THURSDAY, AUGUST 12, 1897.

THE BREEDING OF SEA FISHES.

The Life-Histories of the British Marine Food-Fishes. By W. C. McIntosh and A. T. Masterman. Pp. 516. (London: Clay and Sons, 1897.)

THE pursuit of economic zoology has never been so keenly taken up in this country as has the corresponding aspect of botany. Whether it is that the purely intellectual problems of zoology are relatively more fascinating than those offered by the study of vegetables, or owing to some more recondite reason, it is certain that zoologists make less capital out of the practical application of zoological science to human needs than do the botanists. There is a fine field open for an economic entomologist who has the energy to avail himself of the endless variety of new material, in the form of "noxious insects," which is almost daily discovered in our remoter colonies and tropical territories. The life-history of the animals which serve man as food is another and equally important branch of economic zoology.

In so far as fishes are concerned, there is relatively a good deal of activity among British zoologists in regard to this matter. The explanation of this activity is to be found in the fact that both the British and Colonial Governments have instituted highly salaried "inspectorships" and "commissionerships" of fisheries, and there is a chance that here and there a zoologist, who has written a book on fishes, will be appointed to one of these posts instead of the more usual needy politician or poor relation of a peer. Moreover, since the great Fisheries Exhibition of 1883, laboratories have been organised at different points on the British coast, by the aid of local or imperial funds, for the purpose of obtaining that knowledge of the ways and habits of marine food-fishes, which is a necessary preliminary to legislation in regard to modes and times of fishing and the general regulation of the fisheries industry.

No one has been more active than Prof. McIntosh, of St. Andrews, in building up a sound scientific knowledge of the breeding and habits of marine food-fishes. It is a matter for congratulation that he should have determined to bring together the results of work done under his auspices in a handy volume. He has obtained the co-operation of an able young zoologist, Mr. A. T. Masterman, and the result is a book which, in many ways, resembles that recently published by Mr. Cunningham on British marketable fishes (Macmillan, 1896), but has its own distinctive character and scope. The volume by Prof. McIntosh and Mr. Masterman appears to be less directly addressed to the general public than that of Mr. Cunningham, and is very largely, as the authors state in their preface, founded upon the large quarto memoir, by McIntosh and Prince, published in the *Transactions* of the Royal Society of Edinburgh. Other sources are, however, made use of, and the researches of Cunningham and of Holt, who carried out their investigations as officers of the Marine Biological Association of the United Kingdom, are very freely quoted. Recent investigations by German, French and Italian naturalists are also duly noticed. The book is thus (except for the lack of bibliographical references) a valuable guide to the present state of knowledge as to the breeding of marine fishes, and by the professional naturalist will be found to serve in some respects as a supplement to the book produced by Mr. Cunningham under the direction of the Marine Biological Association.

A few words of criticism suggest themselves. The matter brought together in such a book as the present necessarily consists of a great variety of detail as to the superficial appearance of many different species of fishes at various stages of growth from the egg, as well as of observations on the eggs themselves. It is difficult to give any consistent form or purpose to the exposition of such details, since morphology is not the subject-matter of the treatise. Lithographic plates, with many coloured figures, are used by the authors to bring details of outline and colour before us. But it must be admitted that at present the subject is in a very primitive condition, when all or nearly all that we can hope for is a disconnected series of observations. It will be the work of later days, after a much greater number of observations has been made, to bring the facts together under larger and smaller generalisations.

Under these circumstances it is surely a mistake of the authors to say, as they do, that McIntosh's and Prince's "Researches" "may be said to have attempted for Teleosteans what the lamented Frank Maitland Balfour did for Elasmobranchs." The resemblance seems to me to be absolutely wanting. Balfour described, by means of sections, the cellular embryology of "an Elasmobranch," using only about six species, according to convenience, in his work. His object was not to describe the superficial appearance of young Elasmobranchs of all kinds, and he did not do it, or make any pretence of doing it. His object was to trace the genesis of the organs of the vertebrate body, and he made discoveries of fundamental importance for vertebrate morphology as to the origin of the fins, the notochord, the somites, and the renal organs. McIntosh and Prince have not attempted any work of the kind. They simply give figures of transparent eggs and larvæ of Teleosteans; and whilst thus adding to the observed material of "natural history," can not be said, any more than can the authors of the present volume, to have arrived at a single conclusion of importance to morphology, or to have worked with either the technical methods or the scientific aim of Frank Balfour.

Although one must maintain that such work as that recorded in the present book, and in the "Researches" of McIntosh and Prince, differs in every way from that done by Balfour for Elasmobranchs, one does not imply that it is not useful and excellent work of its kind—another kind. The morphology of the Teleostean as determined by embryology is a much more laborious task than the sketching of pigment-spotted embryos, and has been but very partially attacked as yet; though Grassi, Ryder, Harrison and others have carried on the work of the older observers in regard to such important points as the vertebral column and fin-skeleton.

In their preface the authors say that the life-history of eighty or ninety species of British marine food-fishes are dealt with in their volume.

"Then (in 1883) the life-history of not a single British marine food-fish was known, at least from observations in our country. In the present work between eighty and ninety species are dealt with, the majority of the important forms more or less exhaustively."

This is obviously an error. From some points of view, it may be convenient to regard every marine fish as a "food-fish." The economic importance of observations on the stickleback is increased if we reckon that pugnacious mite as a "food-fish," and a list of contributions to the solution of practical fishery problems is, by such reckoning, enlarged to imposing dimensions. But in the ordinary sense of the term "food-fish," so many as eighty do not exist in British waters, and only a fractional part of these have any economic importance. The word "exhaustively" is also open to some objection; but as we are given the choice of "more" or "less" in relation to it, we can not actually disagree with the authors' statement.

The preface seems also to me to be deficient in that, whilst the authors there make a profession of acknowledging the sources from which they have gained information, and of recognising the activity of other laboratories and other workers than those to be met with at St. Andrews, yet in the most marked manner all allusion to the Plymouth Laboratory and the publications of the Marine Biological Association is omitted. After making a eulogistic statement as to the importance of the work done at the St. Andrews Marine Laboratory, followed by a list of those who have worked there, the authors at once proceed to say:

"For many interesting papers connected with the Fisheries we have to thank our fellow-workers in the maritime States of the continent, in America, and the British Colonies."

The suggestion to an uninformed reader is that the only work on these subjects, done elsewhere than "in the maritime States of the continent, in America, and the British Colonies," has been done at St. Andrews. This is very far, indeed, from a truthful suggestion, and is surely due to some oversight on the part of Prof. McIntosh, who has served on the Council of the Marine Biological Association, and is acquainted with the researches carried out on the west coast of Ireland, at Plymouth, in the North Sea, in the Clyde by a host of able investigators remote from his charming little laboratory. Seeing that the authors' book owes a large and important part of its value to the frequent quotations from the *Journal* of the Marine Biological Association, and the work carried on by Mr. Cunningham at the Plymouth Laboratory, and Mr. Holt at Grimsby, it would have been more gracious on their part to have given credit to the Plymouth Laboratory, and the naturalists working in connection with it, when they professed to make acknowledgments to colleagues and predecessors. The work of these investigators, as also of Green, Bateson, Heape and others is made use of, but often without citation of the author's name, and in almost all cases without reference to the original place of publication; so that as a guide to the literature of the subject, the book fails. The index is constructed in a very startling way. One looks up "Cunningham", in order to ascertain how often, and in what terms, his work has been quoted by the authors, and this is what one finds—"Cunningham, J. T., 18, 92, &c." The use of "&c." as a page-reference in an index is altogether new. It does not seem to me to be a real improvement upon the old plan of giving the numbers of the pages to which reference is desired. It is, however, I am sorry to say, indicative of the spirit in which British cotemporary investigators have been treated by Prof. McIntosh and Mr. Masterman.

In a recent review, written by a St. Andrews man, Mr. Cunningham was rebuked for not having referred to Prof. McIntosh and the St. Andrews Laboratory with sufficient frequency in his work on "British Marketable Fishes." It seems that the treatment of the Plymouth Laboratory and *Journal* of the Marine Biological Association and its staff as "&c.," is the retort of St. Andrews. I am sorry, because I have a personal interest in, and regard for both, the Northern and the Southern institution. It is to be hoped that those who have the disposal of fishery appointments at home and abroad will read the productions emanating both from Plymouth and from St. Andrews, so as to be under no illusion as to the non-existence of either. E. RAY LANKESTER.

THE CALCULUS FOR ENGINEERS.

The Calculus for Engineers. By John Perry, F.R.S. Pp. vi + 378. (London and New York: Arnold, 1897.)

HERE is a new departure; a book on the calculus written without any reference to the examination room, solely with the object of teaching the engineer, first that he is already in possession of the fundamental ideas of the calculus, and accustomed to use them, then that these ideas can be easily put into exact mathematical formulæ, and ultimately that the advantages of the formal calculus thus obtained are great indeed, and can be reaped without an enormous amount of previous knowledge.

Prof. Perry does not treat the calculus as something which requires a number of altogether new notions and a great deal of subtle reasoning to be instilled into the mind of the reader. With the instinct of a true teacher, he sets himself to develop notions already in the mind of the learner, and by constant reference to concrete cases leads up to the mathematical ideas of the differential-coefficient and the integral. The former is not defined, as in the ordinary text-books, for any function $y = f(x)$, but the simplest function $y = a + bx$ is considered and plotted out. In fact, Chapter i. begins with the plotting of curves on squared paper, analytical conics or coordinate geometry not being supposed known. It is found that all such equations which have the same value for b have the same *slope*. Hence b is called the slope of the line, and this is denoted by dy/dx. This is followed by exercises on the straight line, familiarising the reader with the notion of slope, and showing how former knowledge of algebra and trigonometry comes in.

Only after this is the differential-coefficient for the simple case treated generally by giving x and y small increments, and therefrom calculating dy/dx. This process of starting with the concrete, and of considering the abstract question only when all ideas involved have been called into life in the student, is altogether to be praised. Thus a sure foundation is laid.

There follows next the example of a train "going at thirty miles an hour." The notion of velocity (why not call it speed ?), and with it that of acceleration, is made mathematically exact. From the law of falling bodies $s = 16{\cdot}1t^2$, the velocity is next deduced. Here the "limiting value" is introduced, and the ordinary process criticised. To quote Prof. Perry :—"Some people have the notion that we are stating something that is only approximately true ; it is often because their teacher will say such things as 'reject $16{\cdot}1\delta t$ because it is small,' or 'let dt be an infinitely small amount of time,' and they proceed to divide something by it, showing that although they may reach the age of Methuselah they will never have the common sense of an engineer." It is the art of taking for granted what the "common sense of an engineer"—that is, of any man who has been obliged to think seriously about the things before him, and not only about how to fill so many sheets of paper in a certain time with answers—instinctively knows to be true, and of leaving out of account all the considerations which superfine criticism of minute and exact abstract considerations introduce, which Prof. Perry's book specially emphasises.

After such preliminaries, interspersed with remarks on many things, such as force and weight, we have the equation $y = ax^2$ in the abstract, and from it dy/dx and d^2y/dx^2 with their integrals and applications to uniformly accelerated motion, the energy of elongated springs, to Ohm's law and to transformers, till at last the case

$$y = ax^n$$

is considered. Here the binomial theorem is supposed to be known in its general form. This assumption is one of the few points where a greater simplification might possibly be introduced by giving a few examples where n is 3, $\frac{1}{2}$, -1 or -2, to show that the formulæ are right. I believe that the learner would have greater faith in the result obtained by seeing it verified in special cases, and this is easy. In the integration of x^n the case $n = -1$ is here *assumed* to give log x, the proof being left to Chapter ii.

At the end of Chapter i. (nearly half the book) there are applications in the most varied form of the simple function x^n ; and "x^n" forms an appropriate heading to the chapter. Partial differentiation is also introduced as a thing only to be mentioned in order to be understood. We are so much accustomed to have most of the simple functions at our disposal from the beginning, that we do not altogether realise how much can be done with the x^n alone. The applications given by Prof Perry are of a most varied kind, very much more so than those in the ordinary text-books, which almost exclusively treat of problems either purely mathematical or geometrical. The first example relates to a perfect steam engine, then come a study of curves, maxima and minima, strength of rectangular beams, electrical problems, areas, volumes, centres of gravity, moments of inertia, curvature, bending, fluid motion and level surfaces, magnetic field, the two elasticities, laws of thermodynamics and entropy, only to mention some of the headings which strike the eye in turning over the pages. Differential equations, ordinary or other, are introduced without hesitation.

It will be seen from this that the course pursued in this book is very different indeed from that of ordinary text-books. The aim is everywhere to go on slowly with the purely mathematical work, but to make the student feel at each step that he has gained actual and useful knowledge which leads at once to important practical applications ; and also to show from the beginning the naturalness of the processes, and to disabuse the beginner of any preconceived idea that the calculus is brimful of difficult and superfine abstractions.

The second chapter contains the compound interest law and the harmonic function ; it is headed "e^x and sin x." The exponential theorem is assumed to be known. This is followed by a new series of applications, including Newton's law of cooling, slipping of a belt over a pulley, and so on ; and some problems are studied of a body vibrating, introducing both forced vibrations and damping. Mathematical formulation of the problem leads to a linear differential equation of the second order with constant coefficients. The problem of two electric currents with resistance and self- and mutual-induction leads to an equation exactly similar ; a solution of one of these problems contains, therefore, that of the other. The mechanical problem, as being more easily followed, is worked out fully ; transformers are also dealt with. In fact, both the mechanical and the electrical engineer will get from the study of these first two chapters a great deal of information on the subject he is interested in.

There is a third chapter where more compound functions are considered. It will be remembered that in the first two chapters functions of functions are practically left out, and only the simplest and fundamental functions x^n, e^x and sin x are introduced. The author now recommends the student to supplement the knowledge so far gained by reading the ordinary treatises on the calculus ; but he gives a short outline of the results in his third and last chapter, which has the characteristic heading "Academic Exercises." But even here, in a little more than 100 pages, he goes beyond what is found in most elementary treatises ; for he introduces a good many differential equations, and even zonal harmonics and Bessel functions are touched upon. In the middle of the chapter there is a page devoted to Osborne Reynolds' "Theory of Lubrication of Journals," where the essence of Reynolds' complicated investigation is given in a marvellously simple manner.

Of course, from a purely mathematical and academic point of view, it would be easy to find fault, and perhaps to condemn, the whole work. But the book is not meant to be academic ; in fact, it is from beginning to end a protest against the academic treatment of mathematics, and as such we welcome it most heartily.

We recommend the book not only to the engineering student and to all who want to learn the calculus, but, indeed, especially to teachers of the subject, who will find many points raised in it to set them thinking, quite apart from the great variety of examples given. We also recommend it most strongly to teachers in the modern or science side of secondary schools. A careful study of the Introduction and the beginning of Chapter i. will give them many hints as to how to make mathematics attractive to those who are not gifted by nature with the ability to follow abstract reasoning, but who are often very capable of understanding things concrete. They will find also much material for home work.

If the methods here used were more generally introduced into the teaching of mathematics at school, the number of boys declared incapable of learning mathematics would, we feel sure, decrease to an astonishing degree. And indeed the same methods might probably be used in other subjects, and then the science side of secondary schools might lift its head and cease to be the refuge of those who can "neither learn classics nor mathematics." O. HENRICI.

TRAVELS IN THE INTERIOR OF SOUTH AFRICA.

The New Africa: a Journey up the Chobe and down the Okovanga Rivers: a Record of Exploration and Sport. By Aurel Schulz, M.D., and August Hammar, C.E. Pp. xii + 406. (London: Heinemann, 1897.)

THE principal title of this work can hardly be said to be quite applicable to its contents, seeing that the journey it describes was made no less than twelve years ago, before the "scramble for Africa" had reached its full height. In spite, however, of the length of time which has elapsed since the events recorded took place, there is much in Dr. Schulz's pages which well repays perusal. To the class of readers which looks chiefly for an agreeable narrative of sport and adventure, it offers abundant attractions, while those who prefer more solid matter will find scattered through it a considerable amount of information on the country passed through.

Dr. Schulz, who shortly before his journey had qualified in medicine in Berlin, set out from Natal in March 1884, accompanied by Mr. Hammar, on an exploring expedition into the remote interior of South Africa. Proceeding through the Transvaal and Khama's country to the Zambezi, the travellers next ascended the Chobe, its western tributary, to nearly 17° S. lat., and crossed over to the Kubango or Okovanga (this, and not Okavango, is Dr. Schulz's spelling), the principal feeder of Lake Ngami. This river was followed down to the lake, and Khama's country was reached on the return journey by way of the Zuga. A great part of this route led through country rendered classic by the early labours of Livingstone, and since traversed by a host of sportsmen and explorers; but a certain amount of new ground was broken in the region of the Chobe and Okovanga, and as a careful survey was made by Mr. Hammar, some real addition to our knowledge resulted from the journey.

The whole region stretching northwards from Lake Ngami is so level that the rivers form a complex network, the details of which are even now far from completely understood. The confusion is heightened by the fact that several of the streams flow in one direction, or the reverse, according to the time of year. It has long been supposed that the Okovanga sends some of its waters to the Chobe, some finding the connecting channel in the Mababe just west of 24° E. Dr. Schulz claims to have ascertained the existence of another branch of the Okovanga leading to the Chobe. The point of bifurcation was not seen, but an important channel was found to enter the Chobe from the west, and native accounts confirmed Dr. Schulz's suspicion that it came from the Okovanga. The route followed by the expedition led through a barren region of sand-belts, in which the travellers suffered from want of water. The sight of the Okovanga—a fine stream 400 yards broad, of the capabilities of which as a water-way the author expresses a high opinion—was therefore most welcome. It was struck at the town of Debabe or Indala (identical, it appears, with "Andara, or Debabe's town," reached by Green in 1856), and although its course hence to Lake Ngami had previously been explored by that traveller, Andersson and others, Dr. Schulz was able to define, more precisely than they had done, at least the western bank of the series of swamps which mark the course of the river. During this part of the journey the travellers were virtually prisoners, being taken for spies of the Matabele, and conducted under guard to Moremi, chief of the country near the lake, whose people retained no pleasant memory of a Matabele raid to which they had nearly succumbed a few years before. The lives of Dr. Schulz and his party were in some danger for a time, but were saved by the testimony of a child who had been vaccinated by the doctor at Shoshong on the way up.

The book abounds with stories of encounters with the wild animals of South Africa, and gives interesting details illustrating their habits. They were especially plentiful near the Chobe, where their numbers had not yet begun to be thinned by the persecution of sportsmen. One valley is described as having seemed a teeming mass of life, troops of every variety of game appearing to view at the same instant. Dr. Schulz has a good deal to say anent the Mosaros, a desert tribe with which he came in contact, and which he considers a fugitive branch of the Hottentots, distinct from the Bushmen proper, though often called by that name. The book is not provided with an index, but contains a map showing the features of the country along the line of route, with some information on the surface geology. Some of the illustrations give a good idea of the types of country and vegetation common in South Africa.

OUR BOOK SHELF.

