THURSDAY, MARCH 16, 1899.

THE FRILLED FRINGE OF THE SOUTH COAST.

The Geology of the Isle of Purbeck and Weymouth. By A. Strahan. Pp. xi + 278. (London: Printed for her Majesty's Stationery Office, by Wyman and Sons, Ltd., 1898.)

ANY ONE travelling from London to the South Coast may see how the gentle southerly inclination of the chalk, which has carried it under the Tertiary beds, changes on the south side of the trough, bringing the chalk up again with a steeper slope, but now with a northerly dip; how it then folds over the axis of the Wealden anticlinal, only to fall to the south more rapidly than it did before, and pass under the waters of the Channel. If we make our traverse further west, there, in consequence of the strike of the rocks being oblique to the trend of the coast, we find still more southerly folds brought into view, and the chalk, after passing rapidly under the Tertiary beds of the Hampshire basin, re-appearing in the Isle of Wight, with the strata vertical or even thrown over beyond the vertical. Along this line of disturbance older and older Mesozoic rocks turn up in the anticlinal folds.

Here, as in many other parts of the world, we have plications increasing in sharpness as we cross the strike towards some axis of principal intensity. As might be expected, these folds and their accompanying disruptions, being of the nature of local readjustments in an area of long-continued crush, are seen to be of different dates. When we carry our investigations further afield we find that the disturbances of the strata, which in this district are shown to be modern and probably still going on, belong to a very ancient system of strains, for the Palæozoic rocks of Belgium, Dover and Somerset are still more severely contorted, and the Mesozoic formations rest almost undisturbed on the upturned and eroded edges of these older previously folded beds.

The author of the work before us has found himself called upon to describe and explain the structures and sequence of rocks occurring in one of the most interesting of these crumpled coast districts. His reputation as one of the soundest of the younger school of geologists, as well as the names of those of his colleagues who have contributed to the work, are a sufficient guarantee that it is an important addition to scientific literature.

The public hardly realises what an immense amount of valuable scientific work is contained in the maps and memoirs of the Geological Survey, and the accuracy of even the older Survey work is marvellous if we take into account how much of it may be considered as the efforts of pioneers, carried out when comparatively little was known of the methods of discrimination and the data for classification which are now available.

A work of such importance as this by authors of such position in science as those who have contributed to it would have been very differently turned out by the far-sighted American Government, by artistic Italy, or spirited little Portugal. To spend so much on a scientific staff, and then depreciate the results in the face of the world by issuing them in the unattractive form in which our Survey Memoirs are published, is not business-like, to say the least of it. That the present volume is above the average is clearly due to careful drawing and revision by the author rather than to an improvement in the system, which we see in the relegation of the valuable *résumé* by the Director-General to such small print as would seem to indicate as clearly as if it were printed at the head, "Preface, of no importance, pass on to the next," or which gives in some of the sections a lot of small blots and blobs, often unreadable with a lens, to represent the numerals referred to in the text; while the ink, which is superfluous here, might have improved the capitals elsewhere.

The work is a treatise upon the geology of a defined area, and to give an account of this would be to make an abstract of a book already too much condensed. The formations included range from the Fullers' Earth to Recent, but the greater part is devoted to the Jurassic and Cretaceous Series; the Tertiary and Recent beds do not occupy many pages. The rocks are much disturbed, and an interesting account is given of the character and age of the earth movements which have affected them. No molten matter has burst through these broken strata. The crush has been in some cases so severe that the flints have been reduced to powder, and drawn out into black streaks like so much coal dust (p. 179), while large masses of rock have been thrust forward, the older being often pushed over the newer in vast slices, and portions pinched out so that the thickness has been reduced to one-fourth of what it was. The structure of the district is complicated by crossing systems of folds which produce oval or spoon-shaped basins and domes, varying according to the relative intensity of either system. As these are arranged in quincunx pattern they frequently come into view *en échelon*. The classification and nomenclature have demanded the consideration of some theoretical questions of scientific importance; and here especially we have to thank the officers of the Survey for using words which convey a clear idea to the public of what they are talking about, instead of endeavouring to show their own ingenuity, wide reading or knowledge of foreign languages in the invention or adoption of new and unnecessary terms.

If there is a doubt as to the horizon at which the boundary between the Jurassic and Cretaceous systems should be drawn—and a suspicion arises that the equivalent position has not been assigned to it in different areas—we must inquire whether this difficulty arises from wrong identifications among the stratified rocks in either of the localities, or whether there has not been some change of conditions which has made it difficult to prove exact chronological identity between the series seen in the several more or less widely separated areas. For instance, land surfaces are suffering denudation, while sediment is being deposited in an adjoining area in sea or estuary or lake or river. In the district described there are several successive deposits which have a tendency to become coarser as we follow them westward, or point to the local incoming of estuarine or fluviatile conditions. In such an unstable area palæontological continuity or interruption will depend upon slight geographical changes.

Whether an estuary existed in the Weald while beds which have been shown to belong to conditions continuous with those of later Jurassic times were being laid down elsewhere, or whether that estuary did not exist until the movement which resulted in the deposition of the Cretaceous series had fairly set in, is a very pretty subject for inquiry; but the relations of the rocks inferred from sections seen in any district must be fairly stated without any forced hypotheses, adopted in order to accommodate the evidence to inferences drawn from sections in other parts of the country, and it is very difficult to avoid the suspicion that the Lower Greensand of East Anglia, which is the obvious basement bed of the Cretaceous of that area, may not be the equivalent of only the uppermost part of what has been called Lower Greensand further south.

In trying to find a satisfactory explanation of some of the superficial deposits, our author is driven to invoking that *deus ex machina* the frost of the Glacial Epoch (p. 199); but we may let the curtain fall on that.

The Chesil Bank is described in some detail. What with the wear and tear of the pebbles, and the cutting-off of the supply, it would appear that the foot shows an annual balance against the bank, so that some day it must break.

Many questions of economic geology are treated of throughout the work, and a short *résumé* of them is collected into a separate chapter. Among them that of water supply is not the least important. We learn how water that is banked up by other and impure water may be itself quite safe if not too heavily drawn on; but if the pure water be exhausted the surrounding impure water will be sucked into the well, as was done at Portland, where the sea-water which had held up the fresh inland water was eventually drawn into the well by heavy pumping (p. 119).

Many products of commercial value occur in the rocks of the district. Portland stone is used all over the country for building, and is locally burnt for lime. The Purbeck limestone is found in the fine fluted shafts of every church of the thirteenth century which had any pretension to architectural beauty, and has been in great demand for decorative purposes ever since. It has recently been employed in the church at Arundel. The Kimmeridge coal, derived perhaps more from animal than from vegetable matter, is used only by those whose poverty forces them to endure its almost intolerable smell. The brown hæmatite (p. 37-40) is of more scientific than practical importance.

We could hardly recommend the student of geology a more useful vacation course than to take a trustworthy guide of this kind to a limited area, and with it to examine the stratigraphy of the district, especially following and copying the admirable sections given at the end; to trace the boundaries of formations, and then compare his lines with those on the index map given on Plate viii., or, better still, with the Survey maps on a larger scale; to learn, by the help of the figures of peculiar or numerically predominant fossils, to discriminate species, and by them the zones of life; and, when he again finds himself within reach of books, to follow up the special points of difficulty or doubt by hunting up the references so clearly arranged in the appendix, as well as given in the foot-notes. He may thus obtain a very good conspectus of the Jurassic and Cretaceous rocks from the Fullers' Earth up, and an insight into many of the more complicated effects of earth movements and super-induced structures; for the author has wisely treated in a separate chapter of the evidence for the existence, extent, and character of the several disturbances which have to be invoked to account for the relative position of the rocks of the district. Here among recognisable fossiliferous deposits we may trace and study the nature of the great movements resulting in folds, faults, and overthrusts, which are of the same kind as those inferred to exist among the older rocks of Scotland and the Alps, where identification is often less easy.

Any intelligent resident in the district who cares to know the meaning of what he sees around him should possess a copy. In it he may read how the geological structure has determined the character of the scenery (Introduction, pp. 51, 133, &c.), and the interesting analogy between the physical geography of the basins of the Frome and the Thames. He will find an explanation of that pretty hollow known as Poxwell's Circus (p. 69), of the subterranean fires that burned so long in the cliffs of Kimmeridge (p. 57), or of the mode of formation of the travertine, reminding us of the deposition of Geyserite in Yellowstone Park by the aid of a confervoid alga.

If he is an archæologist he will turn with interest to the speculations as to the geological changes supposed to have taken place in Neolithic times, and the gravels deposited in the Palæolithic Age (pp. 234, 235). The Lynchets (p. 97) will remind him of the Raines of the North of England, which have a similar origin, and the account of the Sarsen stones (p. 196), so largely used by the builders of Cromlechs and Stone circles, will open up a wide field for speculation. Or he may turn to a question of more specially local character, and, in the chapter on the Kimmeridge clay, find an explanation of the so-called coal-money, and an account of the cups or vases made from Kimmeridge coal which have been found in barrows, and associated with Roman remains (p. 53).

An old submerged forest is always an object of great interest, and perhaps more suggestive of the changes that time has brought about than any other geological feature. But here along the shore between Bacon Hole and Lulworth Cove we may see a forest of Jurassic age, with numerous trunks and stools of trees belonging to a time when all life was different from that of to-day (p. 102). The landslips of the Isle of Portland (p. 112) tell of another kind of change spasmodically incessant and producing great results.

This is, therefore, a book of wide interest, extending far beyond the limited area which it describes.

PHYSICAL CHEMISTRY.

Leçons de Chimie Physique. Par J. H. van 't Hoff. Ouvrage traduit de l'allemand par M. Corvisy. Pp. 263. (Paris: Hermann, 1898.)

THIS book is a translation of van 't Hoff's "Vorlesungen über theoretische und physikalische Chemie," based on lectures delivered in the University of Berlin during the winter session 1896-97, and as a

clear and terse exposition of the principles of physical chemistry cannot be too highly commended. The treatment of the subject adopted by the author presupposes a considerable knowledge of chemistry and physics, as well as an elementary acquaintance with the differential and integral calculus. The first instalment, here under review, is entitled "Chemical Dynamics," and will be followed by other parts dealing with chemical statics, and the relation between properties and chemical composition. The distinction made by the author between chemical dynamics and chemical statics is similar to that adopted by Lothar Meyer. Under chemical statics he proposes to deal with theories of the structure of matter, the conceptions of atom and molecule, and the determination of constitution and configuration. Under chemical dynamics he here discusses chemical change, affinity, velocity of reaction, and chemical equilibrium.

