Murchisonia do not agree with the type, and there are at least two separate groups distinguished by the outer lip. The typical group has a slit, the other merely a sinus. From the material at present available, in the British Isles as well as in America and the Baltic provinces, elongated forms with a sinus precede those with a slit. So far, no light is thrown on the question as to whether Murchisonia and Pleurotomaria were derived from the same stock, nor has the author yet met with any specimens showing a transition from sinus to slit.

PARIS.

Academy of Sciences, March 17.—M. Bouquet de la Grye in the chair.—Some remarks on the periods of double integrals and the transformation of algebraic surfaces, by M. Emile Picard.—Studies on vegetable earth, by M. Th. Schlœsing. The earth is separated by a process of levigation into fractions, which are analysed separately. The most striking fact obtained by this method of working is the rapid change in the proportions of iron and phosphoric acid in the fractions. The ratio of iron to phosphorus, however, remained practically constant.—On the culture of the fodder beet, by M. P. P. Dehérain. The method of cultivation of the beet, which aims only at producing roots of the largest size, is faulty, as analyses of such roots show that they contain an undue amount of water and nitrates. By planting out so that smaller beets are obtained, it was found that although the gross weight per hectare was somewhat less in the latter case, the weight of dry material was greater and the loss of nitrates was reduced.—M. Yermoloff was elected a correspondant in the Section of Rural Economy in the place of the late Sir J. B. Lawes.—On regular groups of finite order, by M. Léon Autonne.—On the theory of algebraic functions of finite order, by M. Beppo Levi.—On the conservation of refractive energy in mixtures of alcohol and water, by M. A. Leduc. The refractive indices of mixtures of alcohol and water can be calculated from the refractive indices of the two constituents within the limits of experimental error, allowance being made for the contraction which takes place on mixing the two liquids.—On the mobility of the ions in gases, by M. P. Langevin.—Research on a unit for measuring the force of penetration of the X-rays and for their quantity, by M. G. Contremoulins. The principle adopted for these measurements is the comparison of the intensity of illumination of a fluorescent platinocyanide screen with a screen artificially illuminated with a light of known intensity.—The heat of reaction between bodies in the solid and gaseous state, by M. Ponsot.—The heats of solution of solid and liquid ammonia taken at about -75° C., and on the latent heat of fusion of solid ammonia, by M. G. Massol. The method adopted was to dissolve first liquid ammonia and then solid ammonia, both as near -75° C. as possible, in water in a calorimeter; the latent heat of fusion was thus obtained as the difference between these two results. The value thus found for the latent heat of fusion for a gram-molecule of solid ammonia was $-1{\cdot}838$, approximating to that of water, $-1{\cdot}43$.—The volumetric estimation of thallium, by M. V. Thomas. The author has modified the iodometric method of Feit, in such a manner as to avoid the conversion into the sulphate. Test analyses are given showing the accuracy of the method as modified.—Acid and basic sulphates of neodidymium and praseodidymium, by M. Camille Matignon. Four new sulphates are indicated, their properties determined, and their thermochemical relations examined.—A method for the alkalimetric estimation of disodium-methylarsenate or arrhenal, by M. A. Astruc. The method suggested is based on the fact that in the presence of rosolic acid one molecule of this substance requires one molecule of a monobasic acid for neutralisation.—On some derivatives of arabinose, by M. G. Chavanne. The exact conditions are given for the production of a pure substance in the interaction of arabinose with acetyl chloride and bromide. The preparation and properties of the phenylhydrazone of arabinose are also described.—On the supposed binaphthalene-glycol, by M. R. Fosse. It is shown that the body described as binaphthalene-glycol is in reality dinaphthoxanthydrol, and that the derivatives of the supposed glycol are similarly constituted.—On the pseudo-acids, by M. P. Th. Muller. For a true acid the difference of the molecular refractions of the acid and its sodium salt should be equal to the difference of the molecular refractions of sodium hydrate and water, and for a large number of acids of she order of acetic this has been found to be the case, the value of this constant difference being about $1{\cdot}55$. Any marked variation from this value would indicate that the constitution of the acid was different from its neutral salt. This the author has found to be the case for a certain number of isonitroso-compounds of the fatty series.—On the classification of the Cercomonadines, by M. Louis Léger.—The use of organic arsenic and phosphorus compounds in the treatment of tuberculosis, by M. A. Mouneyrat. Sodium methylarsenate taken alone has no effect in preventing the excessive elimination of phosphorus in tuberculosis. But by the administration of this salt, together with an easily assimilable phosphorus compound, such as nucleinic acid, the desired result was obtained. A marked improvement was noticed in less than a month, with gain in weight, increase in appetite, disappearance of the nocturnal sweats, and of fever. At the end of a month or six weeks the sputum became normal, losing its purulent character and, in the majority of cases, with the disappearance of the tubercle bacillus.—The action of temperature on the mineral absorption in etiolated plants, by M. G. André. It was found that the quantity of ash in 100 parts of the dried material is always greater in the normal plant than in the plant etiolated at 15° C.; the reverse was the case in an etiolated plant growing at 30° C., the difference being entirely represented by silica.—On the assimilation of carbon by a green algæ, by M. P. G. Charpentier.—A bacteriological study of the *massif* of Mont Blanc, by M. Jean Binot. The number of germs in the air at the summit of Mont Blanc is extremely small, varying between four and eleven per cubic metre, and increases as the valley is approached. The ice, snow and water on the mountain were made the subject of a separate study. A virulent pyocyanic bacillus was isolated from the ice at the summit, and an exceedingly pure water taken near the Montanvert showed twelve colonies of a virulent *Bacterium coli* per cc.—Experimental researches on the mental life of a xiphopage, by MM. N. Vaschide and H. Piéron.

DIARY OF SOCIETIES.

WEDNESDAY, APRIL 2.

SOCIETY OF PUBLIC ANALYSTS, at 8.

THURSDAY, APRIL 3.

RÖNTGEN SOCIETY, at 8.30.—X-ray Diagnosis of Renal Calculus: Dr. Ch. Leonard.

LINNEAN SOCIETY, at 8.—On the Composite Flora of Africa: W. Spencer Moore.—A Halonial Branch of *Lepidophloios fuliginosus*: Prof. F. E. Weiss.

FRIDAY, APRIL 4.

GEOLOGISTS' ASSOCIATION, at 8.—Klondike, its Geology and Mining: Prof. H. A. Miers.

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