Contributions to the Analysis of the Sensations. By Dr. E. Mach, Professor of the History and Theory of Inductive Science in the University of Vienna. Translated by C. M. Williams. Pp. xi + 208. (Chicago: Open Court Publishing Co., 1897.)

PROF. MACH has expressed his approval of this translation of his "Beiträge zur Analyse der Empfindungen." For the most part it has been excellently rendered into English; but occasionally there are sentences that read queerly—*e.g.* "Relatively greater permanency exhibit, first, certain complexes of colours," &c. (p. 2); "Merely its application is not complete" (p. 32); "Different is my opinion with regard to Stricker's views on language" (p. 131); "If the process is over with . . ." (p. 157).

Every one who is interested in psychophysics will welcome an examination of the sensations by a leading physicist, especially when his analysis is so suggestive and his style so delightful as Prof. Mach's. The style is greatly superior to the mode of construction of the book. It would be an exaggeration to say that it is mainly built up of footnotes; but there are three prefaces, two appendices, addenda, and endless footnotes (with supplementary notes to these). On pp. 34–39 we have some 240 lines of footnotes to 34 lines of text! All this makes the book rather irritating reading, although the notes are valuable and often very amusing. Thus, in a note on the permanence and identification of the ego (p. 4), we read:—

"Not long ago, after a trying railway journey by night, and much fatigued, I got into an omnibus, just as another gentleman appeared at the other end. 'What degenerate pedagogue is that, that has just entered,' thought I. It was myself: opposite me hung a large mirror. The physiognomy of my class, accordingly, was much better known to me than my own."

The author adopts a consistent, monistic conception of Müller's doctrine of the "specific energies," assuming that there are as many physico-chemical neural processes as there are distinguishable qualities of sensation, and regards sensations as *the elements of the world*. The principle of continuity (which has its root in an effort for economy) and the principle of sufficient determination (or differentiation) are employed to investigate the connection between psychologically observable data and the corresponding physical (or physiological) processes. It is throughout assumed that there is a complete parallelism between the psychical and the physical—that there is no real gulf between the two. After a highly interesting discussion of the space-sensations of the eye, the difficult subject of time-sensation is attacked; then sensations of tone. Here we have a criticism of Helmholtz's analysis of the characteristic sensation corresponding to each musical interval, and a new hypothesis (containing a more positive factor in the explanation than the mere absence of beats) is developed at some length.

In spite of its modest dimensions the book is one which no future writer on the subject can afford to neglect. The physicist will find in it much to stimulate inquiry. It offers a refreshing contrast to much that is written on psychology in the originality of its views, of the observations on which they are based, and of the experiments which are devised to test them. *pv.*

Euclid, Books I.–IV. (The University Tutorial Series.) By Rupert Deakin, M.A. Pp. viii + 308. (London: W. B. Clive, Univ. Corres. Coll. Press, 1897).

OF the numerous books which have appeared in the last few years on the propositions of Euclid, each has been put forward as possessing some particular feature of excellence. The writers of these claim, in some cases, that the student cannot have too much detail and explanation given to him in the text, while others aim at a pure cut and dried edition with a great number of accompanying exercises. Each of these types may have their good qualities, for the successful teaching of Euclid is by no means an easy task.

In the book before us the author has, to a great extent, struck a mean between both these lines. His aim has been to lay the proof of each proposition concisely, and yet not too elaborately, before the student, without rendering the proposition too long to cause perplexity and bewilderment. A few easy exercises are added after each proposition, on which the student is advised to exercise his ingenuity.

At the conclusion of each book are inserted a useful series of notes bearing on the propositions, pointing out the chief points of connection and difference between each; then follows a brief but clear summary of the results arrived at in the book under discussion. Teachers might make the students familiar with this summary at an earlier period; and if this be done judiciously, a general survey of the propositions, showing how they are connected with one another, would render the subject more interesting.

Further, some important additional propositions and sets of miscellaneous riders, arranged under different headings, are added, some of which should always be attempted.

The author having had more than twenty years' experience in teaching this subject to both large and small classes, the chief difficulties that are generally met with have received special attention. As a class-book the volume should find much favour.

The Voyages made by the Sieur D. B. to the Islands Dauphiné or Madagascar and Bourbon or Mascarenne in the Years 1669, 1670, 1671 *and* 1672. Translated and edited by Captain Pasfield Oliver, late Royal Artillery. With facsimile maps and illustrations. Pp. xl + 160. (London: David Nutt, 1897.)

THIS little volume might well have been produced by the Hakluyt Society, with the publications of which it is uniform. It is the translation of a rare French book, describing the voyages of one Dubois in the seventeenth century. The translation well reflects the quaintness of the original, although the attempt to imitate the English style and spelling of two centuries since are not always very happy. Captain Oliver has supplied an introduction tracing the history of Dubois, and of the French colonies in the islands of the Indian Ocean during his lifetime; as well as a series of notes on various points mentioned in the text. Apart from the historical interest attached to all early travels the narration of the Sieur D. B. has a certain original value, as he describes from his own observations several of the extinct birds of Réunion, especially the *Solitaire* and *Oiseau bleu*, which were contemporaries of the Dodo of Mauritius, and closely resembled that bird in their habits. These descriptions have long since been fully discussed by ornithologists, both in France and England.

The book is illustrated by a photograph of the surviving giant tortoises which have been removed from the Mascarenes to Mr. Rothschild's park at Tring, and drawings of a number of birds, together with reproductions of modern photographs of the people and products of Madagascar. In view of the renewal of French colonisation in Madagascar, the shrewd observations and far-seeing advice of the old traveller may be worthy of attention. The book well deserved translation, and Captain Oliver is to be congratulated on the excellent manner in which he has brought it out.

Elementarcurs der Zootomie in fünfzehn Vorlesungen. Von Dr. B. Hatschek und Dr. C. J. Cori. Pp. viii + 103. (Jena: Gustav Fischer, 1896.)

THIS little book has been compiled by Prof. Hatschek and Dr. Cori, as a guide to dissection, for the use of elementary students attending lectures in Prag. The fact that no less than ten animals are dealt with in little over one hundred octavo pages sufficiently indicates the scope of the work, which contains simply concise notes of the more important characters of the animals treated, and technical directions for dissecting them. The characters referred to are always such as can be demonstrated by simple dissection, without complicated methods of preparation, and without the use of the compound microscope. It follows from this that the Protozoa are entirely excluded, as are also the Cœlentera.

The names on the title-page are a sufficient guarantee that the information contained in the book is accurate, so far as it goes, and the illustrative drawings are adequate to the purpose in view. No doubt Prof. Hatschek's students will find the book of service to them in their efforts to follow his lectures and laboratory teaching; but there is no reason why English students should desert the works, such as that of Marshall and Hurst, which so many of them at present use.

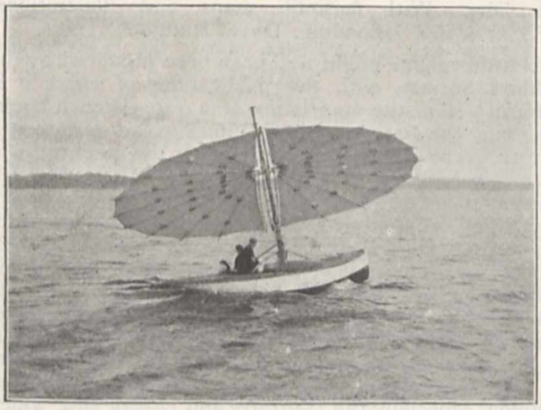
LETTERS TO THE EDITOR.

[*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.*]

Cyclone Sail.

I HAVE sent to you, for publication if you think desirable, a photograph of a type of an ideal sail—ideal, in that the wind acting on it has no tendency whatever to incline the boat.

The wind pressure acts practically at right angles to the mean surface of the sail. When the wind is making a large angle



with the sail, the centre of pressure is almost at the centre of the surface, but when the wind strikes the sail at an acute angle, as in all sails or kites, the centre of pressure moves towards the weather edge; but by suitably adjusting the sail, the desirable result of obliterating all heeling movement has been achieved.

In practice this result has been obtained by putting more sail to leeward than to windward of the mast, and also by placing the sail not quite at right angles to the mast, but more raised on the lee side.

The sail is made oval, with the major axis horizontal, so as to be able to carry more sail with a definite height of mast.

The training in a horizontal direction is accomplished by means of a turntable, and the elevating and lowering by two tackles.

There is a balance weight which helps in elevating the mast, and which is just sufficient to balance the dead weight of the sail in a calm, not inclining the boat.

The sail can be set and furled in a minute; it does not close like an umbrella, but each side shuts up like a fan.

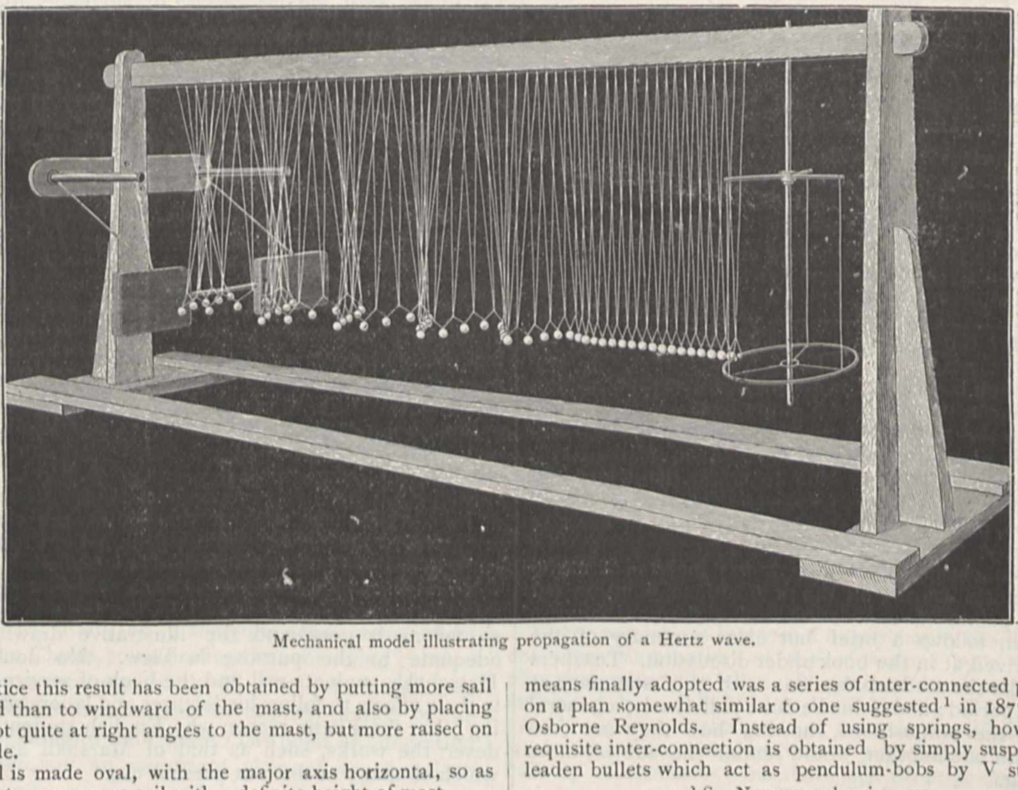
The object of the sail is to be able to sail without inclining the boat, so that the limit of driving force is not governed by the stability of the boat in any way, and also that the boat sailing on an even keel has less resistance than when sailing with a list.

PERCY S. PILCHER.

Artillery Mansions, 75 Victoria Street, S.W.

A Hertz-Wave Model.

IN the spring of the present year I showed, at a meeting of the Physical Society of London, a wave-motion model which I designed to illustrate mechanically the propagation of a transverse wave. As the exhibition of this model on that occasion, and subsequently at the Royal Society and Royal Institution, has elicited a number of inquiries about the apparatus, it is thought that the following brief account of it may be of some interest to lecturers on physics, particularly at a time when the propagation of electric waves through space is occupying much attention. The apparatus, which is depicted in the accompanying cut, is mounted on a strong wooden frame about 2 metres long. At one end (the further in the cut) is the "oscillator," a heavy mass of brass hung by two strong V cords from arms which project parallel to the longer dimension of the frame. This mass, which, for the sake of analogy, is quite unnecessarily shaped to imitate an orthodox electric oscillator, can therefore be set swinging in a transverse direction by a suitable impulse given by hand. At the other end of the frame (the nearer in the cut) is the "resonator," a circle of brass wire hung by a tri-filar suspension. Oscillator and resonator must be adjusted by shortening or lengthening the cords so as to have identical periods of oscillation. The real problem in the construction of the apparatus was to find a mechanical means of transmitting the energy of the oscillator in visible waves to the resonator. The



Mechanical model illustrating propagation of a Hertz wave.

means finally adopted was a series of inter-connected pendulums on a plan somewhat similar to one suggested[1] in 1877 by Prof. Osborne Reynolds. Instead of using springs, however, the requisite inter-connection is obtained by simply suspending the leaden bullets which act as pendulum-bobs by V suspensions

[1] See NATURE, vol. xvi. p. 343.

which overlap, and which, as shown in the cut, are tied together at a point about 4 centimetres above each of the balls. No ball can be laterally displaced without tending to drag its neighbour also; so that a shearing stress is transmitted along the line of balls. As Reynolds showed twenty years ago, the velocity of propagation of the wave-front differs from that of the group of waves owing to the continual dying away of the amplitude of the advancing waves. This effect, due to the inertia of the medium, is of course equivalent to the presence of dispersion in the medium, waves of different frequencies being propagated with slightly different velocities. So far, therefore, as Prof. Fitzgerald remarked when the model was exhibited, it illustrates the propagation of the wave in a refracting medium rather than in the ether of space. The waves in the model travel quite slowly; and there is a fascination in watching their progress along the row of balls, until they arrive at the resonator and set it into responsive vibration. There is, of course, no attempt made here to represent the magnetic part of the electromagnetic wave, at right angles to the electrostatic part; the mechanical displacements in the model corresponding to the electrostatic displacements of the Hertzian wave. A row of inter-connected pendulums such as this affords a means of illustrating many points in physics. For many purposes the elaborate system of suspension by strings may be replaced by a continuous fabric. Thus, for example, a piece of netting, hung on hooks from a horizontal rail, and ending below in a short fringe, with leaden beads on the fringe-tips, will also serve to illustrate the propagation of a transverse wave. The structure adopted absolutely refuses to transmit longitudinal disturbances; there being no compressional elasticity between the balls to propagate a longitudinal wave.

SILVANUS P. THOMPSON.

Blackbird's Nest appropriated by a White Wagtail.

I SEE in NATURE of July 15 (p. 248), a letter to the effect that a wagtail had appropriated a blackbird's nest. I beg to state that on June 12 I had the good fortune to find a similar nest at Coburg in Germany. There was a blackbird's nest behind a summer-house in the garden where I was staying, against the wall about 16 feet from the ground. The white wagtail had lined it with moss, hair, and thread, and laid six eggs in it, which, together with the nest, are now in my collection. The gardener and myself both identified the bird.

G. W. DE P. NICHOLSON.

Jesus College, Cambridge, July 27.

THE ROYAL SOCIETY AND ITS HAND-BOOKS.[1]

IT is with most corporations, and especially with an ancient corporation like the Royal Society, a matter of some practical moment to maintain continuity of life and action, and it is always interesting to record that continuity. The "Record of the Royal Society" has this, apparently, as its aim. The "Year-book of the Royal Society," published some few months ago, contains, so the preface to the "Record" informs us, information which is liable to change, and the "Year-book" will accordingly be issued annually; but "the 'Record' contains information, largely historical, such as will not need more than slight additions from time to time," and it is intended therefore to issue new editions of this only at intervals of a few years, as may be found desirable.

Reference to the "Year-book," a copy of which has been sent to us with the "Record," shows that it contains such matters as a table of the meetings for the Session, a list of the Fellows, lists of the Council and Committees, the Statutes, standing orders, and regulations for various occasions, the Society's balance-sheet, schedule of estates and property, and much other matter which is strictly and exclusively of official utility and interest. But the "Record," although it has been officially prepared, as we learn from the preface, by the secretaries, aided by Mr. H. Rix, the late assistant secretary, and is in the main a hand-book of an official sort intended for official purposes, contains, nevertheless, so much that is historical—so much, let us add, that is quaint and antique in flavour—that it has very considerable general interest.

1 "The Record of the Royal Society of London," 1897, No. 1. "Year-book of the Royal Society of London," 1896–97, No. 1.

The volume opens with an "Account of the Foundation and Early History of the Royal Society," in which Sprat's, Thompson's and Weld's histories have been used to some extent, but in which much use has also clearly been made of the original MSS. upon which those histories are based. The story has often been told how, about the year 1645, "divers worthy persons, inquisitive into natural philosophy and other parts of human learning," used to meet in London, sometimes at Dr. Goddard's lodgings in Wood Street, sometimes at the "Bull Head" in Cheapside, and, in term-time, at Gresham College; how, about 1648 or 1649, some of this company removed to Oxford, where they founded the Philosophical Society of Oxford, while the Londoners continued their meetings, usually at Gresham College, until the famous gathering of November 28, 1660, when, after Mr. Wren's lecture, the company being withdrawn for "mutuall converse," "amongst other matters that were discoursed of, something was offered about a designe of founding a Colledge for the promoting of Physico-Mathematicall Experimentall Learning." In the present "Account of the Foundation" the steps are traced by which this meeting led to the foundation of the Royal Society, the Charter of Incorporation passing the Great Seal on July 15, 1662, for which grace on the 29th of that month the President, Council, and Fellows went to Whitehall and returned their thanks to his Majesty.

The compilers of this "Account" lay stress upon the fact that in the infancy of the Society one most important feature of a meeting was the performing of experiments before the members. "The experiment was performed for and by itself, and not merely, as now, in illustration of a 'paper communicated.' Papers were read then as now; but the reading of such papers formed only a part, and by no means a great part, of the business of the meeting." An example of one of these early meetings is given, and as it does not appear in Weld's "History," and is a very interesting glimpse of seventeenth century science, it may be worth printing it here in full.

September 10th, 1662.

"Mersennus, his account of the tenacity of cylindricall bodies was read by Mr. Croone, to whome the prosecution of that matter by consulting Galilæo, was referred when the translation of that Italian treatise wherein he handleth of this subject shall bee printed.

"It was order'd, that, at the next meeting Experiments should bee made with wires of severall matters of ye same size, silver, copper, iron, &c., to see what weight will breake them; the curator is Mr. Croone.

"The reading of the french manuscript brought in by Sr. Robert Moray about taking heights and distances by catoptricks was differred till the description of the instrument should come.

"Dr. Goddard made an experiment concerning the force that presseth the aire into lesse dimensions; and it was found, that twelve ounces did contract $\frac{1}{24}$ part of Aire. The quantity of Air is wanting.

"My Lord Brouncker was desired to send his Glass to Dr. Goddard, to make further experiments about the force of pressing aire into less dimensions.

"Dr. Wren was put in mind to prosecute Mr. Rook's observations concerning the motions of the satellites of Jupiter.

"Dr. Charleton read an Essay of his, concerning the velocity of sounds, direct and reflexe, and was desired to prosecute this matter; and to bring his discourse again next day to bee enter'd.