Beginning with chemical equilibrium, he treats the subject first from the thermodynamical standpoint, and then from the standpoint of the kinetic molecular theory. This dual mode of treatment has many advantages. The student is introduced to the study of chemical equilibrium without being concerned with any hypothesis regarding the inner mechanism of the systems considered. He is only occupied with the different phases (or mechanically separable components) involved, and gains the necessary insight into the subject through diagrams of volume, pressure, temperature and concentration, together with some simple deductions from the fundamental principles of thermodynamics. Transformation points, vapour pressure, dissociation pressure of solids, and solubility naturally have their place here, equilibrium for one and two substances being treated at length. Examples are also given of cases of equilibrium with three and four substances; but owing to the multiplicity of phases, the diagrams are necessarily complex and rather cumbrous. Dissociation, both gaseous and electrolytic, etherification, equilibrium between electrolytes, hydrolysis, and the avidity of acids and bases are more conveniently dealt with from the molecular standpoint; and the section concludes with general considerations as to the effect of pressure and temperature on chemical equilibrium.

The velocity of chemical action is naturally also treated from the kinetic point of view, and first the author gives a theoretical discussion of the subject, exhibiting the nature of uni-, bi-, and trimolecular reactions, the relation of velocity constants to equilibrium constants, the method for determining the number of molecules taking part in a chemical action, and the nature of the retarding influences at work. Then follows a selection of representative empirical results regarding the influence of the medium, temperature, and pressure on the reaction velocity. Finally, an account is given of the progress of the reaction wave, and in particular of the explosion wave.

The translation is well done, and will probably appeal more to English readers than the original. One or two slips which appear in the German edition might have been corrected in the French version; *e.g.* in the pressure-temperature diagram of sulphur, Fig. 9, the line KF should slope upwards and away from the pressure axis instead of towards it, and at p. 66, line 10, *tension* should obviously be *température*. J. W.

THE CULTIVATION OF BERRIES.

Bush Fruits. By Fred. W. Card. Pp. xii + 537; 113 illustrations. (New York: the Macmillan Company. London: Macmillan and Co., Ltd., 1898.)

THIS is in more senses than one a remarkable book. The title-page tells us that it is a "Horticultural monograph of raspberries, blackberries, dewberries, currants and other shrub like-fruits" (*sic*). The preface tells us that the book "is an extension of a thesis presented to the Cornell University for the degree of Master in Science in Agriculture." It is hard to imagine any university in this country recognising a thesis on the art of growing gooseberries and currants! Yet that the subject is capable of scientific treatment is evidenced by the volume before us. The aim is "to treat general truths and principles rather than mere details of practice. A book cannot instruct in all the details of any rural business because these details vary with the environment and personality of the operator. The book should attempt, therefore, to give such instruction as to enable the reader to think out and to solve the local problems for himself."

The first part is devoted to general considerations concerning the situation and management of a fruit plantation. In the second part the brambles, raspberries, blackberries, and similar fruits are considered in detail, and in a manner utterly different from what we should expect in a graduation thesis.

Part iii. is similarly devoted to "Groselles," a word invented by the author to include both gooseberries and currants. Here we find the same minuteness of detail and accumulation of facts as in the other portions of the volume.

The fruits enumerated are mostly of American origin and of recent development, and they illustrate in a very striking way the enormous strides which our American cousins are making in all matters relating to the cultivation, the packing, "canning" and marketing of fruits. They show a fertility of invention, a readiness to adopt new procedures, and to avail themselves of opportunities to a degree which we look in vain for on this side of the Atlantic. In the matter of climatal conditions the United States have, so far as these particular fruits are concerned, no advantage over the mother country. Already we have American cranberries exposed for sale in every grocer's shop in the kingdom, whilst we do not suppose that the whole available area in Ireland, Wales or Scotland sends to market a week's supply.

A curious circumstance to be noted about the fruits which form the staple of this volume is that they are mostly of American origin. British gooseberries or European currants do not, as a rule, thrive in the States, or, rather, they cannot so well resist the attacks of the mildews and moulds as the bushes of native origin do, and consequently the English varieties go out of cultivation as less fitted to the environment than the native varieties.

Another point to be noted is the comparatively recent origin of these varieties. Our gooseberries and currants represent the selection that has been going on here for ages, and as we rarely if ever see any advance in these fruits nowadays, but only a kaleidoscopic shifting of old

materials, it may be that we have attained the limits of variation in this direction, and that to get something new and better we must break new ground by hybridisation or cross-breeding.

Illustrations are given in the volume before us of numerous insects and fungi which make themselves obnoxious to the fruit-grower. Some of these are the same that are too well known to us; but whether or no, the general principles of prevention or destruction are the same. We know of no work containing anything like so complete an account of these "bush fruit," and although it is mainly serviceable to American cultivators, it will also prove a veritable encyclopædia to British growers.

OUR BOOK SHELF.

L'industrie du Goudron de Houille. By George F. Jaubert. Pp. 172. (Paris: Gauthier-Villars et Fils, 1899.)

IN this book, which belongs to the "Encyclopédie scientifique des Aide-Mémoire," is given a brief account of the numerous chemical substances directly derived from coal-tar. The introduction contains a short historical account of the rise of the coal-tar industry, and this is followed by a very brief description of the methods of separation adopted for light and heavy oils, phenols, and ammonia liquor; a section being specially devoted to the nature and yield of tar formed in the preparation of coke in Carvès ovens for metallurgical operations. The actual processes used for the separations of hydrocarbons and ammonia are very briefly sketched, no diagrams whatever being given. The remaining three-fourths of the book consists of a methodical description of the properties of each of the various chemical substances the presence of which has been recognised in coal-tar or coal-gas; this description, as a rule, being unaccompanied by any account of the methods by which the particular constituent under examination has been isolated from the tar. It is, in fact, a miniature chemical dictionary with a systematic instead of an alphabetic classification. The short bibliography at the end of the book will doubtless be of some use to students.

Grundriss einer Geschichte der Naturwissenschaften. By Dr. Friedrich Dannemann. Vol. II. *Die Entwicklung der Naturwissenschaften.* Pp. 435. (Leipzig: W. Engelmann. London: Williams and Norgate, 1898.)

THE first volume of this work was noticed in NATURE in 1896 (vol. liv. p. 316). It consisted of extracts and translations from the writings of great philosophers and investigators, and presented an attractive panorama of scientific history. The second volume has not been constructed upon the same plan, but consists of a descriptive statement of researches and discoveries which have contributed to the progress of science. Many original illustrations have been reproduced, and numerous references are given to papers which have helped to make scientific history. The volume is an interesting "entwicklungsgeschichte," and it presents the early stages in sufficient detail; but it cannot be regarded as a satisfactory statement of the modern developments of science.

Dr. Dannemann divides the history into four periods, each of which is dealt with in a separate section of the book. The first part contains a survey of the views and works of the early Greek philosophers, up to the destruction of the Alexandrian library in 642 A.D.; the second part is concerned with the period from 642 A.D. to about the end of the fifteenth century; the third period considered extends from the time of Copernicus to the end of the eighteenth century, and includes the epochs of the foundation of modern chemistry and the discovery of the galvanic battery; and, finally, the period—"Die neueste Zeit"—continues the history to the present epoch.

It would, of course, be impossible to give anything approaching a complete account of scientific work from the early Greek philosophers to the present time in a volume of the dimensions of the one before us, and Dr. Dannemann has not attempted to do so. His volume presents a view of the investigations which laid the foundations of modern science, but it does not go further.

The work is an interesting contribution to the literature dealing with the development of the study of nature in many aspects, and as such is an inspiring volume for students of science. Perhaps the author will produce a third volume in which the advances made during this century will be described.

Practical Work in Physics. Part iv. Magnetism and Electricity. By W. G. Woollcombe, M.A. (Oxon), B.Sc. (Lond). Pp. xi + 112. (Oxford: Clarendon Press, 1899.)

THIS little volume completes Mr. Woollcombe's course of practical physics for use in schools and colleges. It is a little difficult to understand why no experiments in statical electricity are included, for some of these are valuable in accentuating principles of great importance to a student of this branch of physics. The pupil into whose hands the instructions here set down are put, must already have some theoretical knowledge of the subjects dealt with, or little benefit is likely to accrue from the performance of the experiments. It is hardly a beginner's book, for, in addition to the necessity for a modicum of preliminary acquaintance with principles, familiarity with trigonometrical ratios is taken for granted. At the same time, for the higher classes of schools of the order in which the author himself teaches, the experiments described are very suitable.

Ostwald's Klassiker der exakten Wissenschaften, Nos. 97–102. (Leipzig: Wilhelm Engelmann. London: Williams and Norgate, 1898.)

THE following additions to Prof. Ostwald's comprehensive series of annotated reprints and translations of scientific classics have lately been published.

No. 97 (pp. 156) contains a translation, with facsimile illustrations, of Newton's second and third books on optics, dealing with the reflection, refraction, and colour of light, and the theory of the rainbow. The papers have been translated and edited by W. Abendroth.

No. 98 (pp. 39) is a paper "Ueber das Benzin und die Verbindungen desselben," by Eilhard Mitscherlich (1839), edited by J. Wislicenus.

Clausius's paper "Ueber die bewegende Kraft der Wärme" (1850), forms No. 99 (pp. 55), and will be of interest to all students of thermodynamics. It is edited by Dr. Max Planck. Dr. Planck also edits Kirchhoff's papers on emission and absorption of light and heat (1859–1862), printed in No. 100 (pp. 41), and the papers read in 1858 on the mechanical theory of heat, printed in No. 101 (pp. 48). The former reprint contains a portrait of Kirchhoff as a frontispiece.

A translation of Clerk Maxwell's papers on lines of force (1861–2) appears in No. 102; and to the eighty-four pages, which they occupy, Prof. Boltzmann adds sixty-two pages of notes.

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.*]

On the Colour of Sea Water.

AITKEN (*Proc. R. S. E.*, vol. ii. p. 472, 1882) has given a complete theory of the colour of sea water as observed at various places, based upon the principle that sea water is a blue liquid. According to this view, the green tint often observed in sea water, especially near land, is to be explained by the presence of fine yellow particles. During a recent voyage by the Messageries steamer *Polynesien*, I was permitted, through the kindness of Commandant Bullard, to erect a tube 736 cm. long against the rail of the after-deck, and to pass through it a continuous stream of water from the ship's salt water service. The water was taken in well forward and at a depth of two or three metres, and consequently was not soiled by the passage of the ship. I made a series of observations with the apparatus described, matching the colour of the sea water by making mixtures of definite substances, and using these mixtures to fill a tube 18 cm. long, placed alongside the water tube. Both tubes were illuminated by diffused daylight reflected from a white screen, and by the aid of diaphragms, &c., it was arranged so that the angular area of the visible part of the screen was the same whether observed through one tube or the other. Observations were made every day on the voyage from Sydney to Marseilles; but, owing to the uncertainty arising from the contamination of the water by the varnish with which the interior of the tube was protected, it is useless to comment on most of the results obtained, except in so far as they give a means of easily reproducing the exact tint of pure sea water as seen through a column 736 cm. long. Make up the following solution:—

Water, 500 c.c.
Soluble prussian blue, ·001 gram.
Saturated lime-water just precipitated by the smallest excess of bicarbonate of soda, 5 c.c.

This mixture, when viewed through a tube 18 cm. long, will show with considerable precision the colour of a sample of water from the Mediterranean, lat. 36° 24′ N., long. 17° 51′ E. of Paris.

By using various lengths of tubes I found that when a match has once been made, it can be preserved (within the limits tested) by increasing the amount of prussian blue proportionally to the length of the column of water under investigation. In these tests I made use of tubes 183 cm. long, which could be mounted in series; the relation held as the number of tubes was increased from two to five.

I consider that it would be worth while for a series of measurements to be made systematically by this method, and therefore mention that the tubes must be of black porcelain or glass; the water must be pumped by the observer's private pump (which must be worked off the electric service), and must give a pressure large enough for a Berkefeld filter. The colour of daylight is also too variable on the deck of a ship protected by awnings, and a form of artificial illumination should be employed. In making the colour matches, it is best to arrange to look down the two tubes simultaneously, using one eye for each tube. By slight squinting, it is easy to get the sensation of two patches of colour on the screen seen side by side.

The majority of the samples of water examined by me took 25 per cent. less blue to match them than the example quoted; and when the water was soiled by the tube, and perhaps at other times, it was necessary to add an amount of picric acid rising to a large proportion of the prussian blue, and, of course, giving a green solution. The transparency of the water is estimated by the amount of precipitated chalk it is necessary to add. At the same time, I am not sure that the loss of light observed, and requiring this addition to the match, is produced by turbidity. It is just as likely that the absorption spectrum of water is crossed by a faint but uniform band from end to end. In this case a black liquid might be added to make the match, but I do not know of one which is anything like black in very dilute solution; of definite materials the best was the aniline dye sold under the name of steel-grey, but it was very distinctly purple.

The water on the west and south-west coast of Western Australia is perhaps more interesting than any I have seen, for it is very green indeed, and very clear; so much so as to raise a doubt of the adequacy of Aitken's explanation, especially as the sand looks white rather than yellow. It is just possible that the sea may in certain places dissolve a sufficiency of yellow colouring matter from living or dead sea-weed to account for the green tint.

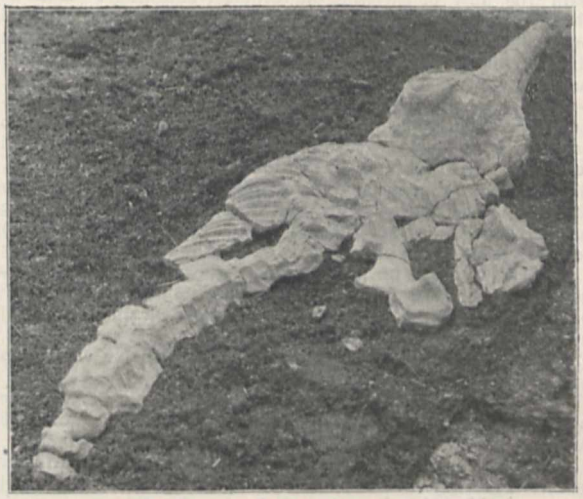
All the observations I made convinced me that the possible scattering of light by very fine particles in suspension has got nothing to do with the colour of the sea water.

RICHARD THRELFALL.

45 Frederick Road, Edgbaston, March 4.

Another Stockton Dragon.

SINCE we chronicled in NATURE in September last the find of an Ichthyosaurus in Mr. Lakin's pit at Stockton, the men in the neighbouring quarries have thirsted for the renown which a similar discovery would bring. Great care has been employed with the pick as each succeeding layer of clay was reached, and more than one false alarm has been raised. Last week a specimen less complete, but still remarkable, was unearthed in the cement works belonging to Messrs. Kay and Co. It lies 50



feet below the surface. The head is tolerably perfect, showing the teeth and one of the eyes. The ribs and paddles are much dislocated, and the lower part of the tail is wanting. The length of the head is 2 feet 8 inches, of the whole fragment 7 feet. It has been admirably photographed by Mr. Elkington, of Bradwell, Rugby, to whom we were indebted for the first monster, and who will supply copies to geologists and others requiring them. It is hoped that the fossil may be secured for the Warwick Museum.

W. T.

Chemists and Chemical Industries.

APART from any question of good taste, it was surely quite unnecessary for Dr. Armstrong to import personal matters into the discussion in which he takes part in his letter appearing in your issue of the 9th inst.

The causes of the relative positions of this country and Germany as regards chemical manufactures, whether due to the real or supposed laches of particular manufacturers or not, are due to national not individual failings, and were admitted so many years back that they have little interest to-day. Moreover, they were not under discussion.

The question was—Whether the best means were being taken to remedy admitted defects in view of the fact that our most successful rivals were demanding what they believe to be improvements in their own methods of producing industrial chemists.

With these words, I will leave my friend Dr. Armstrong's version of "Who drives fat oxen should himself be fat," and pass back to our subject.

I gather, then, that the real cause of the alarm in Germany

is the energetic action of the Central Institution of the City and Guilds of London, &c. I frankly admit that I am rejoiced to hear it, and will thank God, therefore, though not in German, as is the way of superior people.

Some information on other points is, however, desirable to explain apparent anomalies.

For instance, why are we compelled, in Dr. Armstrong's phrase, to "expatriate our most capable students by Royal Commission?"

Why are the German laboratories so full of English and American students that names have to be taken in rotation, and in some cases instructions have had to be issued that preference is to be given to native students, and the number of foreigners limited?

Dr. Armstrong tells us that the education in "quite a number of our schools" is "even superior to that given in Germany." This is good news, and should soon attract—or perhaps it already has attracted—many students from Germany.

But, seriously, can one of our schools be named which, for building equipment and number of staff, is on a level with the best German examples?

Does Dr. Armstrong really mean to defend the use to which the education funds have been put by the counties and boroughs? Does he mean to say that the right persons have been charged with the duty of carrying on technical education? Does he think that a technical faculty could not be founded, or would have no value? Does he maintain that the sums spent—vast in the aggregate—have not been frittered away in teaching fragmentary science, &c., to people who do not need it?

If he says yes, then, regretting to differ, I must still maintain that while teaching as a rule has been, and is, too academical, the money would have been better employed had it been handed over to institutions such as his and Prof. Meldola's, for the purpose of founding technical faculties, for the erection of laboratories, and for the provision of more teachers in them, rather than in founding a host of places for teaching smatterings of science to artisans.

It seems to me to be a repetition of the errors of fifty years back. The originators of the "institutes" and "polytechnics" of the middle of the century made mistakes in a small way, and we are repeating them on a vast scale.

My critic says that this is not so, and that such a view gives an "entirely false impression."

I can only say that I heartily hope that I am wrong, for since no one has felt the opprobrium of the position more, no one will rejoice more if Dr. Armstrong's view is right.

In conclusion, may I add a word on Mr. Pope's letter in your issue of February 23. My withers are unwrung thereby, yet I can sympathise with those manufacturers who did refuse specimens. But there is another aspect of the question, than the easy acquisition of fine objects for the lecture table or laboratory museums for Mr. Pope, and those similarly placed, to consider, viz. the grave responsibility that a teacher incurs when he even seems to advertise the goods of any particular manufacturer. That is why such goods should always be purchased, and thus all obligation avoided. R. J. FRISWELL.

March 11.

IN the current number of the *Berichte*, the following advertisement appears:—"Eine grosse Anilinfarbenfabrik sucht für das theoretische Laboratorium *gut geschulte Chemiker*. Praxis nicht erforderlich." Is not this a striking indication of the nature of the material from which the so-called "German technologist" is evolved, and of the methods by which Germany has attained so great a success in chemical industry?

WILLIAM A. DAVIS.

Central Technical College, Exhibition Road, March 11.

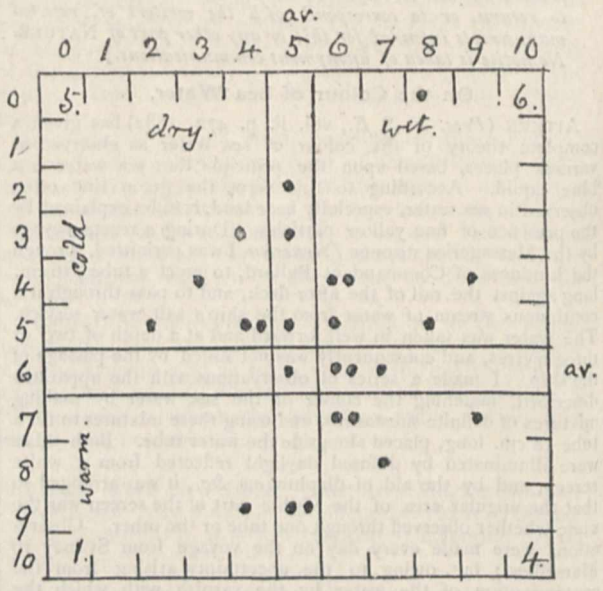
Sunspots and Weather.