"Dr. Goddard made the Experiment to show how much aire a man's lungs may hold, by sucking up water into a separating glasse after the lungs have been well emptied of Aire. Severall persons of the Society trying it, some sucked up in one suction about three pintes of water, one six, another eight pintes and three quarters &c. Here was observed the variety of whistles or tones, which ye water made at the severall hights, in falling out of the glasse again.

"Mr. Evelyn's experiment was brought in of Animal engrafting, and in particular of making a Cock spur grow on a Cock's head.

"It was discoursed whether there bee any such thing as sexes in trees and other plants; some instances were brought of Palme trees, plum trees, hollies, Ash trees, Quinces, pionies, &c., wherein a difference was said to be found, either in their bearing of fruit or in their hardnesse and softness, or in their medicall operations: some said that the difference which is in trees as to fertility or sterility may be made by ingrafting.

"Mention was made by Sr. Rob. Moray of a French Gentleman who having been some while since in England, and present at a meeting of the Society, discoursed that the nature of all trees was to run altogether to wood, which was changed by a certaine way of cutting them, whereby they were made against their nature to beare fruit, and that according as this cutting was done with more, or lesse, skill the more or less fruitfull the tree would bee.

"A proposition was offered by Sr. Robert Moray about the planting of Timber in England and the preserving of what is now growing.

"Mr. Boyle shew'd a Puppey in a certaine liquour, wherein it had been preserved during all the hott months of the Summer, though in a broken and unsealed glasse.

"Sir James Shaen proposed a Candidate by Sr. Rob. Moray."

The experiments were afterwards carried out by "Curators of Experiments," and some account is here added of this office, which was first held by Robert Hooke.

The whole of this condensed history extends to only eighteen pages. It is illustrated by two plates containing portraits, not indeed of the first six Presidents, for the portrait of Sir Cyril Wyche is wanting, but of the Presidents from Lord Brouncker to the Earl of Carbery, with this exception. If these can be continued in future issues, and especially if some likeness of Wyche, and of any others which may be at present missing can be discovered and reproduced, it will make a valuable series. Portraits of Henry Oldenburg, the first Secretary, and of Robert Boyle, one of the earliest Fellows, are also given.

This introductory history of the Society's birth and youth is followed by other matters of more or less historical interest; the text of the Charters, a history of the Statutes, a list of the Benefactors of the Society from "Carolus Secundus, Fundator," downwards; a history of the Trusts, and so forth. We are also furnished with accounts of other institutions which are controlled by, or more or less closely connected with, the Royal Society, from the Kew Observatory, which is governed by a Committee appointed by the Royal Society's Council, to "The Physick Garden" of Chelsea, in which the Society has, as we read, "only a reversionary interest."

With respect to the latter institution, its connection with the Royal Society at its first foundation was closer than at present, and was rather curious. The garden, now more generally known as "The Botanic Garden, Chelsea," was founded by Sir Hans Sloane in 1722, by a deed which enacted "That the garden should at all times hereafter be continued as a Physick Garden" by the Society of Apothecaries, which Society should yearly present to the Royal Society "fifty specimens or samples of distinct plants, well dried and preserved, and which grew in the said garden the same year, together with their respective names or reputed names, and so as the specimens or samples of such plants be different, or specifically distinct, and no one offered twice, until the complete number of two thousand plants have been delivered." This tale of two thousand was completed, we learn, in the year 1762.

The "Record" contains, furthermore, statements of the origin and progress of various branches of work which the Society is still carrying on—the Government Grant for Scientific Investigations, which finds its spring and source in a letter addressed in the year 1849 by Lord John Russell to the late Earl of Rosse; the Society's publications, comprising, besides monographs, the *Philosophical Transactions*—a noble series of volumes extending over more than two centuries—the *Proceedings*, and the *Catalogue of Scientific Papers*. The last-named arduous undertaking is, indeed, one of the most important branches of work at present being carried on by the Society. Some account of it, reprinted in part in the volume under review, appeared in our pages some time since (NATURE, vol. xlv. p. 338). Then there is the library, the pedigree of which, so far as concerns some of the classical and antiquarian literature, is traced through the Arundel Library (presented to the Society in its earliest days by Henry Howard, afterwards sixth Duke of Norfolk) to Bilibald Pirckheimer, the friend of Albrecht Dürer, and from him to Matthias Corvinus, King of Hungary.

Sundry lists are added—a list of instruments and relics, a list of portraits, a list of medals, of presidents, treasurers and secretaries of the Society, and of persons to whom the Society's medals have been awarded, all of which, though arranged, as we have said, in official form, and obviously intended for official purposes, contain matter which the future historian of science cannot fail to find of great importance. Here, for instance, we learn that the Society has in its possession many relics of Sir Isaac Newton, including his telescope, the mask from the cast of his face taken after death, and the MS. of the Principia from which the first edition was printed. Here we learn that the Society treasures Boyle's air-pump, Petty's double-bottomed boat, Huyghens's aerial telescope, Priestley's electrical machine, and the original Davy's safety lamp; and here, under the names of the successive Presidents, we find biographical notes which should be of value. Weld's "History of the Society" carries us down only to the year 1830, and it is but an imperfect compilation at the best. When the story is continued by some later hand—as continued it certainly ought to be—the prospective series, of which this "Record" forms the first volume, should considerably lighten the historian's task.

X.

SOARING FLIGHT.

SOME time ago we referred, in an article on "Soaring Machines" (NATURE, vol. liii. p. 301; see also p. 365), to the experiments which Mr. Percy S. Pilcher had commenced to carry out in this country on the lines laid down by the late Herr Lilienthal in Germany. Since that time Mr. Pilcher has gained considerable experience both in the making and handling of these aëro-planes, and quite recently he was able to make a successful ascent and descent before numerous spectators, under conditions which were not very favourable. An idea of the general shape of the machine he used may be gathered from the six accompanying illustrations, which are enlargements of six out of the numerous pictures taken during flight by means of the cinematograph. The machine itself weighed fifty pounds, the framework being made of bamboo; the latter could be easily folded up, but when spread out and carried the sail material covered a surface area of 170 square feet. The tail, which can be seen at the back of the framework, consisted of two small surfaces placed horizontally and vertically; this had no means of movement in the lateral direction, but was capable of movement in the vertical direction *above* its horizontal position, about a fixed point in the framework. Such an arrangement as this was found to work best, as it eliminated to a great extent the liability of taking "headers." It plays, therefore, a rather important *rôle* in the machine.

When in a position for flight the arms of the operator, as far as the elbows, are placed in a stiff sleeve fitted to each side of the inner portion of the framework, and each hand grasps a small upright peg fixed also to the same support; by this means a firm grip of the apparatus when off the ground may be obtained. It will thus be seen that when in flight the whole weight of the operator is on the two elbows; and it may be further stated that, to prevent the whole arm from becoming straight through any emergency requiring the movement of the body backwards, two fixed pads, supported on uprights attached to the framework, are positioned behind the shoulder-blades.

At the time of the flight (here illustrated) the wind was so light and variable in direction, that an ascent from even the elevated position taken up was almost impossible. Means, however, were at hand by which one end of a thin fishing-line, 600 yards long, could be attached to the machine, while the other end passed through two blocks placed close together on the ground at a distance from the aero-plane of about 550 yards. These blocks were so arranged that a movement of the aerial machine in the horizontal direction corresponded to a fifth of the movement of the boys pulling the line.

The start was made at a given signal, the line being pulled by three boys, and Mr. Pilcher gradually left the ground, and soared gracefully into the air, attaining a maximum height of about 70 feet. After covering a distance of about 180 yards the line suddenly parted, a knot having slipped. The only apparent difference this made was that the operator began now to slowly descend, his motion in the horizontal direction being somewhat reduced. A safe and graceful landing was made at a distance of 250 yards from the starting-point. The photographs illustrate that part of the flight previous to the attainment of the greatest height. It may be mentioned that the tension of the line amounted only to about 20 lb., so that only quite a weak pull was required to give the necessary lifting power: the trial indicated, however, that if the machine had been fitted with a small engine or motor, to give this amount of thrust by means of a screw or otherwise, perhaps an equal or further distance would have been covered.

Mr. Pilcher now proposes to employ, as soon as possible, a small and light engine indicating about four horse-power, this being considerably more than sufficient for flights of moderate length. It is, however, thought advisable to have rather too much than too little power to commence with, as a factor of safety. With this improvement it is hoped that further distances will be covered, and a nearer approximation to a flying machine will be attained.

In these attempts it must not be forgotten that there is always a certain amount of danger attached until we possess sufficient knowledge to guard against it. Experience, then, has to be dearly bought, and it requires no small amount of pluck and determination to trust one's self to these aerial crafts. Further, the serious experimenter must have both time and money at his disposal to successfully combat the many unforeseen difficulties that arise, and to carry out the alterations that must be made, to say nothing of the fact that each trial may result in the apparatus being completely or partially damaged. Those pursuing the inquiry must, therefore, have either considerable private means, or be supported

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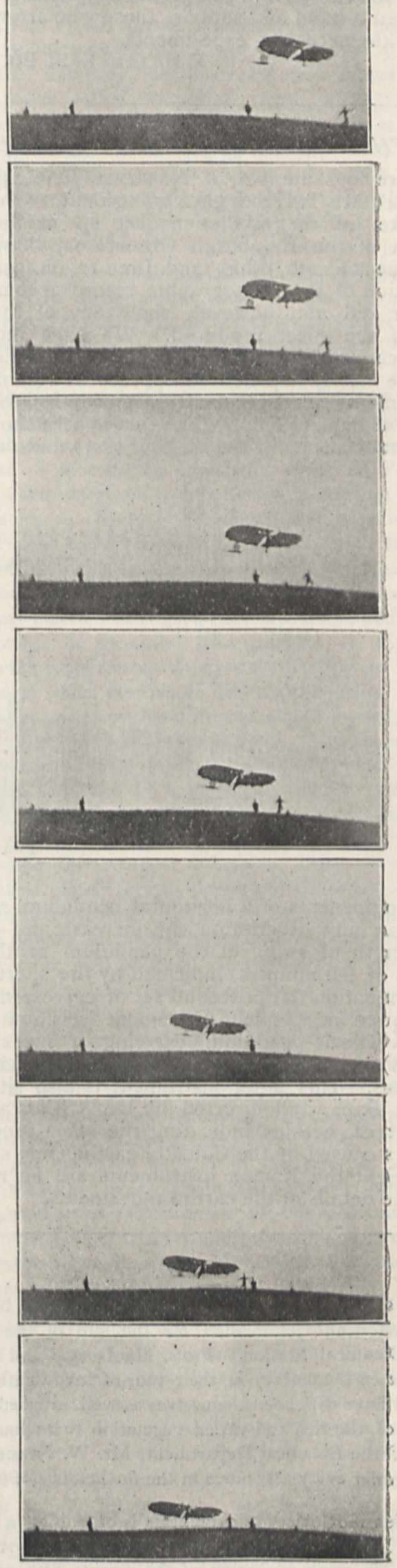


financially by those who take an interest in this big problem. The subject, we know, is still in its infancy; but it is hoped that those who wish that this country should take some part in this problem of aerial navigation should bear a hand and support those who are willing to carry out the necessary experiments.

WILLIAM J. S. LOCKYER.

THE CALCUTTA EARTHQUAKE.

IN a previous number of NATURE (June 24, vol. lvi. p. 174), Mr. T. Heath gave an account, *re* the Indian earthquake, of the oscillations set up in the bifilar pendulum of the Edinburgh Observatory between the times June 11, 23h. 18m., and June 12, 0h. 33m. The reproduction of the photographic record accompanying the letter did not, however, show any of the minor details of the effect produced. We have received a communication from Prof. P. Blaserna, in which these details are clearly depicted on the records obtained with the instruments erected at the Royal Geodetic Observatory of Rocca di Papa (Rome). The curves here shown illustrate the movements of the N.-S. (Fig. 1), and the E.-W.

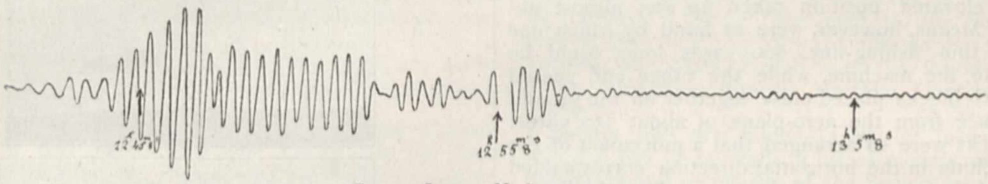


FIG. 1.—June 12, N.-S. component.

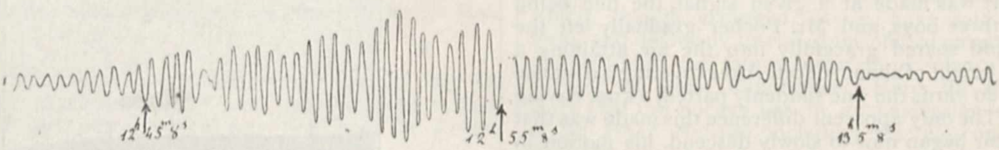


FIG. 2.—June 12, E.-W. component.

(Fig. 2) components of a horizontal pendulum, and show better than any description the increase and decrease in the length of swing of the pendulum at the times (intervals of ten minutes) indicated by the short arrows. We may mention that a second set of curves, made with another quite independent instrument (seismometograph with a vertical pendulum carrying a mass of 200 kilograms), recorded nearly similar disturbances at the same times. This latter instrument is also situated at Rocca di Papa, and directed by Dr. A. Cancani. The above curves, besides indicating the effect produced by the shocks caused by the Calcutta earthquake, show how very efficient the Roman instruments are for recording the minute details of the earth's movements.

NOTES.

THERE seems some probability that Jamaica may be selected by the American Commission for the site of the proposed Tropical Botanical Station. Profs. MacDougal and Campbell have restricted themselves in their tour of investigation to that island, and have expressed themselves as well satisfied with the conditions of the rich and varied vegetation there found. The Director of the Botanical Department, Mr. W. Fawcett, is prepared to render every assistance in the furtherance of the object.

THE Scientific Society of Argentina is organising a Congreso Cientifico Latino Americano, to be held at Buenos Ayres in April next, in commemoration of the twenty-fifth anniversary of its foundation. The Congress will be under the patronage of the President of the Argentine Republic and the Ministers of Justice, Foreign Affairs, and Public Instruction. There will be seven sections, dealing respectively with exact sciences (pure and applied mathematics, astronomy, geodesy and topography), engineering, physics and chemistry, natural science, medical sciences (including hygiene and climatology), anthropology and sociology.

M. HAUTEFEUILLE, member of the Section of Mineralogy of the Paris Academy of Sciences, has been promoted to the rank of Officer of the Legion of Honour. M. J. Vinot has been made a Chevalier of the Legion of Honour.

PROF. WM. LIBBEY, JUN., of Princeton, has succeeded in making the ascent of the Mesa Encantada, near Albuquerque, New Mexico, by the use of a cannon and life-line. The line was thrown over the *mesa*, and successively larger cords were attached, till after two days' labour a rope of sufficient strength to raise a man in a chair was in position. No archæological remains were discovered, except rocks piled up as if man had perhaps piled them. Tradition ran that the *mesa* had been inhabited until the means of access were swept away four centuries ago.

THE Paris correspondent of the *Times* states that Dr. Robert Wurtz, professor at the Paris School of Medicine, has been chosen, as one of the leading French bacteriologists, for a mission in Abyssinia. He is to start for Jibutil and to go on direct to Adis Abeba, where, after having organised a department of vaccination, he will study the rinderpest and similar infectious maladies which chronically ravage Menelik's empire.

THE death is announced of Dr. W. Petzold, known by his contributions to geographical and astronomical literature.

WE regret to announce the death of Prof. Victor Meyer, the distinguished professor of chemistry in the University of Heidelberg.

THE Government of Victoria is offering a bonus of 1000*l*. for the invention of an efficient and not too costly method of ventilating mines.

THE Belgian Chamber of Representatives has voted an additional grant of sixty thousand francs in aid of M. de Gerlache's expedition to the South Pole.

THE statue of Charles Darwin, erected in his native town of Shrewsbury and in front of the school which for nine years he attended, was unveiled on Tuesday. The statue, which is of bronze, is the gift of the Shropshire Horticultural Society, and cost 1000 guineas.

THE thirty-fourth annual conference of the British Pharmaceutical Association was opened at Glasgow on Tuesday, under the presidency of Dr. Symes, of Liverpool.

OWING to the advance of areas of low barometric pressure over our islands from the Atlantic since the beginning of the month, the weather, which for a considerable period had been very fine, under the influence of an anti-cyclonic system, became very unsettled, and thunderstorms were experienced in nearly all parts. The reports issued by the Meteorological Office show that some high temperatures were registered: on the 4th and 5th, readings of 90° (in shade) were recorded in the east of England, and 88° in the southern parts of the country. On the latter day rain fell heavily over the northern parts; at St. Helens (in Lancashire) 2·28 inches were measured in three-quarters of an hour. The disturbance on Sunday, the 8th inst., caused further thunderstorms and rainfall in the southern parts of the country, 0·8 inch being measured at Oxford and 0·7 inch in London. This is the heaviest fall in London in one day since January 8 last.

ABOUT this time every year the Société Industrielle de Mulhouse issues a "Programme des Prix" to be awarded in the following year. The list of prizes to be awarded in 1898 has just been received, and it contains no less than 144 prize-subjects. No useful purpose would be served by describing all these subjects, but attention may profitably be called to the following among them:—5000 francs for discoveries or inventions which in the preceding ten years have been most useful to industries in the district of the Upper Rhine; a medal and 1000 francs for the best memoir upon the combing of textile materials; a medal and 1000 francs for the production of a substance to replace the albumen of eggs in making painters' canvas; 1000 francs for an albumen to replace the white of eggs in all industrial uses of the same; a silver medal and 500 francs for the best memoir on a new and advantageous method of constructing factory buildings; a silver medal and 500 francs for new theoretical and practical researches on the movement of steam in pipes; a silver medal and 500 francs for the invention and application of a registering pyrometer intended to show the temperature of the gaseous products of the combustion of coal in steam engines; a medal and 500 or 1000 francs (according to the importance of the work) for a memoir on electromotive force in mono- or poly-phase alternators. The remaining prizes are mostly medals, which will be awarded for advances in the industrial arts and for long service. All the prizes are open to every one except the members of the committees of the Société industrielle and the Council of administration. Competing memoirs must be sent, before February 15, 1898, to the President of the Society. A copy of the Programme des Prix will be sent upon application to the Secretary.