I HAVE thought the following may be worth attention.

Count the number of *warm* months, and the number of *wet* months, at Greenwich, in each year, since 1841 (*i.e.* months above average in either case). Select the values in each of the five-year groups having a sunspot maximum year central; and the same with minimum.

This gives twenty-five numbers of warm months to be compared with twenty-five numbers of wet months, for sunspot *max.* groups; and like numbers for *min.* groups.

These may be compared by means of dots; using the ordinates for warm months, and the abscissæ for wet months. The average of warm months is six, that of wet months about five.



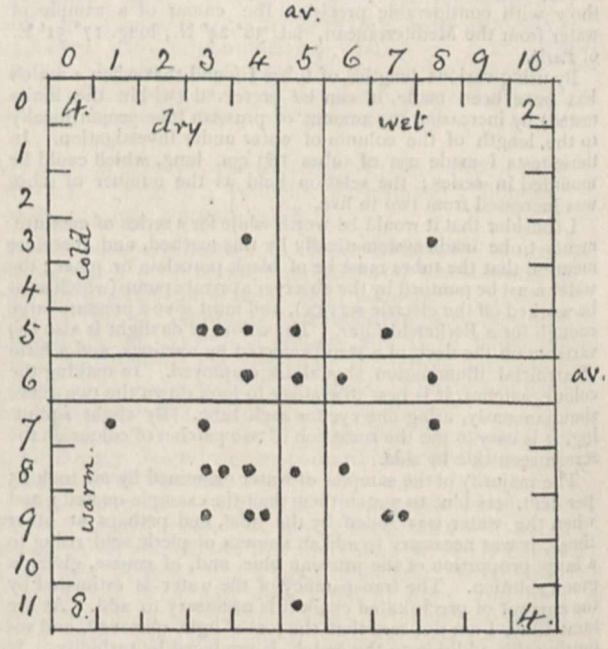
Minimum sunspot groups.

Cold and dry	5	Cold and wet	6
Warm and dry	1	Warm and wet	4

Totals—Cold, 14; warm, 7; wet, 13; dry, 6.

Some interesting contrasts come out.

Thus, in the *minimum* groups, there is only *one* year both warm and dry (1868); in the *max.* groups, *eight*. In the latter, only *two* years both wet and cold; in the former, *six*.



Maximum sunspot groups.

Cold and dry	4	Cold and wet	2
Warm and dry	8	Warm and wet	4

Totals—Cold, 7; warm, 14; wet, 8; dry, 13.

Compare, too, the total, cold, warm, wet, and dry, as at foot of diagram. ALEX. B. MACDOWALL.

THE CHEMISTRY OF THE STARS IN RELATION TO TEMPERATURE.[1]

THE recent advances in our knowledge which have come from the combination and interaction of solar, stellar and laboratory research, carried on by the aid of instruments of much greater power than those formerly used, have given us a firm chemical hold on all the groups of stars in my classification of them. These groups were established by discussing sequences of lines before the origin of the lines had been made out. A series of hieroglyphics is now replaced by chemical facts; and we can now study the chemistry of the stars, as well as their order in a system of classification.

The first question which naturally arises is this: Do the chemical elements make themselves visible indiscriminately in all the celestial bodies, so that practically, from a chemical point of view, the bodies appear to us of similar chemical constitution? This is not so.

From the spectra of those stars which resemble the sun, in that they consist of an interior nucleus surrounded by an atmosphere which absorbs the light of the nucleus, and which therefore we study by means of this absorption, it is to be gathered that the atmospheres of some stars are chiefly gaseous, *i.e.* consisting of elements we recognise as gases here, of others chiefly metallic, of others again mainly composed of carbon or compounds of carbon.

Here then we have spectroscopically revealed the fact that there is considerable variation in the chemical constituents which visibly build up the stellar atmospheres.

This, though a general, is still an isolated statement. Can we connect it with another?

By means of one of the first principles of spectrum analysis we know that the hotter a thing is, the light of which produces a continuous spectrum, the further does the spectrum stretch into the violet and ultra-violet.

Hence the hotter a star is, the further does its complete or *continuous* spectrum lengthen out towards the ultra-violet, and, *caeteris paribus*, the less is it absorbed by cooler vapours in its atmosphere.

Now to deal with three of the main groups of stars, we find the following very general result:—

Gaseous stars	... ...	Longest spectrum.
Metallic stars	... ...	Medium spectrum,
Carbon stars	... ...	Shortest spectrum.

We have now associated two different series of phenomena, and we are entitled to make the following general statement:—

Gaseous stars	... ...	Highest temperature.
Metallic stars	... ...	Medium temperature.
Carbon stars	... ...	Lowest temperature.

Hence the differences in apparent chemical constitutions are associated with differences of temperature.

This, then, is the result of our first inquiry into the existence of the various chemical elements in the atmospheres of stars generally. We get a great diversity, and we know that this diversity accompanies changes of temperature. We also find that the sun, which we independently know to be a cooling star, and Arcturus, are identical chemically.

I next pass from the general to the particular, and give the detailed results recently obtained in the case of stars as hot or hotter than Arcturus—taking Arcturus to represent the solar temperature.

In a paper on the "Chemistry of the Hottest Stars,"[2] in 1897, I stated the results so far arrived at concerning the order in which certain spectral lines appeared, and others disappeared, in stars arranged in a series of ascending temperatures.

[1] This article embodies a paper read at the Royal Society on Thursday, February 23.

[2] *Proc. Roy. Soc.*, vol. lxi. p. 148.

Since that paper was written many important advances have been made, among them I may mention the following:

Proto-metals.

With regard to the metals, the recent work on the enhanced lines in the spectrum of metals, α Cygni[1] and the sun's chromosphere enables us to deal with the lines observed at the highest temperature in the spectra of the following substances: magnesium, calcium, iron, manganese, nickel, chromium, titanium, copper, vanadium, strontium, silicium.

The accompanying untouched reproductions of photographs will show the wonderful similarity which exists between these three spectra.

As we have to deal both with the arc and spark lines of these substances, for the sake of clearness I call the latter "*proto-metallic*" lines, and consider the substances which produce them, obtained at the highest available laboratory temperatures, "proto-metals," that is, a finer form of the metal than that which produces the arc lines, corresponding to the "meta-elements" imagined by Crookes.

The temperature ranges of the enhanced lines of these metals have been investigated in various stars with the following results:—

Metal.	Range of temperature (upward series).	Range of temperature (downward series).
Magnesium	α Ursæ Min. to γ Argûs	α Eridani to Procyon
Calcium ...	α Tauri to γ Argûs	α Eridani to Arcturus
Iron ...	α Tauri to ζ Tauri	β Persei to Arcturus
Titanium...	α Tauri to ζ Tauri	β Persei to Arcturus
Manganese	α Ursæ Min. to α Cygni	β Persei to Procyon
Nickel ...	α Ursæ Min. to α Cygni	β Persei to Procyon
Chromium	α Ursæ Min. to α Cygni	γ Lyræ to Procyon
Vanadium	α Ursæ Min. to α Cygni	Sirius to Procyon
Copper ...	α Ursæ Min. to α Cygni	β Persei to Procyon
Strontium	α Tauri to α Cygni	Sirius to Arcturus

I pointed out in the note referred to that the enhanced lines of the above substances seemed to account for almost all of the more marked lines in α Cygni. It is on this ground that I have investigated their behaviour in other stars before waiting for the results of the complete inquiry. Another reason has been that, although in addition to the enhanced lines of the metals shown in the foregoing table, those of barium, cadmium, molybdenum, lanthanum, antimony, lead, palladium, tantalum, erbium and yttrium, tungsten, cerium, uranium, cobalt and bismuth have already been investigated with lower dispersion, and a spark obtained with the use of a much less jar capacity, so far I have no certainty that any of these substances exist in the reversing layers of stars of intermediate temperature.

The temperature ranges of the arc lines of some of the metals have also been investigated, and the results are shown in the following table:—

Metal.	Range of temperature (upward series).	Range of temperature (downward series).
Iron ...	α Tauri to α Cygni	α Canis Majoris to Arcturus
Calcium ...	α Tauri to α Ursæ Min.	α Canis Majoris to Arcturus
Manganese	α Tauri to α Ursæ Min.	α Canis Majoris to Arcturus

So much, then, for the metals. I now turn to the gases.

Proto-hydrogen.

Some little time ago Prof. Pickering, of Harvard Observatory, found on examining the spectra of the

[1] NATURE, February 9 (p. 342).

southern stars, that one of them on the poop of the ship which forms the constellation Argo, hence called ζ Puppis, contained a system of lines not hitherto recognised, and he naturally concluded that it indicated a new element.[1] On further inquiry he found reason to suppose that this new series was in some way connected with hydrogen, since the lines occupied the same positions as those computed from the same formula and constants from which the ordinary series of hydrogen was calculated, the only difference in the employment of the formula being that even values of n were used instead of odd values.

Profs. Pickering and Kayser both concede that this new form of hydrogen is due most probably to a high temperature, and Prof. Kayser expressly states "that this series has never been observed before can perhaps be explained by insufficient temperature in our Geissler tubes and most of the stars."

If, as suggested both by Prof. Kayser and myself, this new series and the one previously known are probably of the subordinate type, the principal series of hydrogen is still beyond our ken, unless indeed one of the still "unknown" lines represents it, as suggested by Prof. Rydberg. Another possibility is that, even in the hottest stars so far considered, the temperature is not high enough to allow its molecule to exist uncombined.

On the view that the new series of probable hydrogen lines in ζ Puppis represents the effect of a transcendental temperature, an attempt has been made to produce this spectrum in the laboratory. In the high-tension spark in hydrogen at atmospheric pressure the ordinary series of hydrogen lines is very broad. The use of the spark with large jars in vacuum tubes results in the partial fusion of the glass and the appearance of lines which have been traced to silicium, but the new series has not yet been observed.