JERSEY offers many opportunities for workers in the wide field of natural science. The Jersey Natural Science Association, which was founded on Thursday last, ought therefore, by organising the studies of the naturalists of the Island, to be of real assistance in scientific progress. The Island presents many important sections for the student of geology and mineralogy, while the work already done, in a quiet way by some of its inhabitants, indicates how a properly organised body of workers can advance natural knowledge. The new association has been instituted for the purpose of carrying on scientific research and cultivating the spirit of investigation by: (*a*) original papers or communications; (*b*) field work and excursions; (*c*) the delivery of popular scientific lectures when such can be arranged; (*d*) the formation of a museum and lending library for the use of members. The patron of the Association is Major-General E. Hopton, C.B. (the Lieut.-Governor of Jersey), and the officers are:—President, Dr. A. C. Godfray; Vice-Presidents, Mr. R. R. Lemprière (Viscount of Jersey), and Mr. H. E. Le V. dit Durell (Connétable of St. Helier); Hon. Treasurer, Mr. P. Asplet; Hon. Secretary and Librarian, Mr. C. A. Snazelle.

THE death of Prof. Alfred Marshall Mayer, professor of physics in the Stevens Institute of Technology, Hoboken, N.J., on July 13, has already been announced in these columns. From an obituary notice in the *American Journal of Science* we extract the following particulars of Prof. Mayer's life and scientific work:—Prof. Mayer was born in Baltimore, Md., November 13, 1836, and received his education at St. Mary's College, Baltimore. After leaving this institution, in 1852, he spent two years in the office and workshop of a mechanical engineer, where he acquired a knowledge of mechanical processes and the use of tools, for which he had a natural aptitude. This was followed by a course of two years in a chemical laboratory, where he obtained a thorough knowledge of analytical chemistry. In 1856 he was made professor of physics and chemistry in the University of Maryland, and three years later he entered upon a similar position in Westminster College, Mo., where he remained two years. In 1863 he went abroad, and entered the University of Paris, where he spent two years in the study of physics, mathematics and physiology. While in Paris he was a pupil of the distinguished physicist Regnault. After his return to America he occupied a chair in Pennsylvania College, Gettysburg, and later in Lehigh University, Bethlehem, where he was in charge of the department of astronomy, and superintended the erection of an observatory. In 1869, an expedition was sent by the U.S. Nautical Almanac Office to Burlington, Iowa, to observe the eclipse of August 7. Prof. Mayer was placed in charge of the expedition, and obtained a large number of successful photographs. In 1871 he was called to the professorship of physics in the Stevens Institute of Technology, which position he held until the close of his life. Prof. Mayer was an enthusiastic and active investigator, and a prolific writer upon scientific subjects. He made numerous contributions to various journals, cyclopædias, and other scientific publications, but the memoirs in which he embodied the results of his own researches were chiefly published in the *American Journal of Science.* His papers published in that journal, since 1870, number forty-seven titles, covering nearly four hundred closely printed pages, not counting various notes and minor contributions. While embracing a great variety of topics in physics, his studies were more actively pursued in the departments of electricity and electro-magnetic phenomena, in optics, especially photometry and colour-contrasts, but more particularly in acoustics, which was a favourite field of research, in which his discoveries gave him the prominence and authority of a specialist. His acoustical researches form a connected series of papers, which together amount to nearly one-half the total volume of his contributions. Prof. Mayer received the degree of Ph.D. from the Pennsylvania College in 1866. In 1872 he was elected a member of the National Academy of Sciences, and was connected with many other scientific societies. He possessed great ingenuity and skill in construction, and a remarkable degree of delicacy and precision as an experimenter, which enabled him to obtain results that will have a high and permanent value in science.

A SLIGHT earthquake was felt at Hereford on Monday morning, July 19, between half-past three and four. Mr. E. Armitage, writing from Dadnor, Ross, Herefordshire, says that the disturbance was felt at 3.50 a.m. He adds: "The rumbling sound was accompanied by a distinct shock of momentary duration, sufficiently strong to awaken sleepers. The direction of the seismic wave was from east to west."

MR. R. J. USSHER records in the *Irish Naturalist* the discovery of bones of the Great Auk in kitchen-middens on the coast of County Waterford. The bones have been determined as belonging to the Great Auk by Prof. Newton and Dr. Gadow: with them were found bones or horns of ox, goat, horse, pig, red deer, and domestic fowl; also an abundance of shells of oysters, cockles, mussels and limpets, with many pot-boilers or burned stones. It is pointed out that bones of this extinct bird have been found in the kitchen-middens of Denmark, in one or two places in Scotland, in Durham, and on the North American coast. More recently, they have been found on the County Antrim coast. Mr. Ussher's find corroborates this discovery, and shows that the range of the Great Auk extended in Ireland nearly as far south as 52° N. latitude.

A NUMBER of interesting navigational instruments were exhibited at the Fishmongers' Hall last week. The exhibition was organised by a sub-committee of the Shipmasters' Society, with Captain D. Wilson-Barker as chairman, and was principally intended to illustrate the progress that has been made in the art of navigation during Her Majesty's reign. Altogether there were about 200 exhibits, some of which are of historic importance. Included among these was a sextant, by Bird, said to have been used by Captain Cook. There was a well selected number of charts and navigation books, among the exhibitors in this section being Admiral Sir W. J. L. Wharton, F.R.S. The Meteorological Society lent several meteorological instruments such as are in use at sea, while in contrast with the quadrants, sextants, compasses, &c., which did duty in 1837, instruments of a more modern date were on view, comprising some of Lord Kelvin's inventions, such as the deflector for adjusting the compass without swinging the ship, the vertical force instrument, and the sounding machine. Sections were also devoted to ships' models and pictures, ancient charts and books, and ancient instruments.

THE Pilot Chart of the North Pacific Ocean for August, published by the American Hydrographic Office, contains a large amount of information useful to navigators. In addition to the usual arrows showing the prevalent direction and force of the wind and the drift of the currents, there is a forecast of the wind and weather which may be expected during the month, and also a chart showing the mean atmospheric conditions at Greenwich mean noon, any large variation from which may indicate a coming gale. As this is the season of maximum frequency of typhoons, as shown by the table compiled by Dr. Doberck, of the Hongkong Observatory for the thirteen years 1883–96, a special notice of these storms is given. Attention is drawn to the fact that the typhoon of the Western Pacific is in many respects the counterpart of the West Indian hurricane in the Atlantic. Both classes of storms have their origin in the vicinity of tropical groups of islands, and, under similar barometric conditions, both undergo the same slow development, and exhibit the same tendency to recurve upon reaching the northern limit of the north-east trades.

SOME facts of interest in connection with gold-washing on the Saskatchewan River are stated in the Report of the Geological Survey of Canada for 1895 (vol. viii. new series) just issued. The principal paying bars are found along the river within a distance of about sixty miles above and a similar distance below Edmonton. It is pointed out, however, that the occurrence of gold is not limited to the North Saskatchewan, the metal being found, in greater or less abundance, on portions of the courses of all the rivers east of the Rocky Mountains from the forty-ninth parallel northward.

THE auriferous character of the rocks of the Huronian system in Canada has been established by mining operations of recent years. The economic importance and generally metalliferous character of Huronian rocks was recognised by Sir William Logan in reports of the Canadian survey made nearly forty years ago. Referring to this, Dr. Dawson says in the latest report: "It is gratifying to observe that the practical miner is now beginning to appreciate the value of a large amount of geological work carried out in the country to the north of the Great Lakes, which, a few years ago, it might have appeared difficult to justify in the light of any economic results up to that time achieved. There can now be very little doubt that every square mile of the Huronian formation of Canada will sooner or later become an object of interest to the prospector, and that industries of considerable importance may yet be planted upon this formation in districts far to the north, or for other reasons at present regarded as barren and useless." The conclusions which Dr. Dawson arrived at as to the richness of the Yukon district, after his exploration of it in 1887, have lately been so strikingly established by the discovery of large quantities of gold on the Klondyke River, that his suggestions as to the commercial value of Huronian rocks will probably receive the attention of the mining world.

IN the *Bulletin de l'Académie des Sciences de Cracovie*, Dr. L. Natanson gives a kinetic theory of the equations of vortex-motion of fluids. This investigation is of special interest, inasmuch as it takes account of a certain molecular property to which the name "constraint of perturbations" (*coercition des perturbations*) has been applied. As long ago as 1845, the connection of the laws of vortex-motion with the principle of moments was pointed out by Sir G. G. Stokes. Dr. Natanson's paper may be said, in a certain sense, to be a development of this idea, in that he shows how the equations of Helmholtz and Nanson can be verified by supposing the so called "forces of constraint" to satisfy the equations of angular momentum.

A NEW cable recorder, invented by M. Ader, is described in *La Nature* of July 24. It consists essentially of a fine wire stretched vertically in a magnetic field created by a strong horizontal electro-magnet, the poles of which surround the wire. The currents from the cable traverse the wire, which moves to the right or left—that is, towards the north or the south pole of the electro-magnet—according to their direction. A shadow of the wire is projected across a slit, behind which a band of photographic paper travels. A black spot thus falls upon the paper, and as the wire moves to the right or left the movements are traced upon the photographic paper by the shadow of the spot, the result being a record similar to that given by the syphon recorder. The paper is developed automatically in three baths contained in a small dark chamber, and the signals are shown in white upon a black ground. As to the speed obtained, 350 letters a minute, that is, about seventy words, have been recorded through the cable between Marseilles and Algiers, and 150 letters per minute have been recorded upon the Brest-New York cable, the transmitter being at St. Pierre-Miquelon, and the receiver at Brest.

IN July of last year, Prof. Eschenhagen, of Potsdam, presented to the Berlin Academy a preliminary note on certain small variations of the earth's magnetism, which he had then detected for the first time. The apparatus then used consisted of a unifilar magnetometer, in which the magnet, a small steel mirror, was made to lie perpendicularly to the magnetic meridian by the torsion of the suspending quartz fibre. An account of further researches on the same subject is now given in the *Berliner Sitzungsberichte*. The most important oscillations have a period of about thirty seconds, and are observed chiefly between 6 a.m. and 6 p.m., *i.e.* roughly speaking, when the sun is above the horizon. Since October last waves of shorter period, lasting about twelve to fifteen seconds, have only been observed on two days, viz. November 7, 1896 and February 4, 1897; but these were of only half the amplitude of the normal waves. On several occasions, however, groups of waves were observed which could readily be accounted for by interference, as they closely resembled beats in acoustics. From observations made at Potsdam and Wilhelmshaven, it seems probable that the same disturbances take place almost simultaneously over a considerable area, but further observations are required in confirmation of this point. The cause of the phenomenon is uncertain, but Prof. Eschenhagen inclines to the view that it is of atmospheric origin, in conformity with Schuster and Von Bezold's theories of the diurnal variations. The author finally suggests a convenient means of detecting these rapid fluctuations by observing the induced currents in a sufficiently large coil, a method which has the advantage of practically eliminating disturbances of long period.

THE first number of a new quarterly botanical journal has made its appearance, with the title *Bollettino del Reale Orto Botanico di Palermo*, under the editorship of Prof. Borzì, intended as a record of the work done in the Botanical Garden and Botanical Institute at Palermo. Among the articles in the number already published are: A new genus of Cactaceæ, *Myrtillocactus*, by M. Console; Experiments on acclimatisation; and some new and critical species of Liliaceæ, by Prof. Borzì; species of *Agave* described within the last ten years, by A. Terraciano.

THE most recent of the series of "Hand-lists" of plants in cultivation in 1897 at the Royal Gardens, Kew, comprises the tender Monocotyledones (excluding the Orchids). The preface contains a general description of the collection, under the heads of the different natural orders, Scitamineæ, Bromeliaceæ, Palmæ, Pandanaceæ, Aroideæ, &c. It will probably surprise many who are unacquainted with the extent of our national collection to hear that there are now under cultivation at Kew upwards of 400 species of Palm, and 360 Aroids. The collection of Palms is probably the largest in the world.

THE question as to the age of the dicotyledons is one of great importance, and any new facts which may be brought to light are therefore looked upon with great interest. In the *Proceedings* of the Linnean Society of New South Wales (for March 31), the president, Mr. Henry Deane, in his address to the Society, makes an interesting reference to the earliest dicotyledons in the northern hemisphere and in Australia. It may be mentioned, however, that up to 1888 the oldest known dicotyledon was one from the Middle Cretaceous of Greenland, described by Heer under the name of *Populus primæva*. In the same year Prof. Fontaine found in some of the Lower Potomac series—in what was supposed to be Jurassic—some portions of leaves resembling dicotyledons, but not easily distinguishable from the lower groups, ferns, cycads, and other gymnosperms. Further discoveries of known flora have been found in Potomac formation, and an unbroken series from the oldest to the newest beds have been brought to light, and in the latter the dicotyledonous element largely predominated.

As regards their occurrence in old beds in Australia, Mr. Deane says:—"The fossils of the Oxley beds are well developed dicotyledons, quite equal in development to those found in the Upper Cretaceous in Europe and North America. The Oxley beds are near the top of the Ipswich Coal Measures, which are supposed to be at latest Jurassic in age. The difficulty of reconciling the fact of the full development of the dicotyledonous type in Australia with the very archaic rudimentary types of the same age in North America, which are mentioned by Lester Ward, struck me very forcibly, and as in the western parts of the colony it had been shown that the Lower Cretaceous beds lie conformably, or at an angle not distinguishable, upon the beds below them." Mr. R. L. Jack's opinion of these beds is that he believes them "to be below the thick Murphy's Creek Sandstone and the Clifton Coals and Shales . . ." and he cannot see his way to put "the Oxley beds on a higher horizon than the rest of the Ipswich formation." Mr. Deane concludes that the above views "point undoubtedly to the conclusion that at an age when European and American dicotyledons exhibited a rudimentary or transition character, the southern hemisphere already possessed types of high development. Before this becomes an accepted fact, it is needless to say that some further corroboration of the conclusions as to the correspondence in age of the so-called Jurassic beds of Australia and those of the northern hemisphere should be sought."

THE Annual Report, just received, of the Manchester Microscopical Society for 1896 furnishes evidence of useful work done in the northern capital. There are good papers in several departments of botany and zoology, as well as one on "The New Light and the New Photography."

The Photogram for the present month will be found to contain many short articles of interest, and several notes of useful hints. With regard to kinetography we read, "the greatest kinetographic success of the Jubilee was scored by the *Bradford Argus* and by their kinetographers, R. J. Appleton and Co. Both good management and good luck seem to have befriended them, for the eclipsing parasol of Her Majesty the Queen was raised just as she passed their stand, and a happy smile (duly recorded) passed over the royal countenance. A van specially fitted for developing, printing, &c., was attached to one of the trains to Bradford, and by midnight on the 22nd the view of the whole procession was projected on to a screen facing Forster Square, which was thronged by thousands of people." Have many of our readers used the Ilford Special Rapid Plates? These are very quick plates indeed, and require only about a fourth of the time of exposure of the ordinary plates. If a person is used to slow plates, these rapid ones must be handled with care. The tendency should be to try to rather under- than over-expose them; the developer should not be too strong at first, and should be kept well under control. They should also during development be placed in the dark. Accompanying a few words on "A Notable Photographer," are two excellent reproductions from negatives taken by Mr. H. Walter Barnett.

THE following are among the articles, and other publications, which have come under our notice during the past few days:—"The San José Scale and its Nearest Allies," by Prof. T. D. A. Cockerell, published by the U.S. Department of Agriculture (Division of Entomology), Technical Series, No. 6. The information given in this bulletin will enable all entomologists, and every one else who has access to a compound microscope, to distinguish definitely between the San José scale and its closest allies.—The New York *Nation* is publishing a series of articles upon the Schools of Archæology at Athens, by J. R. S. Sterrett.—The second part of a valuable report on the valley regions of Alabama (Palæozoic Strata), by Henry McCalley, has been published by the Geological Survey of that State, under the direction of Dr. E. A. Smith. Part i. dealt with the Tennessee Valley region, and Part ii. is concerned with the resources of the Coosa Valley region. The report is illustrated with a number of fine reproductions of photographs, and contains a mass of information upon the physical features, geology, natural resources, soils, agricultural features, timber, water-power, climate, health, rainfall and drainage of Alabama.—The metamorphosis of a dragon-fly is described by the Rev. A. East, in the August number of *Knowledge*, and is illustrated with reproductions of six striking photographs of different stages of emergence of the insect from the nymph skin.—The official report of the International Meteorological Conference, held at Paris last September, and reported in NATURE at the time (vol. liv. p. 624), has just been published by authority of the Meteorological Council. Among the subjects and authors of papers appended to the report are:—"The Centres of Action of the Atmosphere," by Prof. H. H. Hildebrandsson; "Simultaneous Magnetic Observations," by Dr. Eschenhagen; "The Registration of Atmospheric Electricity," by M. A. Chauveau; "The Reduction of Anemometrical Data," by Dr. Sprung; "The Employment of the Hypsometer to determine the Pressure of the Air and the Gravity Correction for Mercurial Barometers," by Prof. Mohn; "International Co-operation in prosecuting work and publishing results in Ocean Meteorology," by Dr. Neumayer.

THE additions to the Zoological Society's Gardens during the past week include a —— Genet (*Genetta* ——) from South-east Brazil, presented by Mr. J. E. Matcham; a Guinea Baboon (*Cynocephalus sphinx*, ♂), two White-collared Mangabeys (*Cercocebus collaris*, ♂ ♀), a Moustache Monkey (*Cercopithecus cephus*, ♂), from West Africa, presented by Dr. H. O. Forbes; two Tawny Owls (*Syrnium aluco*), European, presented by Mr. T. Guittonnean; a Natal Python (*Python natalensis*) from Natal; a Green-necked Touracou (*Gallirex chlorochlamys*) from East Africa, presented by Mr. W. Champion; a Horned Lizard (*Phrynosoma cornutum*) from Texas, presented by Mr. G. J. W. Vickers; two Common Chameleons (*Chamæleon vulgaris*) from North Africa, presented by Major Spilsbury; four Black-eared Marmosets (*Hapale penicillata*) from South-east Brazil, a Green-cheeked Amazon (*Chrysotis viridigena*) from Columbia, two —— Terrapins (*Clemmys* ——), deposited; three Bennett's Wallabies (*Macropus bennetti*, ♂ ♂ ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

SUNSPOTS AND THE MEAN YEARLY TEMPERATURE AT TURIN.—In a small memoir entitled "Sulla relazione fra le Macchie Solari e la Temperatura dell' aria a Torino," Dr. G. B. Rizzo shows in a striking way the effect of the relative frequency of solar spotted area on the Turin temperature. For this investigation he has been able to employ a continuous series of observations, commencing from the year 1752 to the present time, made by Prof. Ignazio Somis, the R. Accademia delle Scienze, and the Astronomical Observatory of Palazzo Madama. The resulting numbers show that not only is the eleven-yearly period plainly marked, but that a well observed "lag" of the temperature is displayed by the observations

Forming the two equations, the first giving the relative frequency of solar spots, namely,

$$r = 46{\cdot}31 + 20{\cdot}70 \sin (184^\circ\, 24' + z),$$

and the second the relative change of temperature, namely,

$$t = 21{\cdot}85 + 0{\cdot}22 \sin (94^\circ\, 53' + z),$$

where z represents the distance in arc from the beginning of an eleven-year period, and forming the differences from the mean value of the whole period, the following table shows the variation recorded.