In his first communication, Prof. Pickering mentions lines at 4698, 4652, 4620, and 4505, but he does not refer to them in his second paper, which has special reference to the new series. The line 4505 was at first taken to be one of the components of the new series, but this seems to have been subsequently superseded by the employment of the line about 4544, which agrees better both as regards intensity and the calculated position 4543·6.

As this new hydrogen series seems to bear the same relation to the well-known one as the proto-metallic lines bear to the metallic, I call the gas which produces it proto-hydrogen for the sake of clearness.

The new series of lines discovered by Prof. Pickering has been found in the spectra of ζ, ε, δ and κ Orionis photographed at Kensington in 1892.

Prof. Pickering himself has since found this system of lines in other stars than ζ Puppis, and Mr. McClean, in his admirable work on the brightest stars of the southern hemisphere, has obtained photographs of the spectrum of γ Argûs, and on which the new series appears.

From a discussion of these stars in relation to the others photographed, there can be little doubt that we are here face to face with the very hottest stars so far known, and that the new series of hydrogen lines represents one among the last stages of chemical simplification so far within our ken.

We are, therefore, now in a better position to determine the relation of this new gas to other gases, both known and unknown, appearing in stars of nearly equal temperature.

Other New Gas Lines.

But even with our present knowledge of stellar spectra we find that in relation to the hottest stars there are still some gaps in our chemical knowledge; not only is this so, but have we any right to assume, taking into account the limitations of our means of observation and of the strict limitation of our observations to the relatively small part of space nearest us, enormous though it is, that we are as yet really in touch with the highest stellar temperatures?

Again, we cannot be certain that the small number of stars as yet studied puts us in presence of the highest stellar temperatures. Those stars which apparently are at the very apex of the temperature curve are involved in unknown lines, and require a special study.

Two typical unknown lines have wave-lengths at 4089·2 and 4649·2,[1] and besides these three other unknown lines occur in γ Argûs.

As these most probably reveal still undiscovered gases, I include them in the following table showing the limits

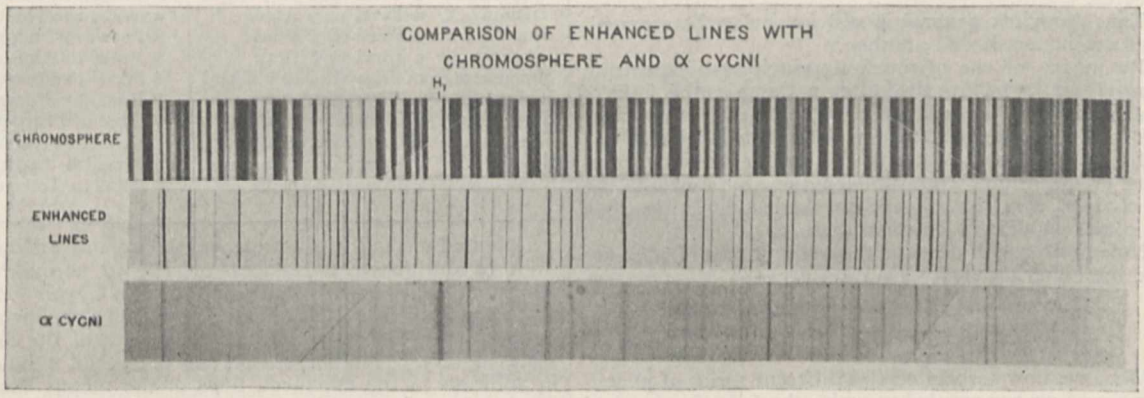


FIG. 1.

Origin.	λ of chief lines.	Range in ascending series of stars.	Range in descending series of stars.
Unknown.	4457, 4451, 3876	Seen only in γ Argûs.	
Hydrogen (New).	4544·0 … 4200·4	ζ Orionis to γ Argûs.	No stars available.
Unknown.	4089·2	α Crucis to ζ Orionis.	
Unknown.	4649·2	,,	α Eridani.
Helium.	4471·6, 4026·3	Rigel to γ Argûs.	α Eridani to γ Lyræ.
Asterium.	4388, 4009	Rigel to γ Argûs.	α Eridani to γ Lyræ.
Hydrogen.	Complete Series.	Aldebaran to γ Argûs.	α Eridani to Arcturus.

[1] See *Astrophysical Journal*, iv. p. 369, and v. p. 95.

[1] *Proc. Roy. Soc.*, vol. lxii. p. 52.

of stellar temperature to which the various known and unknown lines, probably of gaseous origin, extend.

Mr. McClean has stated that certain of the oxygen lines (amongst which is the strong triplet at λλ 4070·1, 4072·4 and 4076·3) appear in the spectrum of β Crucis and other stars of nearly equal temperature. My own observations, so far as they have gone, tend to confirm this view; but other photographs and more laboratory work are needed to explain certain changes of intensity which have been observed. The lines attributed by Mr. McClean to oxygen have been noted between α Crucis and ζ Orionis in the upward series, and in stars at about the α Eridani stage of temperature in the downward series.

There is evidence that the strongest lines of nitrogen at λ 3995·2 and λ 4630·9 make their appearance in stars at about the temperature of α Crucis. These lines appear from Rigel to ζ Orionis in the upward series, and are present in the stars at the α Eridani stage in the downward.

I pointed out many years ago[1] that at high temperatures the flutings of carbon in the violet are replaced by a line at λ4267·5. There is a line at this wave-length in the spectra of stars ranging in temperature from that of Rigel to ζ Orionis on the up side, and from α Eridani to β Persei on the down side of the temperature curve.

There is no known line of gases or metals to which this line can be assigned. It is probable, therefore, that carbon exists in stars of the same temperature as that at which oxygen and nitrogen have been traced.

Two lines in the spectrum of Silicium (λ4128·5 and λ4131·5) have been traced in stars between the temperatures of α Ursæ Min. and α Crucis in the upward series, and between those of α Eridani and Procyon on the downward.

The accompanying map shows the facts relating to stars as hot as, or hotter than, the sun, as we know them at present.

[1] *Proc. Roy. Soc.*, vol. xxx. p. 461.

Description of Map.

The map is arranged on the following plan. The temperature of the sun and Arcturus forms the lowest stage. The upper limit is defined by γ Argûs, the hottest star so far known. On the left the stars named are those of increasing temperature, on the right those of decreasing temperature. Those on the same horizon represent equal mean temperatures so far as the cleveite gas and enhanced lines help us to determine them. The blank spaces indicate that so far no star has been photographed in the spectrum of which the enhanced lines exactly match those on the opposite side.

The names of the various chemical substances included in the discussion are given at the top. I have retained the prefix "proto" to that condition of each metallic vapour which gives us the enhanced lines alone, and I have added it to that form of hydrogen seen only in the hottest stars.

The behaviour of the most typical line of each chemical substance is indicated by a double line looped at the top at its highest range. The length and varying thickness of the lines in stars on both sides of the temperature curve are derived from the observed appearance and intensity of the lines, noted in the different stars.

The wave-lengths of the lines discussed are shown at the bottom of the map.

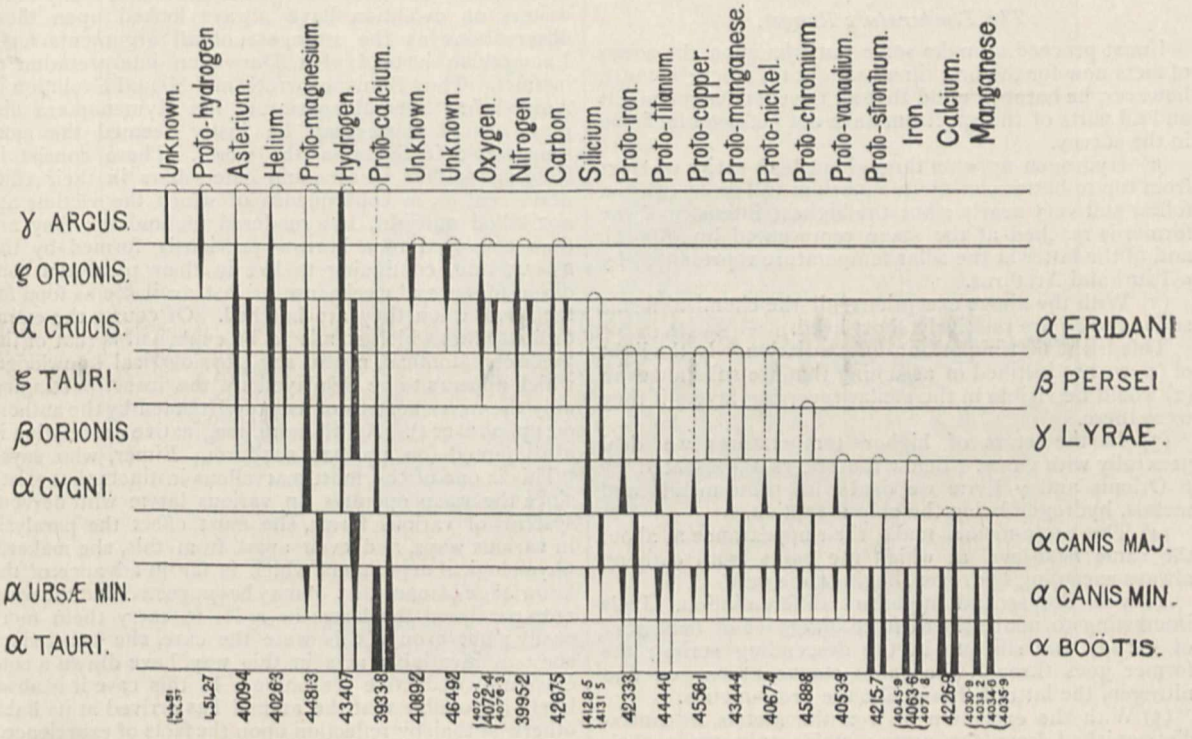


FIG. 2.

Details of Changes observed.

The facts embodied in the map present to us the spectral changes noted in stars of Groups III., IV. and V. of my classification,[1] and are a result of a more general inquiry than those referred to in my previous papers,[2] the origins of a very considerable number of stellar lines having since then been traced to enhanced lines of metals and to known gases.

[1] *Proc. Roy. Soc.*, vol. xliii. p. 117 (1887).