Year of period.	Deviations from the mean: Spots.	Deviations from the mean: Temperature.
1	− 7·34	+ 0·21
2	− 16·64	+ 0·13
3	− 20·65	+ 0·01
4	− 18·11	− 0·11
5	− 9·82	− 0·19
6	+ 1·59	− 0·22
7	+ 12·50	− 0·17
8	+ 19·42	− 0·07
9	+ 20·20	+ 0·05
10	+ 14·56	+ 0·16
11	+ 4·29	+ 0·22

The author's summary of the investigation leads him to the following conclusion:—

The eleven yearly variations of the sunspots and the mean temperature at the earth's surface are due to some periodic cause, which acting at the sun increases the spots, and on our planet increases the temperature, with a retardation in time of a quarter of this period; on the other hand, a similar cause acts on the earth diminishing the temperature, and on the sun increasing the spots with a like retardation.

RECENT CONTRIBUTIONS TO ASTRONOMY.—Among some of the astronomical pamphlets we have received recently, may be mentioned the following:—"Connaissance des Temps" for the year 1899. Among the additions to this volume one may refer to the epochs for the elongations of the fifth satellite of Jupiter; a series of elements from which can be calculated the exact positions of the satellites of Mars, Saturn, Uranus and Neptune, in which the unpublished results of the researches of M. H. Struve are employed. There is also a table giving the ecliptic elements of the major planets, their satellites, and of Saturn's ring. Of the eclipses mentioned two partial ones occur, the first on January 11 and the second on June 9; the latter is of interest, as it will be visible from Paris.—A pamphlet entitled "Enquêtes et Documents relatifs à l'enseignement supérieur" (vol. lxii.) contains the reports of the different directors on the provincial French observatories for the year 1898. Among those to which reference is made are: Algiers by M. Ch. Trépied, Besançon by M. L. J. Gruey, Bordeaux by M. G. Rayet, Lyons by M. Ch. André, Marseilles by M. Stephan, Toulouse by M. B. Baillaud, and the observatory of Pic du Midi de Bigorre by M. Marchand.—Another publication of interest and utility is that due to the late Dr. E. J. Stone, consisting of tables for facilitating the computation of star-constants. These have been modified and revised by Prof. H. H. Turner, the Savilian Professor of Astronomy at Oxford. Prof. Turner, with the aid of a grant from Miss Bruce, to whom astronomy is very much indebted, has certainly simplified the use of the tables, and they have now been printed in three-figure form which, after considerable use at Greenwich, give satisfactory results "both as regards saving of time and retention of all needful accuracy." We may mention that Prof. Turner has done away with the use of the constants m, n and tan ω, so that the tables will by this alteration be suitable for any epoch.

THE AUGUST METEORS.—As we go to press the swift moving August meteors will be speeding through our atmosphere, rendering themselves luminous to us according as they pass within or without this envelope. As they originate from a point situated near η Persei, lying in the north-eastern part of the heavens, and rather low down in the sky in the earlier part of the evening, the longest trails should be looked for down in the south-western quadrant of the heavens. A long watch on Monday evening from 9 p.m. to 2 a.m. resulted in the observation of only a few real Perseids, though there were several of those which ordinarily would be termed "sporadic," but which, according to that energetic observer Mr. W. F. Denning, would be attributed to fixed radiant points of minor importance. Two cameras pointed to the Cassiopeiæ and Perseus regions of the heavens, and exposed for considerable lengths of time, were not fortunate enough to catch any of the trails. Perhaps other observers elsewhere have been more fortunate. The night, however, was at times very fine, especially after midnight. The moon, being low down in the southward, did not interfere to any extent with the photographic effects. Clouds prevented work at several stations on Tuesday night.

THE ALGOL VARIABLE Z HERCULIS.—Dr. Ernst Hartwig, writing to the *Astronomischen Nachrichten* (No. 3437) about the Algol Variable Z Herculis, draws attention to the fact that this interesting variable is now conveniently situated for good comparisons. From observations of the diminution of the light alone in the first half of the month of June, using the 1894 light curve, it was found that the times for the principal minima differed only a few minutes from the ephemeris given in the *Viertel Jahrschrift*, while the times of the occurrence of the secondary minima, in which the star is only a third of a magnitude below its general brightness, occurred twenty minutes later than the computed times. The length of period, which was published in a previous number of the *Astronomischen Nachrichten* (No. 3260), and the ephemeris based on this, is thus found to be correct to a few seconds.

REPRODUCTION OF COMETARY PHENOMENA.—The following brief notice appeared in the *Times* of August 5:—"A Reuter telegram from Berlin of yesterday's date says: 'According to a communication made by the Royal Observatory, Prof. Goldstein, of this city, has succeeded in experimentally reproducing by means of kathode rays certain very distinct and characteristic cometic phenomena, such as the radiation of light from the head of a comet and the resultant development of a tail. He has also been able by these means to account for certain peculiarities of this class of phenomena which have been observed in recent years.'"

SOME PROBLEMS OF ARCTIC GEOLOGY.[1]

II. FORMER ARCTIC CLIMATES.

IN a summary of the geological history of the Arctic Ocean (*ante*, p. 301) it was remarked that in Silurian times the water was warmer than it is at the present day; and there is no doubt that the climate of the Arctic regions has varied greatly. According to the belief generally accepted there have been periods when the climate of the northern hemisphere was so severe that an ice sheet extended from Ireland to Siberia, from the Thames Valley to the North Pole; and then at other times, as the whole earth enjoyed the doubtful benefits of a tropical climate, Greenland's now icy mountains were bordered by a coral strand. This view of the great variation of Arctic temperature has been so widely held that it has exercised a very great influence on theories of faunal migrations and on the former climates of the world. The volumes which summarise the results of the *Challenger* expedition show to what an extent some of the latest speculations as to climatic change have been influenced by this theory: for in that work Dr. Murray strongly advocates Blandet's suggestion that in late Palæozoic times there was "over the whole globe an almost complete equality in the distribution of light and heat" due to the "very much greater size of the sun in the early stages of the earth's history." And this bigger Palæozoic sun was assumed in order to explain the fact that "the Arctic Ocean was a coral sea in Carboniferous times."

Let us, therefore, briefly consider how far the evidence of Arctic geology supports the statements that have been based upon it in this respect. The theory that the Arctic regions once enjoyed a tropical climate was first advanced on the evidence of some fossil plant beds, of which the most famous occur in Disco Island and neighbouring parts of the coast of Greenland. The fossil plants from these beds were described by Heer, whose conclusions have been summarised by Lyell as follows:—"In this rich flora considerably more than half are trees, which is the more remarkable since trees do not exist in any part of Greenland even 10° further south. More than fifty species of Coniferæ have been found with species of Thujopsis and Salisburia now peculiar to Japan. There are also beeches, oaks, planes, poplars, maples, walnuts, limes, and even a magnolia. Among the shrubs were many evergreens, as *Andromeda* and two extinct genera, *Daphnogene* and *M'Clintockia*, with fine leathery leaves; together with hazel, blackthorn, holly, logwood and hawthorn. *Potamogeton*, *Sparganium* and *Menyanthes* grew in the swamps; while ivy and vines twined around the forest trees, and broad-leaved ferns grew beneath their shade. Such a vigorous growth of trees within 12° of the pole, where now a dwarf willow and a few herbaceous plants form the only vegetation, and where the ground is covered with almost perpetual snow and ice, is truly remarkable."

These statements were so positively made and so fascinatingly sensational, that they have been repeated in every text-book, while the protests against them have been generally ignored. Protests, however, have been often made. The first botanist to visit the Disco plant beds was the late Dr. Robert Brown; and as the result of his investigations he wrote—"I must protest against the way in which Prof. Heer has been making species and genera out of these fossils with a recklessness regardless of consequences." Mr. Starkie Gardner checked a long series of Heer's determinations, and declared them valueless; he remarked that Heer's conclusions were "based upon specimens too fragmentary to be of any value, and belong to types of leaves which are so universal that they would, even if perfect, fall into the undeterminable residuum of a fossil flora." He concluded that at least half of these genera and species of Heer's must be suppressed.

Prof. Nathorst, in whose care Heer's type specimens are now resting, is fortunately undertaking a careful revision of the evidence, and he is as emphatic as Brown and Gardner regarding the unsatisfactory nature of Heer's identifications.

The most important point in this reduction of Heer's species, is that it is the plants which are most indicative of the tropical conditions, such as the palms, which have to be abandoned. That many big-leaved plants grew in areas which now support only an insignificant growth of saxifrages and crucifers, is undeniable; and the leaves in question often present resemblances to those of trees, such as the plane, maple and lime. But palæobotanists now distrust the evidence of leaves alone, which are, moreover, especially untrustworthy in the Arctic regions. If a specimen of a Norwegian shrub that has grown at Tromsö be compared with a specimen of the same species that has grown at Christiania, the former will be seen to have less wood but larger leaves. The continual daylight in the summer has a very stimulating effect on leaf production, and the leaves are larger and fleshier than they would be if once a day their growth were stopped by night.

But it may be said, this will not explain the occurrence of the great tree stems which are found in association with the Arctic coal seams and leaf beds. It was mainly to explain the growth of these tree trunks that Sir John Evans introduced his well-known theory of the shifting of the pole; for at one time it was held that an annual exposure for three months to continuous darkness would have been quite inhibitory to the growth of trees. Botanists, however, now tell us that in a cold climate the winter's darkness would be an advantage to vegetation instead of a fatal objection; and the darkness is actually secured artificially in the gardens of St. Petersburg as a protection to trees. Trees even now do grow beyond the Arctic Circle, and the darkness is no absolute bar to their having ranged many degrees further north. That pines and other conifers did so in the past is proved both by the mode of occurrence of the fossils and by the histological structure of the wood. But that all the trees found buried in the rocks of Spitsbergen and Greenland grew where they now occur is by no means so certain. It is probable that most of them have been carried to their present latitude as drift wood. The famous Forest Bed at Cromer was so named in the belief that it was the site of an old forest; but it is now regarded as an estuarine deposit, formed at some distance from the place where the trees that occur in it grew. Similarly, the description given by Brainerd of the petrified forest found in the north of Greenland by the Greeley expedition is as consistent with the view that the tree trunks were drifted as that they grew *in situ*. In the case of the Disco leaf beds we fortunately have the opinion of a trained botanist, the late Robert Brown. He examined the plant beds especially in reference to this point, and he tells us that not "in any instance did I find the leaves in conjunction with or attached to the stem, by which I could positively say that these were the leaves of the tree to which the stem belonged, or that the stem was brought there, or was in any way connected with the same natural or physical causes which influenced the leaves." Brown quotes, and apparently approves, Steenstrup's remarks, "perhaps they [the leaves] were blown by the wind to their present locality." So Brown saw no evidence that the West Greenland plant beds mark the site of ancient forests.

The quantity of drift wood cast upon the Arctic shores is enormous. Many raised beaches are strewn with pine and larch logs, to which the roots are often attached and are buried in the mud. Mosses and sedges, willows and saxifrages grow upon the beach; their remains, together with wind-borne material, may gradually fill up the spaces between the tree trunks, and the whole may be buried by rainwash from cliffs above the beach, or by tide-borne sand should the beach again sink below sea-level. Under such circumstances an impure coal seam would be formed; and a future geologist might easily be deceived by the numerous tree trunks, and the rich leaf remains, into the belief that at the era of its formation the locality had supported a forest growth, which could not now be paralleled less than 20° further south.

Most of the Arctic drift wood consists of logs of pine and larch from the Siberian forests; but blocks of mahogany from Central America sometimes occur, and West Indian beans are not uncommon. Hence the occasional presence of tree stems of tropical types may easily be explained without assuming any great change of climate. But the action of ocean currents is not the only factor that may have complicated the evidence of these northern plant beds. Many limitations are necessary in the application of fossils to the elucidation of former climates. Genera that once lived in cold regions may now be restricted to the tropics owing to a change in habit; and plants that were once world-wide in distribution may now survive only in a few especially favourable localities. Thus in the Carboniferous period the most abundant ferns belonged to the order Marattiaceæ, of which there are twenty-seven living species; twenty-two of these occur in the torrid zone, three in the south temperate zone, two in the north temperate zone, and there are none in the frigid zone. This does not prove that, wherever Marattiaceæ are found in carboniferous rocks, the climate was

[1] Concluded from page 303.

torrid; it only illustrates the fact that the order was a primitive type once very widely spread throughout the world, and now restricted by the competition of more specialised types. Therefore the occurrence in the Cretaceous rocks of Greenland of the tree-fern *Dicksonia*, which, although it still lives in New Zealand, is said to be most characteristic of the tropical parts of Northern Queensland, is no proof that the Arctic regions had a tropical climate. And it would not be so, even if Sir J. D. Hooker had not warned us, that ferns are the least trustworthy witnesses as to climatic conditions.

Hence an examination of the evidence of the fossil plants of the Arctic regions leads to three conclusions: (1) that, as current opinion rests on Heer's determination of fossil palms and tropical leaves which cannot now be supported, the changes of climate have been greatly exaggerated; (2) that without a complete revision of Heer's work, such as is now being carried out by Prof. Nathorst, the exact extent of the climatic changes cannot be estimated; (3) that the conclusions based on the belief that three months' darkness would be fatal to the growth of trees, cannot be maintained, while most of the fossil tree trunks in question have probably been brought as drift wood from the south.

The fossil faunas of the Arctic regions have been held to demonstrate climatic changes no less enormous than do the fossil floras. The most striking proofs quoted were the asserted occurrence of fossil coral reefs in the Silurian and Carboniferous rocks of various parts of the Arctic area, notably Bank's Land, Grinnell Land, Spitsbergen, and the New Siberian Islands. It is, perhaps, the best-known fact in the science of geographical distribution that coral polypes cannot build coral reefs in water of a lower temperature than 68° F. If, therefore, coral reefs formed by madreporarian corals do occur in the Arctic regions, this would be conclusive evidence of a great change in the temperature of the northern ocean. Let us take the case of the corals of Grinnell Land, of which specimens were brought home by Colonel Feilden, and determined by Mr. Etheridge. The collection included eleven species; of these six were simple corals, one was a simply branching, another was a cluster of simple corals, and the remaining three species, although compound, occurred in small nodules. Of corals in the condition of reef builders, there are none in the collection. Simple corals live in the Arctic ocean at the present day, while compound corals as large as the specimens from Grinnell Land are found far outside the range of existing coral reefs, and at far greater depths. The collection from Grinnell Land gives no proof that coral reefs were ever formed there. We have only to compare the few insignificant species from that region, with the massive corals that lived at the same time in English seas, to realise that there was almost as great a difference between the temperature of the sea in the two areas in Silurian times as there is to-day. Baron von Tol's list of Anthozoa from the Silurian rocks of the New Siberian Islands also includes eleven species; but of these only three are true Madreporaria. Compound Hydrozoa and Alcyonaria have a greater range than the reef-building Madreporaria, both in latitude and depth. Hence, in arguing from the distribution of the fossil corals, we must eliminate all except Madreporaria; and the moment we apply this rule to the New Siberian coral reefs, we lose all but a few small Madreporaria, which certainly cannot be described as forming reefs.

If limestones as full of corals as the Silurian rocks of Wenlock Edge, or some of the beds in the Carboniferous series at Clifton, be ever found north of 80° N. lat., they will no doubt prove that at the time of their formation the Arctic Ocean was a coral sea. But the evidence so far seems insufficient. That the northern seas had a warmer temperature at some parts of the Palæozoic era than at present is not denied. It is proved by the occurrence of coral reefs in various parts of Europe and America; and in places massive corals grew as far north as the Arctic Circle, as in the Timan Mountains, and sometimes even a few degrees beyond, as in Bank's Land. But the northern coral faunas are poorer than those of temperate Europe, and as we go nearer the pole, they become so stunted that they ceased to form reefs.

The corals alone, therefore, are insufficient to prove the universality of a tropical climate in early geological times, and it is advisable to consider the evidence of the fossil faunas as a whole. Arctic marine faunas are known from six of the geological systems—the Silurian, Devonian, Carboniferous (including Permian), Triassic, Jurassic and Cretaceous. The six faunas are characterised by the following general features:—

(1) They are often rich in individuals, but poor in species.

(2) Crustacea, trilobites, zoophytes, and other animals with chitinous exo-skeletons are proportionately common and often large in size.

(3) Compound corals are scarce, and occur in nodules instead of in reef-forming masses.

(4) Sea-urchins and sea-lilies are extremely scarce—in fact, barely represented.

(5) There is a striking poverty in new or special types.

But these are, in the main, the characteristics of the existing Arctic fauna; and it is difficult to compare the Arctic fauna of any one period with that which then lived in southern Europe, without concluding that all through geological time the northern faunas have lived under the blight of Arctic barrenness.

This reminds us of the question of the shifting of the position of the pole, which was proposed as a help to palæontologists in explaining the former Arctic faunas and floras. But the facts seem explicable without the aid of this hypothesis. Neumayr has published a map of the probable climatic zones in the Jurassic period, which appear to have been as parallel to the equator then as they are now. In Tertiary times the evidence of the fossil plants seems to show the same; for, from whatever direction we approach the pole, the fossil floras become sparser and more boreal in aspect, as we may see by a comparison of the plants of Disco Island and Grinnell Land, of the Great Slave Lake and Prince Patrick Land, of Iceland and Spitsbergen, and of Saghalien and New Siberia.

Hence the palæontological evidence, instead of demanding the shifting of the pole, seems to be opposed to this theory, and to show that, in all the periods for which palæontological evidence is available, the pole stood near its present position. Palæontological evidence, moreover, when freed from sensational exaggeration, shows that the variations in the climate of the Arctic region have not been so extreme as have been assumed, and thus it greatly simplifies the discussion of the causes of the changes that have occurred. The size of the Palæozoic sun was increased to warm the Arctic Ocean up to the temperature of a coral sea; the pole was shifted to remove the fatal spell of Arctic night, and clothe parts of the polar lands in subtropical forests. When Lyell proposed to explain the climatic variations by alterations in the position of land and water, he called upon his theory to account for the alternation of a vast polar ice-cap with tropical conditions. Such results could not be explained by the geographical theory, which accordingly fell into disrepute.

But if we call upon that theory to explain changes for which there is valid evidence, it is not improbable that it may not suffice. A different distribution of land and sea, a greater or less elevation of the mountain ranges, a deflection of the ocean currents, the reduction of the ice-covered sea, and the meteorological changes that would be thus produced may, as Lyell thought, be quite sufficient to account for all the climatic variations which the facts of Arctic geology require.

J. W. GREGORY.

THE IRON AND STEEL INSTITUTE.

THE annual summer meeting of the Iron and Steel Institute was held last week at Cardiff. The President this year is Mr. E. P. Martin, who is at the head of the executive of the great Dowlais Iron Works; and it was appropriate, therefore, that the meeting should be held in the commercial metropolis of Wales. The meeting was in every respect most successful, though certainly it fell off somewhat from a technical point of view; but that, after all, was largely due to the weather, it being too hot to sit in a lecture theatre and discuss details of iron and steel manufacture. An unusually large number of members attended, and many of them were accompanied by ladies.

On the members assembling on Tuesday morning, the 3rd inst., they were welcomed by the Mayor of Cardiff, after which Mr. Martin took the chair, and other formal business having been transacted, Mr. Thomas Wrightson's paper, "On the Application of Travelling Belts to the Shipment of Coal," was read. In this he described a new method of placing coal into a ship, expeditiously and without breaking it. The latter is a very important point, as small coal or dust is worth very little; and the old-fashioned method of shooting coal from a staith direct into the hold of a vessel, leads to the formation of a great deal of small coal. The apparatus Mr. Wrightson has designed, and which is in use on the Tyne, consists of a series of belts or creepers and a continuous chain, with leaves attached, working in a trunk. The coal is lowered on to the belts, and is thus conveyed any required horizontal distance until it reaches the end of the staith or pier against which the ship is moored. One end of the trunk, in which the continuous chain or belt works, is lowered into the hold of the ship, and by means of the trays the coal is lowered down and gently deposited in the required position. The action of the lowering part of the apparatus is similar to that of a grain elevating machine, or of a bucket and ladder dredger; but of course the working is reversed, the material being lowered in place of being raised. The machine in use was said to be capable of dealing with 400 tons of coal an hour, and as, presumably, a machine could be used for each hatch, a vessel of say 2400 tons dead weight, and having three hatches could, we suppose, be brought to her bearings in a couple of hours. In the discussion that followed, the arrangement was rather sharply criticised, but it must be remembered that Cardiff is the home and birthplace of a rival scheme that has been in successful operation for some years. Naturally those who have used the older method and have experienced the benefit of it as compared with the primitive shoots, are loath to change, and it is also natural that the maker of the original apparatus should not welcome a competing scheme with too great enthusiasm. It would seem, however, that the Wrightson invention ought necessarily to have an advantage in point of speed because it is continuous, whilst the work with the older method is intermittent.

Mr. George B. Hammond's contribution, "On the Manufacture of Tin-plates," was an omnibus paper dealing with the subject at large—historically, commercially, and technically. From the historical and technical point of view, there was very little new to say, and indeed the commercial side of the question is already a thrice-told tale of sadness and decay. America was our great customer for tin-plates, and under the enormous impetus given to the industry by the spread of the canning trade in provisions fortunes were made in South Wales, and enormous wages were paid. The inevitable reaction followed. The United States, pursuing their protectionist policy, put an import duty on tin-plates which was absolutely prohibitive, and that market was lost. There were, however, other outlets for the commodity, and had both employers and employed recognised the need of hard work and frugality the trade need never have fallen to the low ebb it has. Over-prosperity had, however, destroyed the moral fibre of those who had experienced it. There were large profits, high wages, antiquated methods, and artificial restrictions to output which no one wished to forego, and the consequence is that South Wales sees every prospect of American competition in neutral markets. This, however, is somewhat beside Mr. Hammond's paper; but it would be difficult for us to deal with the technical part without the illustrations of machinery which accompanied the paper.

On the following day, Wednesday, the first paper taken was that of Prof. Honoré Ponthière, "On a Thermo-chemical Study of the Refining of Iron." It was read in brief abstract by Mr. Brough in the absence of the author. From its title it will be seen how impossible it would be to abstract such a subject within anything approaching the limits of space at our disposal. It began with a discussion on the conditions under which the elements exist in iron, and treated of the various possible or probable reactions which take place during the process of steel-making by the two chief processes, and of puddling.

Mr. E. H. Saniter's paper "On Carbon and Iron" followed, being read in full by the author. This was the most important contribution to the meeting. It discussed the thermal treatment of tri-basic carbide of iron; the saturation point of iron with carbon by fusion in contact with excess of carbon; the saturation point of iron with carbon by heating without fusion in contact with excess of carbon; and the etching of pure carbon alloys at a red-heat in order to ascertain their structure by means of the microscope at that temperature. The last branch of the subject brought forward points of considerable interest, and the paper raised the old, and it would seem interminable, controversy on the alpha and beta states of iron. Mr. Saniter, we gather, is more of a carbonist than an allotropist, and his reasoning seemed to support the former party. Unfortunately there were no allotropists present, or if there were they were silent; so the discussion went all one way. The photo-micrographs attached to the paper were interesting, and in some respects this new method of treatment showed unexpected results. Mr. Saniter made a strange mistake in his paper. He attributed to so competent an authority as Edward Riley the statement that the saturation-point of iron for carbon was 4 per cent. Mr. Riley, who was present, naturally exclaimed against this, and asked Mr. Saniter for his authority, which the latter gave as the Journal of the Institute for the year 1877. What the saturation-point may be has not, we believe, been exactly determined, but at any rate it is higher than 4 per cent. Mr. Saniter's mistake, of course, was that he did not verify his authority when the statement was so questionable and the reference to the original so easy.

The last paper read at the meeting was Mr. Henning's contribution on a recorder of stretching, which was taken charge of by Mr. Wicksteed, in the absence of the author. The portable recorder referred to consists of a pair of clamps attached to the two ends of the specimen rod. To one of these clamps is attached a parallel motion with a projecting arm, at the end of which is a pencil. The motion is worked by rod from the other clamp, so that when the specimen stretches, and the clamps are thus pulled apart, the arm moves. In this way a record can be obtained on a card which is mounted on a revolving drum, which is actuated by a cord from the poise weight. It will be seen that in construction the apparatus bears a resemblance to a steam engine indicator, both in regard to the parallel motion and the paper-drum. It was objected during the discussion that the poise could not be moved fast enough to give true indications when the specimen ultimately gave way; but probably if a record can be obtained within the elastic limit, that will be sufficient for the majority of engineers, as a material strained beyond this limit is very little good for structural purposes.

Five other papers were on the agenda, but were not read at the meeting.

The excursions and entertainments during this meeting were numerous and the hospitality profuse. Several of the large iron and steel works were visited, the Cardiff and Newport docks were inspected, and also other places of industrial interest. There were lunches, dinners, soirées, a Welsh concert, garden parties, and illuminations packed in as close as time would permit; but the culminating point in all these delights was the Marchioness of Bute's ball. To this over three thousand guests, including all the members of the Iron and Steel Institute and the ladies accompanying them, were invited.

ON PRACTICALLY AVAILABLE PROCESSES FOR SOLDERING ALUMINIUM IN THE LABORATORY.

IT seems that ever since the metal aluminium has been used in construction, difficulties have arisen in soldering it. Further, from contemporary literature it appears probable that some perfectly satisfactory methods of getting over the difficulty are known, but not published in sufficient detail to be available.

Hence it seems well to put on record any advance towards the solution of this somewhat troublesome problem. In the first place, my experience is that it is not easy to solder aluminium simply by using an alloy of definite composition without a flux. Also that the only other process which does not require special apparatus, that based upon the use of silver chloride, is very troublesome indeed unless the local fusion of the aluminium be immaterial. I find, however, that cadmium iodide is distinctly more satisfactory. If it be fused on an aluminium plate, decomposition of the salt occurs long before the melting point of the aluminium is reached. The result is generally the violent evolution of iodine vapour and formation of an alloy of cadmium and aluminium on the surface of the metal.

The decomposition of the cadmium iodide is, however, too rapid to be convenient, and the pulverulent white residue is in the way. It is, therefore, of advantage to add some other body which, if possible, will obviate these defects. I find that zinc chloride answers fairly well. Thus I mix concentrated zinc chloride solution with a little ammonium chloride, evaporate in a round porcelain dish, and ignite a low red heat till a part of the ammonium chloride is volatilised. The fused chlorides are now mixed with cadmium iodide. The proportions of zinc chloride and cadmium iodide are best adjusted experimentally.

The final result, when the salts are completely fused together, is a flux which readily enables tin (or other soldering alloy) to unite perfectly with aluminium. The melted flux can be taken up in a pipette with india-rubber teat, and dropped on to the surface of the metal to be soldered. Some powdered metallic tin is also sprinkled on the surface. The aluminium is then heated over the Bunsen flame till the flux just melts; it can then be quickly spread where it is wanted with a piece of copper wire or thin glass rod. As the temperature is further raised the flux decomposes, and the tin readily alloys itself with the surface of the aluminium; while the flux is decomposing, the tin can be spread in a continuous layer by means of the little glass rod or wire.

Instead of cadmium iodide, fused lead chloride may be used in a similar manner.

I should like to substitute some of the less volatile alkyl-ammonium chlorides for the ammonium chloride, but have not had opportunity. A. T. STANTON.

THE STUDY OF NATURAL HISTORY IN JAPAN.

A NEW publication, entitled *Annotationes Zoologicae Japonenses*, has just been launched at Tokyo, under the auspices of the Zoological Society there. In 1888 the Society commenced the issue of a monthly journal—the *Dōbutsugaku Zasshi* (*Zoological Magazine*)—in the Japanese language, and the periodical is now in its ninth volume. About two years ago a department written in European languages was added to the magazine, and the new publication may be regarded as another step forward in the same direction. The old and the new magazines will be carried on as separate publications; but while the former will be exclusively intended for Japanese students, the latter will be issued primarily for the purpose of making the progress of zoology in Japan better known outside that country. For the present, the *Annotationes* will be published quarterly, and the intention is to widely distribute it among all institutions and societies interested in zoological progress. In the future, therefore, zoologists may chiefly look for contributions to their branch of science from Japanese sources in two publications, viz. in the *Journal* of the College of Science, Imperial University, for elaborate memoirs, and in the new periodical for shorter notices and papers. Other publications, such as the *Bulletin* of the College of Agriculture, will, of course, occasionally publish articles on zoological subjects as heretofore.

In introducing the new journal, and defining its aim and scope, Dr. K. Mitsukuri, Professor of Zoology in the Imperial University, and President of the Tokyo Zoological Society, gives a brief retrospect, which is abridged below, of the progress of zoology in Japan.

It is probably unknown to most persons in the West that early in the eighth century of the Christian era there was already established in Japan an Imperial University with four departments—Ethics, History, Jurisprudence, and Mathematics—and with the prescribed number of four hundred students. There were also, at the same time, a bureau devoted to Astronomy, Astrology, Calendar-compilation and Meteorology, and a Medical College with professors of Medicine, Surgery, Acupuncture, Necromancy (the art of healing by charms), and Pharmacology. The last-named branch of study included the collection, cultivation, and investigation of medicinal plants, and thus a considerable amount of botanical knowledge must already have been acquired by that time. Towards the end of the ninth century, when a catalogue of books existing in Japan was compiled by the order of the then reigning Emperor, the Imperial library was found to contain 16,790 volumes, divided into forty departments—and this in spite of a disastrous fire of some years previous. Among the medical works were some with very modern sounding titles, such as "The Curing of Diseases of Women," and "On the Methods of Healing Diseases of the Horse." Japan in those early days derived its culture from India, China, and Korea; but the details above enumerated clearly show that educated society must already have attained a high degree of civilisation.

Coming to more modern times, it is known that, during the long peace of two hundred and fifty years which the rule of the Tokugawa *shoguns* secured for Japan, literature, the arts, and all peaceful industries were developed with remarkable vigour and rapidity, and that the study of natural history shared in this progress. Apart from that innate love of nature and the natural which was ever showing itself in poetry and other arts, the study of natural products was always pursued, ostensibly with the purpose of collecting *materia medica*, or of discovering things that might be used as food in case of a famine, or of identifying objects mentioned in the Confucian classic, "Shi-King." But it is not difficult to perceive that naturalists looked in reality beyond these simple or utilitarian ends, and investigated animals and plants for their own sake, although the principal aim of their researches seems to have been the comparatively barren one of establishing a relationship between Japanese products and those described in various Chinese works on natural history. Frequent were the excursions and expeditions undertaken with the view of collecting natural objects, among which plants were especial favourites, and all parts of the country seem to have been tolerably well explored in this way. Numerous were the treatises on natural history, published or unpublished. Many of these were encyclopædic in their comprehensiveness and size, such as "Shobutsu Ruisan," by Inao Jakusui (1000 parts, early in the eighteenth century), and "Honzō Kōmoku Keimō," by Ono Ranzan (48 parts, 1803). The last-named naturalist was so famous for his extensive knowledge that, we are told, his pupils were nearly one thousand in number. Prof. Matsumura, in his book on the enumeration of Japanese plant-names, gives 306 titles of Japanese works on botany compiled previously to 1868. Many of the natural history volumes had beautiful coloured illustrations, which serve their purpose even at the present day. natural history displays were of common occurrence, when naturalists came together with their treasures, and showed them to one another and to the public. Of these the exhibitions given by Hiraga Gennai in the middle of the eighteenth century were perhaps the most celebrated. The present Botanic Garden of the Imperial University was established early in the Tokugawa period, viz. in 1681, and was long renowned as the "O Yaku En" (Garden of Medicinal Plants). The mastery of the Dutch language by a few earnest physicians in the middle of the eighteenth century is one of the greatest triumphs ever achieved by patient scholarship. Originally undertaken with the purpose of ascertaining something about Western medicine, their efforts soon exerted an influence on all branches of learning. The whole rich treasury of Western civilisation became suddenly accessible through the channel thus opened of the Dutch language. It is not possible to over-estimate the effect of the new acquisition on the progress of Japan. Suffice it to say that the country would not be what it is to-day but for this leaven which had been working through and through the whole mass of society for over a hundred years before the Restoration of 1868 enabled it to bear its legitimate fruit. This innovation, together with the visits of Thunberg (1775) and Siebold (1821), had due effect upon the natural history studies also. The system of Linné, especially in regard to plants, seems to have been well grasped, with very little delay. The most famous productions of the new school on natural history subjects are probably "Shokugaku Keigen" (Elements of Botanical Science) by Udagawa Yoan, 1835; and "Sōmoku Zusetsu" (Icones Plantarum) by Iinuma Yokusai, 1832—the latter being a standard work at the present day. It is perhaps a circumstance interesting enough to record that a work on the use of the microscope was published in 1801.

Looked at from the modern standpoint, the natural history of the pre-Restoration period (before 1868) was without doubt strongest in botany. The science of zoology seems to have been greatly backward in its development compared with that of the sister science, and its study was probably similar in method and aim to that of the Middle Ages in Europe. It seems to have concerned itself mostly with making commentaries on Chinese works of natural history, like "Honzō Kōmoku," or with identifying Japanese objects with names given in those writings. Excepting a little on birds, fishes and shells, hardly any work that can be called scientific, in any modern sense, seems to have been accomplished. Nevertheless this school did an immense service by showing that the study of natural objects was worth the best efforts of intellectual men. Names like Arai Hakuseki, Inao Jakusui, Kaibara Ekken, Ono Ranzan,[1] are among the most honoured in the annals of our learning.

With the restoration of the Emperor to his full power, in 1868, came the wholesale reconstruction of all political institutions, and the country has been, and is still, going through such a social revolution as has seldom been witnessed in any part of the world. Along with many other things, the old school of

[1] All these names are given in the Japanese fashion, with the surname first.

natural history was swept away, as chessmen from the board at the end of a game. So far as our science is concerned, there is a complete break at this period. The modern school of zoology dates from the appointment of Prof. E. S. Morse, of Salem, Mass., U.S.A., to the chair of Zoology at the University of Tokyo, in 1877. His indefatigable zeal and genial manners won many friends for the new science among all classes of society, while his lectures, popular or otherwise, drew attention for the first time to the immense strides which our science, under the stimulus of Darwinism, was making in the West. He, with a few students under him, also soon had in working order a tolerably good museum—the nucleus of the present zoological and anthropological collections of the Science College. It was also during his stay and through his care that the Tokyo Biological Society, from which the Tokyo Zoological Society is directly descended, was first organised. It is truly wonderful how much he accomplished in the brief time he was in Japan. On the return of Prof. Morse to America, he was succeeded by Prof. C. O. Whitman, now of the University of Chicago. It was the latter who first introduced modern technical methods. These two Americans, Morse and Whitman, thus stood sponsors to the modern school of zoology in Japan.

Since 1881, the development of zoology in Japan has been entirely in the hands of Japanese.[1] The spirit of earnest study which signalised the natural history school of the pre-Restoration days is happily revived, but with higher and wider purposes, and with greater facilities for successful attainment. Though only twenty years have passed since the "new departure," a vigorous school of zoology has already sprung up.

There can be no doubt that the establishment of the marine station at Misaki, by the Imperial University, in 1887, gave a great impetus to the study of zoology in Japan. Situated at the point of the peninsula jutting out between the Bay of Sagami and the Bay of Tokyo, it has access to localities long since famous as the home of some remarkable forms of animal life. Along the coast, all sorts of bottoms are found, yielding a rich variety of animal forms, while the hundred-fathom line is within two or three miles of the shore, and depths of five hundred fathoms are not very difficult of approach. The existence of a remarkable deep-sea fauna in these profounder parts has been ascertained within the last few years, and zoological treasures are now being constantly hauled up. The great "Black Current" (*Kuro Shiwo*) sweeps by, not many miles out, and a branch of it often comes right into the harbour of Misaki, gladdening the heart of the Plankton collector. Face to face with this inexhaustible treasury of animal forms, the zoologist will have to possess unusual powers of self-restraint, indeed, not to grow enthusiastic over his science.

The prospects of zoological science in Japan have never been brighter than they are at this time. All of its main branches, including applications of it to practical purposes, such as fisheries, sericulture, entomology, &c., are now fairly represented. Each year will see gradual additions to the specialists of different groups, as the number of graduates from the Imperial University increases. The marine station at Misaki, which has become too small for our growing body, will be removed within the present year to a new site, about two miles north of its present location, and its accommodations will be considerably enlarged. While perhaps not essential to the pursuit of science, the extreme beauty of the situation, which commands a matchless view of Fujiyama and the Sagami Bay, will certainly not lessen its attractions; and an additional charm to those who are interested in the heroic achievements of the past may be found in the historical associations with which the spot abounds. A proposed railway, passing near the new site, will bring the station within two or three hours of Tokyo. A number of teachers, scattered over different parts of the country, are acting somewhat as sentinels at the outposts of zoology, and doing good service in collecting animals from different localities. The field of activity has also lately been suddenly widened by the addition of Formosa to the territory of Japan, and the work of a collector now on that island will, it is hoped, be but the forerunner of many similar undertakings.

[1] Some who read this statement may consider that I have not given due credit to those zoologists from other countries who have lived in, or visited, Japan from time to time. It is certainly as far as possible from my intention to slight the labours of Hilgendorf, Döderlein, Pryer and others, but the fact remains that the recent development of the zoological school in Japan has been almost entirely independent of these men. It is a pleasure to me to add that Mr. Owston, of Yokohama, has been very active in unearthing the treasures of the deeper parts in the Sagami Sea.—K. MITSUKURI

THE WORSHIP OF METEORITES.[1]

HERE is a small fragment of iron that has a curious history. It is a portion of a mass of meteoric iron found upon a brick altar in one of the Ohio mounds. Along with it were various objects—a serpent cut out of mica—several terra-cotta figurines—two remarkable dishes carved from stone into the form of animals; pearls, shells, copper ornaments, and nearly three hundred ankle bones of deer and elk. There were but one or two fragments of other bones, and one animal furnished but two of these ankle bones; hence they must have been selected for some special, important reason. The figurines had been apparently broken for some purpose, and the whole collection had suffered in the fire not a little. In a like altar of another mound of the same group were found nearly two bushels of like objects.