[2] *Proc. Roy. Soc*, vol. xliv. p. 1 (1888); *ibid.*, vol. xlv. p. 380 (1889); *Phil. Trans.*, 184A, 1893, p. 725.

It will be seen that this more general inquiry entirely justifies the prior statement[1] that the metallic lines are thickest in stars increasing their temperature, and the hydrogen lines thickest in stars decreasing their temperature, in other words, on the opposite arms of the temperature curve. I have already stated a possible explanation.[2]

It will be observed that, so far, I have not been able to find stellar spectra on the downward side corresponding to those of γ Argus and ζ Orionis; but it is more than probable that near the apex of the curve only a small change, will be observed; their default, therefore, is of less consequence than it might have been.

The same remark applies to α Cygni and Sirius; but here it is certain that the differences in the relative intensities of the gaseous and enhanced lines will be considerable, judging from what happens above and below the heat stages represented by them.

The stars used in the discussion give us very definite results, showing that the various chemical forms are introduced at six very distinct heat levels.

The Temperature Ranges.

I next proceed to make some remarks upon the series of facts now for the first time brought together; it must, however, be borne in mind that all the chemical elements and all parts of the spectrum have not yet been included in the survey.

(1) Hydrogen appears throughout both series of stars from top to bottom. Proto-magnesium and proto-calcium follow suit very nearly; but the highest intensity of the former is reached at the stage represented by α Cygni, and of the latter at the solar temperature represented by α Tauri and Arcturus.

(2) With the above exceptions all the chemical forms so far traced are relatively short-lived.

This is the first important differentiation. In the light of (1) we are justified in assuming that the substances in (2) would be visible in the stellar reversing layers if they were there.

(3) In the stars of higher temperatures we deal generally with gases. Below the stages represented by β Orionis and γ Lyræ we deal with proto-metals and metals, hydrogen being the only exception.

(4) The proto-metals make their appearance at about the same heat-level at which the gases (with carbon), always excepting hydrogen, begin to die out.

This is the second important differentiation. It is interesting to notice the distinct difference of behaviour of carbon and silicium in the descending series; the former goes through the same stages as oxygen and nitrogen, the latter behaves like the proto-metals.

(5) With the exception of iron the metals, as contra-distinguished from the proto-metals, only make their appearance in stars at and below the heat-level of Sirius.

This is the third important differentiation. It is accompanied with a notable *diminution* of hydrogen and proto-magnesium, and with an *increase* of proto-calcium; indeed, the latter seems generally to vary inversely with the hydrogen.

In all these changes we seem to be brought into presence of successive polymerisations due to reduction of temperature. Of the origin of proto-magnesium and proto-calcium the stars as yet tell us nothing; but it is difficult to believe that the earliest forms of the other metals are not built up of some of the constituents of the heat ranges represented by those between γ Argus and α Crucis.

The question arises whether the order of visibility at reduced temperatures now indicated does not explain the absence of proto-hydrogen, oxygen, and nitrogen from the spectra of the sun and nebulæ; the metals present in, and the absence of quartz from, meteorites, and the similarity of the gaseous products obtained from meteorites and metals, native and other, in vacuo at high temperatures.

NORMAN LOCKYER.

[1] *Proc. Roy. Soc.*, vol. lxi. p. 182.
[2] *Proc. Roy. Soc.*, vol. lxi. p. 183.

THE INSTINCTS OF WASPS AS A PROBLEM IN EVOLUTION.[1]

THIS work has been looked forward to with the deepest interest by all naturalists who are familiar with Dr. and Mrs. Peckham's observations upon the courtship of the spiders, and who were aware that this long-continued and laborious research had been undertaken by them. The observations and conclusions of M. Fabre upon the instincts of the solitary wasps have been so often quoted, and have formed the foundation of so large a superstructure of theory, that it became of the highest importance that they should be repeated by other naturalists. The late George Romanes and many other writers on evolution have always looked upon these observations as the strongest of all arguments for a Lamarckian instead of a Darwinian interpretation of instinct. Thus Romanes wrote in "Mental Evolution in Animals": "Several species of the Hymenoptera display what I think may be justly deemed the most remarkable instincts in the world. These consist in stinging spiders, insects, and caterpillars in their chief nerve centres, in consequence of which the victims are not killed outright, but rendered motionless; they are then conveyed to a burrow previously formed by the *Sphex*, and, continuing to live in their paralysed condition for several weeks, are at last available as food for the larvæ when they are hatched. Of course the extraordinary fact which stands to be explained is that of the precise anatomical, not to say physiological knowledge, which appears to be displayed by the insect in stinging only the nerve centres of its prey" (quoted by the authors on pp. 221, 222). A still more imaginative description is also quoted (on pp. 220, 221) from Eimer, who says: "This is one of the most marvellous instincts that exist; since the wasp operates on various larvæ with nervous systems of various forms, she must effect the paralysis in various ways, and even apart from this, she makes a physiological experiment which is far in advance of the knowledge of man. . . . It may be suggested that the wasp only paralysed the larvæ in order to carry them more easily; but even if this were the case, she must, since she now invariably acts in this way, have drawn a conclusion by deductive reasoning. In this case it is absolutely impossible that the animal has arrived at its habit otherwise than by reflection upon the facts of experience." The authors truly say of these remarks, and the rest of the quotation from Eimer: "One can hardly be expected to take such statements seriously, since it is certain that the writer has no knowledge of the life-histories of these insects." Eimer and Romanes were both quoting from Fabre, and, relying upon his inferences even more fully than upon his observations, they both held that a Lamarckian interpretation is inevitable. Such instincts, they maintained, can only have arisen by the inheritance of the results of intelligent observation. In order thoroughly to test the foundation upon which such far-reaching conclusions have been built, Dr. and Mrs. Peckham have carefully observed all the species of solitary wasps which they could find in their beautiful summer home, with Dr. C. A. Leuthstrom, on Pine Lake, Wisconsin. As in the case of other insect orders, these Hymenoptera have a wonderfully familiar look to an

[1] "On the Instincts and Habits of the Solitary Wasps." By George W. Peckham and Elizabeth G. Peckham. Wisconsin Geological and Natural History Survey. *Bulletin* No. 2. Scientific Series No. 1. (Madison, Wis.: published by the State, 1898.)

English zoologist, the same genera and closely similar species occurring in very large numbers. The present writer has had the great privilege, in the summer of 1897, of seeing Dr. and Mrs. Peckham at their work, and of discussing with them many of their results.

The habits of one or more species of the following genera were studied with the utmost care, and are described in Chapters i.–xiv.: *Ammophila*, *Sphex*, *Rhopalum*, *Stigmus*, *Crabro*, *Salius*, *Aporus*, *Bembex*, *Oxybelus*, *Trypoxylon*, *Astata*, *Diodontus*, *Cerceris*, *Philanthus*, *Pompilus*, *Agenia*, *Tachytes*, *Lyroda*, *Priononyx*, *Chlorion*, *Harpactopus*, *Pelopaeus*.

It will be admitted that the careful study of species in these twenty-two genera constitutes a serious amount of evidence which entitles the authors' conclusions to the most careful consideration.

Chapter xv. contains a *résumé* of the most interesting observations and conclusions in Paul Marchal's important monograph on *Cerceris ornata*. Chapter xvi. is devoted to the sense of direction; xvii. to the stinging habit in wasps; while Chapter xviii. states the conclusions upon the instinct and intelligence of wasps, which the authors believe to be justified by their observations.

The fourteen plates are skilfully drawn by J. H. Emerton, who illustrated the authors' works on spiders. Plates I. and II. contain excellent coloured illustrations of thirteen of the species whose habits are described; the remaining plates are uncoloured. Plates III., IV. and V. deal with the habits of *Ammophila urnaria*, the most interesting of the species which were studied. Fig. 1 is a reproduction of Plate IV. (p. 11), and shows the manner in which *Ammophila* stings the caterpillars, which it stores up in the burrow in which it lays its egg. After much patient watching the whole process was observed from beginning to end on three occasions. On the first of these the caterpillar was first stung on the ventral surface between the third and fourth segments. "From this instant there was a complete cessation of movement on the part of the unfortunate caterpillar," which was then stung between the third and the second, and between the second and the first segments. The wasp then circled in the air above the caterpillar, "and then, descending, seized it again, further back this time, and with great deliberation and nicety of action gave it four more stings, beginning between the ninth and tenth segments and progressing backward." The second wasp also stung the third, second, and first segments in order; and then she went on to sting the fourth, fifth, sixth and seventh, but stopped at this point, proceeding, however, to bite the neck of the caterpillar in a very thorough manner (malaxation). In the third example the wasp gave one sting between the third and fourth segment, and then spent a long time in biting the neck. In this case, however, the caterpillar had been placed by the observers in the way of the wasp, and she seemed rather indifferent to it.