It must have been in some ceremony of a religious, possibly one of a funereal, character that the mound builders collected here on the altar their ornaments and other valuables, and after burning them buried the charred débris in the huge earthen mound that was built over them and the altar.

What would we not give if this fragment could be endowed with the power of repeating to us its experience—chapters in the history of that people? But nearly all that we can say is that it was found among objects held by them in peculiar esteem, and used by them in some serious, probably religious ceremony.

There was formerly, and so far as I know there is still, in the collection of meteorites in Munich, a stone that weighs about a pound. It fell in 1853 in the region north of Zanzibar, on the East African coast, and was seen and picked up by some shepherd boys. The German missionaries tried to buy it, but the neighbouring Wanikas, because it fell from heaven, took it to be a god. They secured possession of it, anointed it with oil, clothed it with apparel, ornamented it with pearls, and built for it a kind of temple to give it proper divine honours. The agents of the missionaries were not allowed even to see the stone, far less could they purchase the Wanika's tutelar deity. Neither entreaties, nor arguments, nor offers of the missionaries, nor of the officials were of any avail. But when three years later the wild nomad tribes of the Masai came down upon the Wanikas, burned their village, and killed large numbers of them, the Wanikas thought very differently of the stone's protecting power. In fact they lost all respect for it. A famine having meanwhile arisen, the elders of the tribe were quite ready to exchange their palladium for the silver dollars of the missionaries.

Among the Buddha legends is one of two merchants who offered food to the Buddha, which was accepted, and in consequence of their request for some memorial of him the Buddha gave them a hair and fragments of his nails, and told them that hereafter a stone should fall from heaven near the place where they lived, and that they should erect a pagoda and worship these relics as though they were Buddha himself.

The nations of India have always been specially superstitious about stones fallen from the skies. In 1620 an aerolite fell near Jullunder, and the king sent for a man well known for the excellent sword blades that he made, and ordered him to work the lump into a sword, a dagger and a knife. The mass, however, would not stand the hammer, but crumbled in pieces. By mixture with iron of the earth the required weapons were made.

In 1867 a shower of stones fell, some forty in number, at Saonlod. The terrified inhabitants of the village, seeing in them the instruments of vengeance of an offended deity, set about gathering all they could find, and having pounded them into pieces they scattered them to the winds.

In 1870 a meteorite fell at Nidigullam, and the Hindoos at once carried it to their temple and worshipped it. The same has been repeated in India on the occasion of several other stonefalls in the present century. One native ruler refused to allow a stone to be carried across his territory for fear of the injury that might come to his people or his lands.

Two Japanese meteorites, formerly the property of a daimio family, were long kept and handed down as heirlooms, being in the care of the priests in one of the family temples. They were among the family offerings made to Skokujo on her festival days. They were connected with her worship by the

[1] A lecture delivered in New Haven, Conn., by the late Prof. Hubert A. Newton. (Reprinted from the *American Journal of Science.*)

belief that they had fallen from the shores of the Silver River, Heavenly River, or Milky Way, after they had been used by her as weights with which to steady her loom. One of these stones was presented by its late owner to the British Museum, and it is in its collection of meteorites.

There is a curious institution among the Chinese that has existed, according to Biot, from a time more than one thousand years before Christ. The Chinese attributed to different groups of stars a direct influence upon different parts of the empire. Some of these groups correspond, for example, to the imperial palaces, to the rivers, the roads, and the mountains of China. By reason of this belief, regular observations are made by the imperial astronomers of all that passes in the heavens, especially of the groups of stars in which comets and meteors originate, or across which they travel. The interpretation of what is seen in the sky forms part of the duties of these very important officials. These observations have been carefully written out, and are preserved in the archives of the empire. Upon the ending of a dynasty, by change of name or otherwise, these comet and meteor records have been published as a special chapter of the chronicles of the dynasty. The existing dynasty began in 1647, since which date the records are, therefore, unpublished.

In 1492 a stone of 300 pounds weight fell at Ensisheim, in Alsace. The Emperor Maximilian, then at Basel, had the stone brought to the neighbouring castle, and a Council of State was held to consider what message from heaven the stonefall brought to them. As a result, the stone was hung up in the church with an appropriate legend, and with strictest command that it should ever remain there intact. It was held to be an omen of import in the contest then in progress with France and in the contest impending with the Turks. Nineteen years later a shower of stones fell near Crema, east of Milan. The Pope was at war with the French, and the stones fell into the French territory. Before the year had passed the French, after a long possession of Lombardy and serious threatening of the States of the Church, were forced to retire from Italy. At this time Raphael was painting for an altar-piece his magnificent Madonna di Foligno, now in the Vatican. Beneath the rainbow in the picture, indicating divine reconciliation, Raphael painted also this Crema fireball, apparently to set forth divine aid and deliverance.

I have thus rapidly gone over some selected facts, showing how the mound builders, the wild Africans, the Hindoos, the Japanese, the Chinese, the modern Europeans have been ready to revere these mysterious bodies that come from the skies. But it is in the Greek and Latin literature that we have reason to expect the more numerous and full accounts, both legendary and historic, of this reverence and worship.

It is now, I believe, admitted by the best scholars that both in Greece and in Italy, there was a period earlier than the age of images, when the objects worshipped were not wrought by hand. Men worshipped trees and caves, groves and mountains, and also unwrought stones. Even after men began to make their objects of worship, these were in many cases mere hewn stones, not images. The earlier Greek term ἄγαλμα, an object of worship, stands apart from the later term εἰκών, image.

What would be more natural in that age to the affrighted witnesses of the most magnificent of spectacles, the fall of a meteorite, than for them to regard the object which had come out of a clear sky, with terrific noise and fire and smoke, as something sent to them by the gods to be revered and worshipped? It was nobler to worship a stone fallen from the sky than one of earthly origin.

The worship of an unwrought stone once established has wonderful vitality. For example, the Greek writers speak of such a worship in their day among the Arabian tribes. When Mohammed, with his intense iconoclasm, came down upon Mecca and took the sacred city, he either for reasons of policy, or from feeling, spared the ancient worship of this black stone. Entering into the sacred enclosure, he approached and saluted it with his staff (where it was built into the corner of the Kaaba), made the sevenfold circuit of the temple court, returned and kissed the stone, and then entered the building and destroyed the 360 idols within it. To-day that stone is the most sacred jewel of Islam. Towards it each devout Moslem is bidden to look five times a day as he prays. It is called the Right Hand of God on Earth. It is reputed to have been a stone of Paradise, to have dropped from heaven together with Adam. Or, again, it was given by Gabriel to Abraham to attest his divinity. Or, again, when Abraham was reconstructing the Kaaba that had been destroyed by the deluge, he sent his son Ishmael for a stone to put in its corner, and Gabriel met Ishmael and gave him this stone. It was originally transparent hyacinth, but became black by reason of being kissed by a sinner. In the day of judgment it will witness in favour of all those who have touched it with sincere hearts, and will be endowed with sight and speech. The colour of this stone, according to Burckhardt, is deep reddish brown, approaching to black; it is like basalt, and is supposed by some to be a meteorite.

It is not important for my purpose to separate the history from the myth. Eusebius quotes from an old Phœnician writer, Sanchouniathon, that the goddess Astarte found a stone that fell from the air, that she took it to Tyre, and that they worshipped it there in the sacred shrine. We have reason to question whether that Phœnician writer ever lived. What matters it? The existence of the story in Eusebius' time has to us a significance not greatly unlike that of the existence of the worship itself in the earlier years.

Virgil describes a detonating meteor in such terms that I feel reasonably sure that either he had seen and heard, or else he had had direct conversations with others who had seen and heard, a splendid example of these meteors. The passage is in the second book of the Æneid. The city of Troy was captured and was burning. All was in confusion. The family of Æneas was gathered ready for flight, but Anchises would not go. An omen, lambent flames on the head of his grandson, began only to shake his purpose to perish with his country. He prayed for more positive guidance. It is Æneas who describes the scene:

"Hardly had the old man spoken when across the darkness a star ran down from the sky carrying a brilliant light torch. We saw it go sweeping along above the roof of the house. It lighted up the streets, and disappeared in the woods on Mount Ida. A long train, a line of light, remained across the sky, and all around the place was a sulphurous smell. A heavy sound of thunder came from the left. Overcome now, my father raised his hands to heaven, addressed the gods and worshipped the sacred star. 'Now, now,' he cried, 'no longer delay.'"

This story is, of course, all legendary, but Virgil's description of the scene is true to life as conceived by pagan Rome in his day.

The images that fell down from Jupiter, or that fell from the skies, are often spoken of by Greek and by Latin writers. I mention three or four cases only where this allusion points to a meteoric origin as possible or probable. The earliest representative of Venus at old Paphos, on the island of Cyprus, was one of these heaven-descended images. It was not the Venus of the Capitol, nor the Venus of Milo, but as described was a rude triangular stone.

Cicero, in the grand closing passage of his oration against Verres, calls upon Ceres, whose statue he says was not made by hands but was believed to have fallen from the skies. The earliest of the images of Pallas at Athens was said to have had a like origin. Pausanias saw at Delphi a stone of moderate size which they anointed every day, and covered during every festival with new shorn wool. They are of opinion, he adds respecting this stone, that it was the one given by Cybele to Saturn to swallow as a substitute for the infant Jupiter, which Saturn after swallowing vomited out on the earth.

There is a marvellous story of a peculiar stone in the poem Lithika by the apocryphal Orpheus. Phœbus Apollo gave the stone to the Trojan Helenus, and Helenus used it in soothsaying. It was called Orites, and by some *Siderites*. It had the faculty of speech, and when Helenus wished to consult it he performed special ablutions and fasts for twenty-one days, then made various sacrifices, bathed the stone in a living fountain, dressed it and carried it in his bosom. The stone now became alive, and to make it speak he would take it in his arms and dandle it, when the stone would begin to cry like a child for the breast. Helenus would now question the stone, and receive its answers. By means of these he was able to foretell the ruin of the Trojan State. Whoever framed that story had, I believe, before him a real stone, and the description is very like that of a meteorite, saying nothing of its having come from Apollo. The Orphic writer says that it was rough, rounded, heavy, black, and close-grained. Fibres like wrinkles were drawn in circular forms over the whole surface above and below.

Here I show you a stone such as was described—rounded, black, heavy, close-grained, and having fibres like wrinkles in circular forms over the whole surface above and below.

The name *Siderites* was at a later date applied to the loadstone, but by this writer the two stones are separately described, and are apparently distinct. If this name was of Greek origin it seems to be allied to *sideros*, *iron*, and this heavy stone, like nearly all meteorites, probably contained iron. If, however, this name came from a Latin source (for it is used both by Greek and by Latin writers) it has affinities with *Sidus*, a star, and its meteoric character is still more clearly indicated.

One of the most interesting of the stories about images that have fallen from heaven, is the basis of that beautiful tragedy of Euripides. "Iphigeneia in Tauris." To many of you the story is familiar, but it will bear repetition.

The goddess Diana detained at Aulis the Grecian fleets by contrary winds, and required the sacrifice of Iphigeneia, the daughter of Agamemnon, before the Greeks could set sail. The father consented; and the daughter, apparently sacrificed, was really rescued by Diana, and borne to the Tauric, or Crimean peninsula on the north shore of the Black Sea. She was then made a priestess in the temple of the goddess. At this shrine the barbaric inhabitants used to sacrifice before an image of Diana, that fell from heaven, all strangers that were shipwrecked upon the coast. The unhappy Iphigeneia, forced to take a leading part in these human sacrifices, laments her sad lot:—

"But now a stranger on this strand,
'Gainst which the wild waves beat,
I hold my dreary, joyless seat,
Far distant from my native land;
Nor nuptial bed is mine, nor child, nor friend.
At Argos now no more I raise
The festal song in Juno's praise;
Nor o'er the loom sweet sounding bend,
As the creative shuttle flies,
Give forms of Titans fierce to rise,
And dreadful with her purple spear
Image Athenian Pallas there.
But on this barbarous shore
Th' unhappy stranger's fate I moan,
The ruthless altar stained with gore,
His deep and dying groan;
And for each tear that weeps his woes,
From me a tear of pity flows."

Orestes, the brother of Iphigeneia, had avenged upon his mother the murder of his father. For this he was driven by the Furies. While stretched before the shrine of Phœbus he heard the divine voice from the golden tripod, commanding him to speed his way to the wild coast of the Taurians, thence to take by fraud or by fortune the statue of Diana that fell from heaven, and carry it to Attica. Doing this he should have rest from the Furies.

He was captured, however, along with his friend Pylades, and brought to the altar to be sacrificed. The relationship of the brother and sister became here revealed, and they together fled, carrying with them the image. It was not without a struggle that they reached the shore, but finally,

"On his left arm sustained
Orestes bore his sister through the tide,
Mounted the bark's tall side and on the deck
Safe placed her and Diana's holy image
Which fell from heaven."

Neptune favoured the Greeks, Minerva forbade pursuit, and the image was borne to Halae (or as some said to Brauron) in Attica.

Cicero spoke of the Trojan Palladium as something that fell from the sky: *quod de coelo delapsum*. Other classical writers, notably Ovid, speak of it in similar terms. The story in its various forms points toward a stonefall as its basis. One form of it runs thus:—

Pallas and her foster sister Athena were wrestling with each other, when Pallas was accidentally killed. In grief Athena made an image of Pallas and set it up on Olympus. When King Ilus was about building his city on the Trojan plain he prayed for a favourable omen. In response to his prayer Jupiter cast this image down at the feet of the suppliant king. In the new city it was set up in a temple specially erected to contain and protect it. So long as Troy could keep safely this image, the city, it was firmly believed, could not be taken by its foes.

According to one story, the Greeks stole the image before capturing the city. As many cities afterwards claimed to possess the treasure as claimed to be the birthplace of Homer. According to the Romans, Æneas carried the Palladium to Italy, and the image was regarded as the most sacred treasure of the Roman State. For centuries even in historic times it was so carefully kept by the Vestal Virgins that the Pontifex Maximus was not allowed to see it.

We naturally have doubts about the nature, or even the existence, of an object so kept out of sight. What it was that the Vestals thus guarded, or whether they had anything to represent the image of Pallas, will probably never be known. But it is far otherwise with another famous object of Roman worship. To the east of the Trojan plain on which the Palladium fell, rise the mountains of Phrygia and Galatia. In Pessinus, near the border line of these two countries, and in the caves and woods near Pessinus, the goddess Cybele, the mother of the great gods, Jupiter, Neptune and Pluto, was specially worshipped. This worship may not have been more degrading than the worship of many other Asiatic divinities. But it was wretched and unmanly almost beyond our possible conception. It furnished to Catullus the theme for the most celebrated of his poems, one of the strongest pictures in all literature. The Grecian athlete entered her service with joyful music and dancing. Too late he looks back from the Asiatic shore, out of his hopeless degradation, on the nobleness of his former Grecian life. The lion of Cybele drives him in craven fear again into the wild woods, to spend his days in the menial servitude. The Roman poet exclaims, "O goddess, great goddess Cybele, goddess queen of Dindymus; far from *my* house be all thy frenzies; others, others, drive thou frantic."

At some unknown early time a meteoric stone fell near to Pessinus. It was taken to the shrine of Cybele, and there set up and worshipped as her image. This image and its worship very early attained a wide celebrity. About two hundred years before Christ, in the time of the second Punic war, the stone was transported to Rome. The detailed history of the transfer is given by several writers in varied terms. It forms one of Livy's charming stories, it is told in poetic terms by Ovid, it is given as a tradition by Herodian. For every detail of the history I do not ask confiding belief, but the principal event is, I suppose, historically true.

In the year 205 before Christ, Hannibal had, since crossing the Alps, been holding his place in Italy for more than a dozen years, threatening the existence of the Roman State. The fortunes of war were now somewhat adverse to the Carthagenian general. A shower of stones alarmed the Romans. The decemvirs consulted the Sybilline books, and there found certain verses which imported that whensoever a foreign enemy shall have carried war into the land of Italy he may be expelled and conquered if the Idæan mother be brought from Pessinus to Rome. These words were reported to the Senate. Encouraging responses came at the same time from the Pythian oracle at Delphi.

The Senate set about considering how the goddess might be transported to Rome. There was then no alliance with the States of Asia. But King Attalus was on friendly terms with the Romans because they had a common enemy in Philip II. of Macedon. The Senate, therefore, selected an imposing embassy from the noblest Romans. A convoy of five quinqueremes was ordered for them, that they might make an appearance suited to the grandeur of the Roman people. The embassy landed on their way and made inquiry of the oracle at Delphi, and were informed "that they would attain what they were in search of by means of King Attalus, and that when they should have carried the goddess to Rome they were to take care that whoever was the best man in the city should perform the rite of hospitality to her." The king received them kindly, but refused their request; whereupon an earthquake tremor shook the place, and the goddess herself spoke from her shrine, "It is my will, Rome is a worthy place for any god; delay not." The king yielded; a thousand axes hewed down the sacred pines, and a thousand hands built the vessel. The completed and painted ship received the stone, and bore it to the mouth of the Tiber.

It was the spring of the following year before the ship arrived. Meanwhile new prodigies frightened the people. A brilliant meteor had crossed Italy from east to west, a little south of Rome, and a heavy detonation followed. From this, or from some other meteor, another shower of stones had fallen. In expiation, according to the custom of the country in case of stonefalls, religious exercises during nine days were ordered. The Senate after careful deliberation selected one of the Scipios, deciding that he of all the good men in the city was the best, and they deputed him to receive the stone. The whole city went out to meet the goddess. Matrons and daughters, senators and knights, the vestals and the common people all joined the throng. But a drought had reduced the water of the Tiber so that the vessel grounded upon the bar. All the efforts of the men pulling upon the ropes failed to move it. A noble matron who had been slandered stepped forward into the water. Dipping her hands three times into the waves and raising them three times to heaven, she besought the goddess to vindicate her good name if she had been unjustly slandered. She laid hold of the rope and the vessel followed her slightest movement, amid the plaudits of the multitude.

Scipio, as he had been ordered by the Senate, waded out into the water, received the stone from the priests, carried it to the land, and delivered it to the principal matrons of the city, a band of whom were in waiting to receive it. They, relieving each other in succession and handing it from one set to another, carried it to the gates of the city, and thence through the streets to the temple of Victory on the Palatine Hill. Censers were placed at the doors of the houses wherever the procession passed, and incense was burned in them, all praying that the goddess would enter the city with good will and a favourable disposition. The people in crowds carried presents to the temple. A religious feast and an eight days' festival with games were established to be celebrated thereafter each year in the early part of April.