I have quoted these observations at some length because a closely allied European wasp (*A. hirsuta*) seems more than any other species to have afforded the evidence relied upon by Fabre and those who have followed him. By the study of but nine wasps of the same genus, and fifteen caterpillars, the American naturalists have shown that the immense superstructure which has been raised on so small a foundation is in large part due to a fertile imagination. So far from the assumed perfection and accuracy with which every detail is supposed to be repeated, the instinct is shown to be excessively variable. The frequently quoted conclusions that the object of the sting is to reduce the larva to helplessness and yet to keep it in a fresh condition, that a dead larva would be unsuitable food and an active one a danger to the offspring of the wasp—all these conclusions are entirely disposed of by a few carefully specially directed observations. These show that the larva rapidly dies in a large proportion of cases and yet affords excellent food, and that it may remain sufficiently

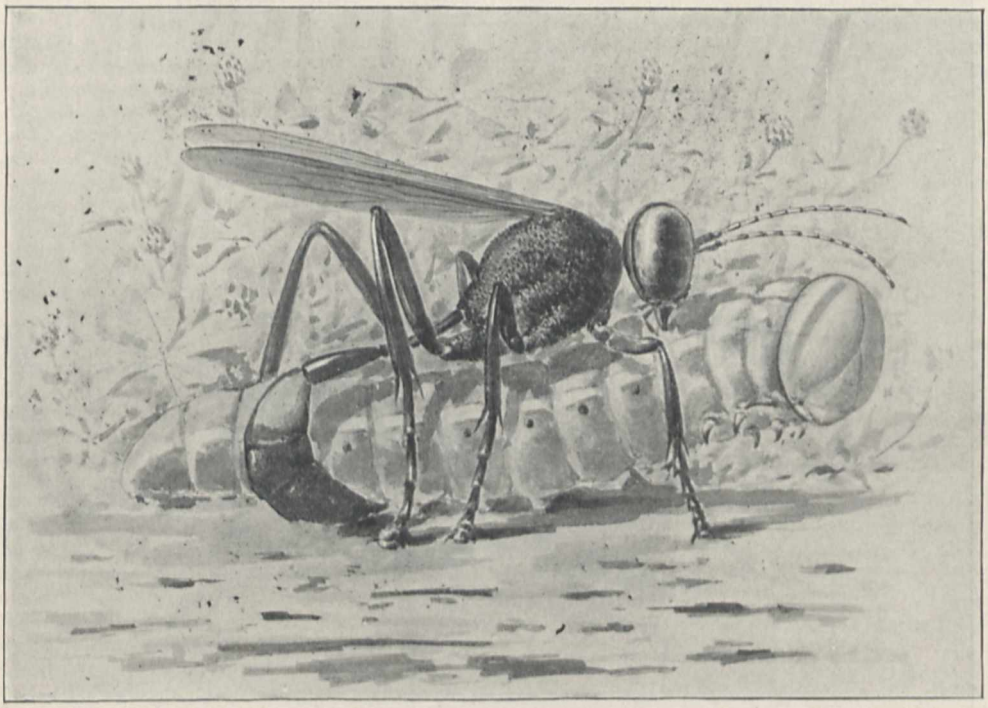


FIG. 1.—*Ammophila urnaria*, stinging caterpillar.

uninjured to wriggle continuously without stimulation, or to move violently when bitten by the larva of the wasp.

The fifth plate (p. 23) is reproduced in Fig. 2, and shows *Ammophila urnaria* using a stone to pound down the earth with which the entrance to the burrow is covered. This very interesting observation is confirmed by the study of *Ammophila Yarrowi* in Western Kansas by S. W. Williston.

The remaining plates show the appearance of many other species which were studied, and also include representations of their burrows, prey, and several very interesting "locality studies" made by wasps of many species before they leave a freshly dug burrow to seek for prey. The representation of these complex movements in the neighbourhood of the burrow strongly supports the authors' conclusions in favour of the dominant importance of the sense of sight in these Hymenoptera—

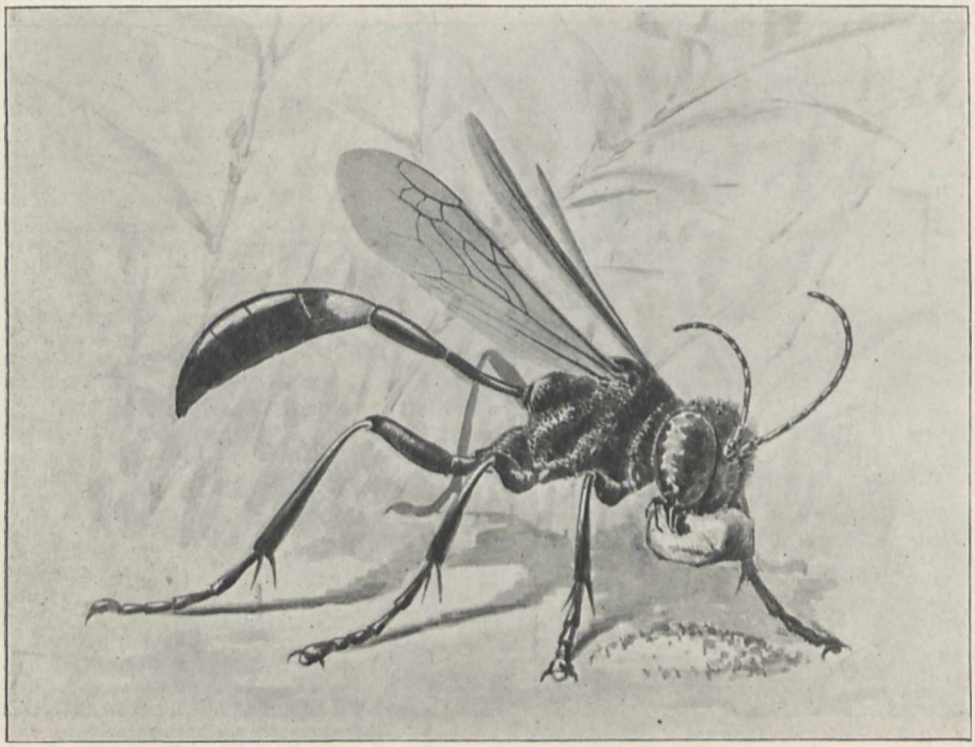


FIG. 2.—*Ammophila urnaria* using stone to pound down earth over nest.

conclusions which they also support by many other observations and experiments.

The following activities or performances are regarded as truly instinctive: stinging, the methods of attack, capture and carriage of prey peculiar to each species, the kind of prey selected, the general style and situation of the nest, the form of cocoon.

If the exigencies of space permitted, it would be of great interest to discuss many of the points raised in this valuable research. It is only possible on the present occasion to point to certain observations which indicate that the action of the wasp's poison on the ganglionic centres may be through the hæmolymph and not necessarily direct. If this be so, it disposes of the necessity for any great precision in the locality of the sting. A puncture *anywhere* would produce effect, although probably more rapidly and completely if made in the neighbourhood of a ganglion. Further observations on this point are greatly needed, including a long series of experiments in which wasps of many kinds are held in the forceps and made to sting their natural prey in various parts of the body. The question of malaxation suggests another most interesting field of inquiry; in fact, the great value of the work depends as much upon its suggestive and inspiring spirit, as upon the full record of discovery which it contains.

The type is clear and good, although the quality of the paper leaves much to be desired. There are a few obvious misprints and erroneous references which will soon be detected by the reader.

The volume ends with the following paragraph—and the reader will admit that very solid grounds are given for the conclusions. "The general impression that remains with us as a result of our study of these activities, is that their complexity and perfection have been greatly overestimated. We have found them in all stages of development and are convinced that they have passed through many degrees, from the simple to the complex, by the action of natural selection. Indeed, we find in them beautiful examples of the survival of the fittest."

E. B. P.

SIR JOHN STRUTHERS, M.D., LL.D.

ON February 24 death removed from amongst us the *doyen* of the professors and teachers of anatomy in Scotland.

John Struthers was born at Dunfermline in 1823. He began to study medicine in the University of Edinburgh in 1841, and obtained the degree of Doctor of Medicine in 1845, when he wrote his thesis "On the Physiology and Physiological Anatomy of the Muscles and Nerves of the Eyeballs, and on the Theory of their Derangement

in Strabismus." In November of the same year he was elected a Fellow of the Royal College of Surgeons of Edinburgh. Two years later, the same College granted him a licence to teach anatomy in the Edinburgh extra-mural School of Medicine, and from that time to his retirement in 1889, he was continuously engaged in teaching anatomy by lectures and in the dissecting room.

In 1863, on the death of Prof. Alexander Lizars, he was appointed by the Crown to the chair of Anatomy in the University of Aberdeen, an office which he held for twenty-six years.

During the early years of his teaching in Edinburgh, where he was preparing himself for the professorial position which he subsequently attained, he proved to be a hard-working and laborious teacher. Although for a time he held a surgical appointment in the Royal Infirmary, his heart was in anatomical work, and he found that to preserve his position in the School it became necessary to give his whole time to the anatomical class. The chair of Anatomy in the University during the period when Dr. Struthers was lecturing in the extra-mural School, was filled by Prof. John Goodsir, a great philosophical anatomist and original investigator. By a strict attention to his duties, by the mastery of detail and a faculty of lucid exposition, Struthers obtained a reputation which attracted students ; so that his class became satisfactory as regarded numbers, and his position as a teacher was so well assured, that during Goodsir's illness in the session 1853–54, Struthers was appointed to undertake the duties of the chair of Anatomy.

On his appointment to the chair of Anatomy in Aberdeen in 1863, he found the arrangements for anatomical teaching in that University to be in a crude and backward condition. With the energy and power of steady application, which were so characteristic of the man, he at once set himself to develop the methods of teaching, and to make them worthy of a University course, so that the reputation of the chair was greatly increased, and the number of the students attending the class was more than doubled. He employed both his voice and pen in promoting the raising of funds for the construction of new buildings, in which not only his own, but the other branches of medical study could be properly taught, and he contributed in a very material manner to the prosperity which attended medical and scientific education in the University of Aberdeen.

There can be no doubt that, in carrying out the reforms which he was so instrumental in procuring, he had many hard battles to fight against the prejudices and imperfect conceptions of what was required in the modern teaching of medicine, held by many of his colleagues, more especially in the faculties of arts and theology. It required a man of great determination of character, who knew what was wanted, and would not readily acccept a defeat, to raise to their proper level, and in accordance with the needs of the time, the buildings and materials required for medical and scientific teaching. Although much in addition has been done during the ten years that have elapsed since Struthers retired from the chair, the spirit of improvement which he had been so largely instrumental in developing has continued to grow under the direction of his later colleagues and successors.

This is scarcely the place to dwell on the attention which Sir John Struthers gave to the public relations of his profession. One cannot, however, overlook the fact that he took a great practical interest in the efforts which were made between 1850 and 1886 to promote medical legislation, and to provide for the service of the public a medical practitioner possessing a higher standard than formerly of general and professional education. As representing his University for some years on the General Medical Council, he was most active in the discussions which led to the period of medical education being raised from four to five years before a diploma could be obtained. When, on his retirement from the Aberdeen chair, he went to reside in Edinburgh, he became a manager of the Royal Infirmary in that city, and did good service in developing the means afforded by that great hospital for imparting clinical instruction, more especially in the special departments of medical and surgical practice.

The Royal College of Surgeons of Edinburgh recognised his professional services and his attachment to the College which had granted him, in his early life, his licence to teach, by making him from 1895 to 1897 its president. During this period he devoted much of his time to the reorganisation of the museum of the College, and he contributed to it many valuable anatomical specimens.