Before another year had passed Hannibal, after having maintained his army in Italy for fifteen years, was forced to withdraw again to Africa. From the liberal offerings of the people, in gratitude for deliverance, a temple was erected to Cybele, long known as the Temple of the Great Mother of the Gods, so that twelve years after its arrival at Rome the stone was taken from the Temple of Victory and set up in its new home. A silver statue of the goddess was constructed, to which the stone was made to serve in place of a head. Here, in public view, for at least five hundred years that stone was a prominent object of Roman worship. Its physical appearance is described by several writers. It was conical in shape, ending in a point, this shape giving occasion to the name *Needle of Cybele*. It was brown in colour, and looked like a piece of lava. Arnobius, a Christian writer just before the accession of Constantine, and over five hundred years from the date of its arrival at Rome, says of the stone:

"If historians speak the truth and insert no false accounts into their records, there was brought from Phrygia, sent by King Attalus, nothing else in fact than a kind of stone, not a large one, one that could be carried in a man's hand without strain, in colour tawny and black, having prominent, irregular, angular points, a stone which we all see to-day, having a rough irregular place as the sign of a mouth, and having no prominence corresponding to the face of an image." Arnobius goes on to ask whether it was possible that this stone drove the strong enemy Hannibal out of Italy—made him who shook the Roman State, unlike himself, a craven and a coward.

Just when this stone disappeared from public view I do not know. In directing the recent excavations on the Palatine Hill, Prof. Lanciani was at first in great hopes of finding it; because it had no intrinsic value to the many spoliators of Rome, nor to the former excavators of Roman temples. But the place in which he expected to find it was absolutely empty. At a later date, however, he found in a rare volume an account of excavations made on the Palatine Hill in 1730, in which the private chapel of the Empress was found and explored. In this we perhaps have an account, and, it is to be feared, the last account of a sight of the Cybele stone. The writer says: "I am sorry that no fragment of a statue, or bas-relief, or inscription has been found in the chapel, because this absence of any positive indication prevents us from ascertaining the name of the divinity to whom the place was principally dedicated. The only object which I discovered in it was a stone nearly three feet high, conical in shape, of a deep brown colour, looking very much like a piece of lava, and ending in a sharp point. No attention was paid to it, and I know not what became of it." This description is almost identical with that given by Arnobius, and others, of the stone from Pessinus.

Another stone of meteoric origin was brought to Rome, and there for a brief period was most fantastically worshipped. This was near the beginning of the third century after Christ. It came, like the other stones of which I have spoken, from Asia. In the city of Emesa, on the banks of the Orontes, about midway between Damascus and Antioch, there was in those days a magnificent temple of the Sun. A gorgeous worship was maintained before a stone that fell from heaven, that served as the image of the Sun-god. The description of the stone is not very unlike that of the Cybele meteorite. Herodian, who probably saw it, says: "It is a large stone, rounded on the base, and gradually tapering upwards to a sharp point; it is shaped like a cone. Its colour is black, and there is a sacred tradition that it fell from heaven. They show certain small prominences and depressions in the stone, and those who see them persuade their eyes that they are seeing an image of the Sun not made by hands."

This Sun-god was named Heliogabalus, and before the altar a boy of nine years of age began to serve as priest. Such a Syrian service did not make the boy grow manly nor virtuous, and when at the age of fifteen he became emperor through the money and intrigues of his grandmother, and the murder of the Emperor Macrinus, we have for three years at Rome the view of the sorriest scrapegrace that ever sat on a throne. He assumed with the name of Antoninus also the name of his god Heliogabalus. To the great disgust of the Roman Senate and people, he brought with him from Syria the image of his god, the sacred stone, and himself continued before it his priestly service with all its fantastic forms and gesticulations. He built within the city walls a grand and beautiful temple, with a great number of altars around it; he repaired thither every morning, and sacrificed hecatombs of bulls and an infinite number of sheep, loading the altars with aromatics, and pouring out firkins of the oldest and richest wines. He himself led the choruses, and women of his own country danced with him in circles around the altars, while the whole senatorian and equestrian orders stood in a ring like the audience of a theatre.

But now he must have a wife for his god. So he broke into the apartments guarded by the vestals and carried to the palace the Trojan Palladium, or what he supposed was that object, and was intending to celebrate the nuptials of the two images. His god, however, he concluded, would not be pleased with a warlike wife like Pallas; therefore, he ordered to be brought from Carthage an ancient image of Urania, or the Moon, which had been set up by Dido when she first built old Carthage. With this image he demanded the immense treasures in her temple, and he also collected from every direction immense sums of money to furnish to the Moon a suitable marriage portion when married to the Sun.

He built another temple in the suburbs of Rome, to which the Emesa stone, the god (?) was carried in procession every year, while the populace were entertained with games, and shows, and feastings and carousings. Herodian thus describes this performance:—

"The god was brought from the city to this place in a chariot glittering with gold and precious stones, and drawn by six large white horses without the least spot, superbly harnessed with gold, and other curious trappings, reflecting a variety of colours. Antoninus himself held the reins—nor was any mortal permitted to be in the chariot; but all kept attendant around him as charioteer to the deity, while he ran backward, leading the horses, with his face to the chariot, that he might have a constant view of his god. In this manner he performed the whole procession, running backwards with the reins in his hands, and always keeping his eyes on the god, and that he might not stumble or slip (as he could not see where he went), the whole way was strewn with golden sand, and his guards ran with him and supported him on either side. The people attended the solemnity, running on each side of the way with tapers and flambeaux, and throwing down garlands and flowers as they passed. All the effigies of the other gods, the most costly ornaments and gifts of the temples, and the brilliant arms and ensigns of the imperial dignity, with all the rich furniture of the palace, helped to grace the procession. The horse and all the rest of the army marched in pomp before and after the chariot."

The reign of a foolish boy at this period of Rome's history was necessarily a short one, and at the age of eighteen the soldiers killed him and let the Roman populace have the body to drag through the city streets. The worship of the Sun-god at once ceased, and, no doubt, the stone also was thrown away. The Cybele stone, however, remained an object of public worship, since the quotation from Arnobius, which I have given, was written nearly a century later than the reign of Heliogabalus.

I propose to speak briefly of one more meteorite whose worship has had a world-wide fame: the image of the Ephesian Artemis. This worship had its centre at Ephesus, but was widely extended along the shores of the Mediterranean. Temple after temple was built on the same site at Ephesus, each superior to the preceding, until the structure was reckoned one of the seven wonders of the world. As a temple, it became the theatre of a most elaborate religious ceremonial. As an asylum, it protected from pursuit and arrest all kinds of fugitives from justice or vengeance. As a museum, it possessed some of the finest products of Greek art, notably works of Phidias and Apelles. As a bank, it received and guarded the treasures which merchants and princes from all lands brought for safe keeping. In its own right it possessed extensive lands and large revenues. The great city of Ephesus assumed as her leading title that of *νεωκόρος*, or temple-warden of Artemis, putting his name on her coins, and in her monumental inscriptions.

The image, which was the central object in this temple, was said to have fallen from heaven. Copies of it in all sizes and forms were made of gold, of silver, of bronze, of stone and of wood, by Ephesian artificers, and were supplied by them to markets in all lands. What a lifelike picture is given us in the 19th chapter of the Acts of the Apostles, of the excited crowd of Ephesians, urged on by the silversmiths, who made for sale the silver shrines of the goddess, and who saw that their craft was in danger if men learned to regard Artemis as no real divinity, and to despise the image that fell down from the sky.

We cannot suppose that the Ephesian Artemis image of the first century was a meteorite, though we have the distinct appellation, Diipetes, fallen from the sky. But I believe that there was a meteoric stone that was the original of the Ephesian images, and it seems not at all improbable that in some one of the destructions of the temple it disappeared. Or, in the progress of time, there may have been a desire to represent the goddess in a more artistic form than the shapeless stone afforded.

Many forms of the Ephesian Artemis are still preserved, and they have, amid all their variations, a certain peculiar character in common. That common character seems to me to confirm the statement that the original image fell from heaven. This goddess is regarded, let me say, as different from the Grecian Artemis, the beautiful huntress so well known in Greek art, and I am speaking only of the images of the Ephesian Artemis.

There is one peculiarity in the outward forms of the meteorites that is characteristic of nearly all of them. I mean the moulded forms, and the depressions all over the surfaces. They are better appreciated by being seen, than by any description I can give you. They are common to meteorites of all kinds, from the most friable stone to the most compact iron. (I show you one, a stone from Iowa—also the plaster cast of another, a stone from some fall, I know not which one.) Those who have lately visited the collection in the Peabody Museum may recollect the model of an iron that fell two or three years ago in Arkansas, which displays most beautifully these depressions.

Let now an artist attempt to idealise any one of these moulded forms, and to make something like a human shape out of one of them. He must necessarily set it upright, and he must give it a head. You have then a head surmounting one of these moulded forms. Let now the convenience and the taste of the artificers of the images have some liberty to act—and we know that they did act, for we have considerable variety in these images—and a development in the conventional representation of the image is sure to follow.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

The State of Pennsylvania has made a grant of 150,000 dollars to Lehigh University.

Dr. Ralph Stockman has been appointed to succeed the late Prof. Charteris in the chair of Materia Medica and Therapeutics in the University of Glasgow.

It is announced that the late Dr. Matthew Hinchliffe, of Dewsbury, Yorkshire, has bequeathed about 50,000*l*.—almost the whole of his property—for purposes of higher education in Dewsbury.

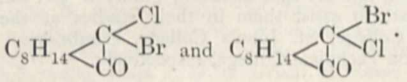
In connection with the opening of a technical day school at the Borough Polytechnic Institute next month, and the general development of the Institute, the Governors have made the following appointments:—Mr. E. T. Marsh, head-master; Dr. F. Mollwo Perkin, head of the chemistry department; Mr. G. E. Draycott, lecturer in engineering.

Senior county scholarships, tenable for three years, providing free tuition (up to 30*l*. a year) and a maintenance grant of 60*l*. a year, have been awarded by the Technical Education Board of the London County Council to the following candidates:—Charles Cornfield Garrard, of Finsbury Technical College, who intends to proceed to Germany for three years to study chemistry; George William Howe, of Woolwich Polytechnic, who intends to proceed to the Durham College of Science, Newcastle-upon-Tyne, to study engineering; Edith Ellen Humphrey, of Bedford College, who intends to proceed to Germany for three years to study chemistry; Frederick Edwin Whittle, an intermediate county scholar of the Central Technical College, who desires to continue his engineering studies at the college. A senior county scholarship, tenable for one year, has been awarded to William Laurence Waters, of the Central Technical College, to enable him to complete his engineering course. The following special grants have been made:—To H. C. Green, H. H. F. Hyndman and W. H. Winch, grants of 50*l*. each for the coming year, to assist them in their studies at the Universities of Oxford and Cambridge; to T. M. Lowry, A. W. Poole, and H. E. Stevenson, grants of 30*l*. each for the coming year, to assist them in their studies at the Central Technical College, St. John's College, Cambridge, and the East London Technical College, respectively.

SOCIETIES AND ACADEMIES.

London.

Chemical Society, June 17.—Prof. Dewar, President, in the chair.—The following papers were read:—Molecular refraction of dissolved salts and acids, Part ii., by J. H. Gladstone and W. Hibbert. The molecular refraction of a salt in aqueous solution is sometimes greater and sometimes less than that of the same salt in the crystalline state. The authors have also made determinations of the refraction constants of various substances—hydrogen chloride, nitric acid, lithium chloride, and ferric chloride—in water and organic solvents.—On a space formula for benzene, by J. N. Collie. The author has devised a new space formula for benzene in which the six hydrogen atoms are divided into two sets of three each, one set being situated inside the molecule, whilst the other set is on the outside.—On the production of some nitro- and amido-oxypicolines, by A. Lapworth and J. N. Collie. Dioxypicoline, $C_6H_7NO_2$, is readily nitrated, yielding a nitrodioxypicoline, $C_6H_6N_2O_4$; this, on reduction, yields an amidodioxypicoline $C_6H_8N_2O_2$, which is easily hydrolysed with formation of a trioxypicoline, $C_6H_7NO_3$.—Further experiments on the absorption of moisture by deliquescent substances, by H. W. Hake. From experiments made on a number of deliquescent substances the author concludes that during deliquescence a quantity of water corresponding to a definite hydrate is taken up.—The fusing point, boiling point and specific gravity of nitrobenzene, by R. J. Friswell. In view of the discordant values given by various authors for the above constants, the author has re-determined the physical constants of both solid and liquid nitrobenzene.—The action of light on a solution of nitrobenzene in concentrated sulphuric acid, by R. J. Friswell. A solution of nitrobenzene in concentrated sulphuric acid is very rapidly blackened by exposure to sunlight or burning magnesium ribbon.—The reduction of perthiocyanic acid, by F. D. Chattaway and H. P. Stevens. The reduction of perthiocyanic acid by tin and hydrochloric acid gives an almost quantitative yield of thiourea and carbon bisulphide in accordance with the equation:—$H_2N_2C_2S_3 + 2H = CS(NH_2)_2 + CS_2$.—The so-called hydrates of isopropyl alcohol, by T. E. Thorpe. The author has been unable to find any experimental evidence in favour of the existence of the four hydrates of isopropyl alcohol which have been described.—The carbohydrates of cereal straws, by C. F. Cross, E. F. Bevan and C. Smith.—Studies on the constitution of tri-derivatives of naphthalene. No. 16. Conversion of chloronaphthalenedisulphonic acids into dichloronaphthalenesulphonic acids, by H. E. Armstrong and W. P. Wynne. The authors find that the conversion of naphthalenesulphonic acids into chloronaphthalenes by heating with phosphorus pentachloride may be thoroughly trusted as a means of determining constitution in the naphthalene series, inasmuch as no isomeric change occurs. The chloronaphthalenedisulphonic chlorides when heated with phosphorus pentachloride are converted partly into dichloronaphthalenesulphonic chlorides and partly into trichloronaphthalenes of the same orientation.—Conversion of 1 : 1′- into 1 : 4′-dichloronaphthalene by hydrogen chloride. The products of hydrolysis of 1 : 1′-dichloronaphthalene-3-sulphonic acid, by H. E. Armstrong and W. P. Wynne.—Note on the formation of diacetanilide, by G. Young. Acetanilide is readily converted into diacetanilide by boiling with excess of acetic chloride.—Derivatives of phenetol azophenols, by J. T. Hewitt, T. S. Moore and A. E. Pitt. In order to obtain further information respecting the remarkable coloured derivatives of benzeneazophenol, the authors have prepared and examined the ortho- and para-phenetolazophenols and their derivatives.—δ-Ketopinic acid and camphoic acid, by W. S. Gilles and F. F. Renwick. The inactive δ-ketopinic acid obtained by oxidising active pinene hydrichloride can be separated into two optical antipodes by crystallising its strychnine salts; the tribasic acid obtained by oxidising ketopinic acid is camphoic acid.—Note on stereoisomeric di-derivatives of camphor and on nitrocamphor, by T. M. Lowry. On brominating chlorocamphor, or chlorinating bromocamphor, products are obtained which seem to be isomorphous mixtures of the stereoisomeric αα-chlorobromocamphors.—



Nitrocamphor is birotatory in benzene solution; when its benzene solution is evaporated and the residue heated on the water bath, a substance is obtained which differs widely in physical properties from nitrocamphor.—The interaction of ethylene dichloride and ethylic sodiomalonate, by B. Lean and F. H. Lees.—Hexanaphthene and its derivatives. Preliminary note, by Miss E. C. Fortey.

PARIS.

Academy of Sciences, August 2.—M. Wolf in the chair.—On the commencement of the combination between hydrogen and oxygen, by M. Berthelot. The temperature at which hydrogen and oxygen begin to combine has been the subject of numerous researches; but widely differing results have been obtained, even by the same observers, in attempting to repeat an experiment under apparently precisely similar conditions. These differences are undoubtedly due to secondary reactions, and the present paper is devoted to the elucidation of some of these. In presence of baryta, the gases completely combine at 280° in twenty-six hours. The reaction, however, is a complex one, since if the experiment is stopped after five hours, barium peroxide is found to be present. With caustic potash analogous phenomena were observed.—On the analysis of aluminium and its alloys, by M. Henri Moissan. An examination of the methods of analysis of aluminium, proposed by M. Balland, has shown that the gain in speed is accompanied with a loss in accuracy. The original method proposed by the author, although tedious, is necessary for trustworthy results.—On the fixation and nitrification of nitrogen in arable earths, by M. P. P. Dehérain.—The toxic effects produced by the sweat of a healthy man, by M. S. Arloing. It is shown that perspiration contains substances of considerable toxic power, the properties of which possess some analogy with some of the microbial toxines.—On the symmetrical tetramethyldiamidodiphenyldianthranoltetramethyldiamide from the corresponding oxanthranol, by MM. A. Haller and Guyot. The formation of this substance is easily effected by the use of phosphorus oxychloride as a condensing agent, although the previous attempt of O. Fischer with sulphuric acid failed.—Occultation of the group of the Pleiades by the moon, July 23, 1897, at Lyons, by M. Ch. André.—On isothermal surfaces, by M. A. Pellet.—Light apparatus for the rapid determination of the acceleration due to gravity, by M. Marcel Brillouin. A short pendulum beating quarter seconds was used, together with a chronometer the escapement of which was so modified as to furnish flashes of light at known intervals apart.—On permanent changes of shape undergone by glass, and on the displacement of the zero of thermometers, by M. L. Marchis.—On the compressibility of gases in the neighbourhood of the atmospheric pressure, by MM. A. Leduc and P. Sacerdote.—On the atomic weights of nitrogen, chlorine and silver, by M. A. Leduc.—Thermochemical determinations relating to cupric compounds, by M. Paul Sabatier.—On some bromoketones, by M. A. Collet.—Observations on the combination of some diazo-compounds with phenols, by MM. Ch. Gassmann and Henry George.—On caroubinose, by M. Jean Effront.—On an organic compound rich in manganese extracted from ligneous tissue, by M. G. Guérin. The substance in question contained 0·4 per cent. of manganese.—Presence of iodine in parathyroid glandules, by M. E. Gley. The glandules are small bodies attached to the thyroid gland proper of the rabbit. The percentage of iodine is much larger in the former than in the latter.—The eparterial bronchia in the Mammifera, and especially in Man, by M. D. A. d'Hardivillier. — The first stages in the development of the Pedipalps, by Mdlle. Sophie Pereyaslawzewa. — Sympathetic nervous system of the Orthoptera, by M. L. Bordas.—On a new Sporozoa (*Cœlosporidium chydoricola*) intermediate between the Sarcosporidia and the *Amœbidium* (Cienkowsky), by MM. Félix Mesnil and Émile Marchoux.—Phagocytic organs observed in some marine annelids, by Dr. J. Cantacuzène.—Experimental study of the Coccidia, by M. Louis Léger.—On the independence of certain bundles in the flower, by M. Paul Grélot.—Reflex functional troubles of peritoneal origin, observed during the evisceration of deeply anæsthesised animals, by MM. L. Guinard and L. Tixier.—On the diamond-bearing rocks of the Cape and their variations in depth, by M. L. De Launay.—On the probable antiquity of tin mining in Brittany, by M. L. Davy. The tin mines in Brittany would appear to have been used by the Gauls prior to the Roman Conquest.—On the action of high frequency currents from the point of view of arterial tension, by M. A. Montier.—On a palliative electrical treatment of facial neuralgia, by M. J. Bergonié.

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