Sir John Struthers was a voluminous writer on several branches of anatomical science, although, as he often used to say, the time which he required to devote to teaching, to University business and to the consideration of the public relations of his profession greatly curtailed the hours which he was able to give to research. His most noteworthy investigations, those which probably more than any other of his contributions to science will give him a permanent position in anatomical literature, were his memoirs on the anatomy of the Cetacea, more especially on the Whalebone whales. They were for the most part, if not entirely, printed in the *Journal of Anatomy and Physiology*, and his memoir on the anatomy of the Hump-backed whale, which gives the most detailed account of its skeleton that has yet been published, was subsequently reproduced in a separate volume.

The chief characteristic of his anatomical writings was the minute attention paid to detail. He seemed to spare neither time nor labour in striving to give accuracy to his descriptions, a quality which to an anatomical writer is of fundamental importance. He, however, carried out his love of minute accuracy to such an extent that when he began to record variations in the weight of the clavicle, and expressed in fractions of an inch the diameters of the bodies and processes of the large vertebræ of a great whale, it is not an unfair criticism to make, that so ample a supply of detail is apt to obscure the essential characters of an object. The memoranda which he prepared, and the reports which he wrote on University and other public questions in which he was interested, displayed the same quality of laborious detail ; so that we may say of Sir John Struthers, that he possessed an infinite capacity for taking trouble, and that he did work in his day and for his generation.

NOTES.

DR. HELMERT, professor of geodesy in the University of Berlin, and director of the Prussian Geodetic Institute, has been elected a correspondant of the section of geography and navigation of the Paris Academy of Sciences, in succession to Sir G. H. Richards.

A MONUMENT to Pasteur is to be unveiled at Lille on Sunday, April 9. On the same day the Pasteur Institute of Lille will be formally opened. M. Viger, Minister of Agriculture, and M. Guillain, Minister for the Colonies, will preside at the ceremonies.

WE much regret to announce that Sir Douglas Galton, K.C.B., F.R.S., died on Friday last, at seventy-seven years of age.

SIR WILLIAM TURNER, F.R.S., professor of anatomy in the University of Edinburgh, has been elected president of the British Association for the Bradford meeting next year.

THE *Lancet* states that the late Prof. Rutherford has bequeathed to Edinburgh University his valuable medical library and his physiological and microscopical specimens and diagrams.

IN consequence of the forthcoming international geographical congress at Berlin, the thirteenth German Geographentag, which was to be held at Breslau this Easter, has been postponed until Easter of next year.

SIR NORMAN LOCKYER, K.C.B., has been nominated by the Royal Society to succeed the late Rev. Bartholomew Price as a member of the Board of Visitors of the Royal Observatory, Greenwich.

THE third Congrès des Sociétés savantes will be held at Toulouse on April 4.

THE next Congress of the South-East Union of Scientific Societies will be held at Rochester on May 25, 26 and 27.

THE death is announced of Dr. Wilhelm Hankel, professor of physics in the University of Leipzig.

MAJOR J. EVANS, professor of pathology in the Calcutta Medical College, died on Monday from the plague.

THE death is announced of Dr. Francis N. Macnamara, formerly professor of chemistry at the Calcutta Medical College, and chemical examiner to the Government of India. Upon his return to England after leaving the Indian Medical Service, he was appointed by the Secretary of State Examiner of Medical Stores at the India Office. He was about to relinquish this appointment when death overtook him, on March 5, at the age of sixty-seven. Dr. Macnamara was the author of a number of works and papers on hygiene and medical chemistry.

IN connection with the second International Acetylene Congress, an international exhibition of acetylene gas will be held in Budapest in May next, when gold and silver medals will be awarded.

WE learn that the physics garden of the Society of Apothecaries in Chelsea, founded by Sir Hans Sloane in 1722, is about to enter upon a new period of activity and usefulness. A physiological laboratory is to be built, a scientific curator appointed, and courses of lectures on different branches of botany are to be given.

IT is stated in the *British Medical Journal* that a laboratory for the application of the Röntgen rays has recently been opened in Madrid, under the name of Instituto Radiografico de Español. The Institute, the installation and equipment of which are on a magnificent scale, is said to have cost some two million pesetas (80,000*l*.). It is reported that the impression produced by the size of the place, the luxurious manner in which it is fitted up, and the wealth of apparatus which it contains, on the large assembly of medical men and journalists who were present at the opening, was one akin to stupefaction. The director of the Institute is Dr. Mezquita.

IT is announced in the *Electrician* that E. P. Kaüffer, a member of the Verein Deutscher Ingénieure, who died in 1897, left this society a legacy, from which a first prize of 3000 marks, and a second of 1500 marks (about 150*l*. and 75*l*. respectively) are to be awarded for the best essay in reply to the question: "What practical and useful processes are available to transform heat directly (without motors) into electro-dynamical energy?" Herr Bissinger, Prof. Borchers, Prof. Dietrich, Herr Kapp and Dr. Kohlrausch have been chosen as judges. The competition is international, and is not confined to members of the Verein. Essays are to be written in German, and must be sent in before December 31, 1899, to the Verein Deutscher Ingénieure, 43 Charlottenstrasse, Berlin, N.W.

THE St. Petersburg correspondent of the *Times* reports that the Russian Geographical Society is fitting out, with the aid of funds supplied by the Tsar, a new expedition for the exploration of Central Asia. The expedition, the work of which is intended to cover two years, is to be under the command of Lieutenant Koslow, and will leave St. Petersburg at the end of the present month. It will make its way through West Mongolia and the Desert of Gobi, will cross the Nan-shan Mountains by Lake Koko-nor, and penetrate into the region lying round the upper waters of the Yellow River.

THE Department of Science and Art has received through the Foreign Office a communication from the Director of the Commercial Museum, Philadelphia, calling attention to a Universal Commercial Congress and Exposition to be held there, under its auspices, during the autumn of the present year. There is being erected for the purposes of the Exposition a series of buildings in which will be displayed such American manufactures as are most representative and best adapted to foreign requirements; but it is intended also to accept as exhibits similar articles from European manufacturers, in order to afford an opportunity for a thorough and comparative study of the world's industries. The Congress will be presided over by the President of the United States at the opening Session on October 10, and all nations will have an opportunity of being represented, and having a voice and vote in its deliberations, through duly accredited delegates sent by the various Governments and commercial organisations.

A NEW incandescent lamp, in which a filament consisting of the carbide of silicon, coated with silicon and carbon by means of a modification of the usual flashing process, has been invented by Herr Langhans. Particulars of the process of manufacture are given in the *Electrician*, from which we learn that owing to the refractory nature of the material used for the filaments, lamps thus made will stand being run at a higher efficiency than is possible with any carbon filament. As is only too well known by users of the glow lamp, its two great faults, which become more marked with every increase in the efficiency when *new*, are falling off in the light and the blackening of the bulbs as time goes on. Both these faults, notwithstanding the high efficiency, are said to be practically absent from the carbide of silicon lamp. It is claimed that the new lamp, starting at an efficiency of 2·8 watts per amyl-acetate candle (*i.e.* about 3·1 watts per English candle), will run from 600 to 800 hours without any material decrease in the light emitted, increase in the watts consumed per candle, or any blackening of the glass bulbs. So that, apart from the gain in appearance and comfort from the lamps remaining bright and clean, the user of this lamp should save, on this estimate, some 25 per cent. on his lighting bills, as compared with the expenses of the use of the ordinary carbon filament lamp.

THE *Proceedings* of the Swedish Academy of Science, vol. xxxi., contains a discussion of the mean atmospheric pressure in Sweden for the years 1860–1895, by Dr. H. E. Hamberg. The work forms one of a series of valuable papers by the Meteorological Office at Stockholm, in commemoration of its twenty-fifth anniversary, and includes both tables of monthly and yearly mean values for thirty-four stations, and mean isobaric charts for the same periods. An examination of the annual variation shows that there are no less than four maxima and four minima. The first maximum, that of mid-winter, occurs in January and February, and is most pronounced in the south of Sweden. It is produced by the deviation of the Asiatic high-pressure, which extends over parts of Europe. The second maximum occurs in spring, and is most marked in the north; it is apparently caused by the polar anticyclone, in

conjunction with the high pressure over part of the North Atlantic. The subsidiary maxima occur in September and November. The first minimum occurs in March, and is very marked. It appears to be due to the low pressure over the Atlantic, and to the diminution of the continental anticyclones. The second, or summer minimum, occurs in July and August. It is caused by cyclonic formations developed by the high temperature over Europe and Asia. The subsidiary minima occur in October and December.

IN the *Indian Meteorological Memoirs*, vol. vi. part iv., Mr. J. Eliot, F.R.S., discusses the occurrence and distribution of hailstorms in India during the fifteen years 1883–97. Information of all important hailstorms is collected by the revenue authorities, with the view of remitting the collection of part or the whole of the land tax over the affected areas, and Mr. Eliot has wisely arranged for copies of the data to be supplied to the Indian Meteorological Office. In the very interesting discussion, he points out that 94 per cent. of the hailstorms occur during the north-east, or dry monsoon (December to May), when the diurnal range of temperature is large, and that they are almost entirely absent during the south-west, or wet monsoon (June to November). A noteworthy feature of the distribution is that in certain districts the storms occur chiefly during the first part of the dry monsoon, *i.e.* during the cold weather season, while in other provinces they originate chiefly during the hot weather. As regards the diurnal distribution, during the hot weather period the hailstorms occur chiefly (about 74 per cent. of the total number) between 3 p.m. and 8 p.m. In the cold weather season, they are most frequent during the hottest time of the day, 3 p.m. to 4 p.m.

WE are glad to learn from a Report, just published, that the stimulus supplied by the visit of the British Association to Bristol last year, and the special efforts made by the Committee, have resulted in increased interest being taken in the Bristol Museum, one consequence of which has been a succession of valuable gifts to the collections. In April 1898 an important discovery of animal remains belonging to the Pleistocene period was made at Uphill, near Weston-super-Mare. Steps were at once taken by the Committee to secure for the museum collections the results of an exploration of the site. The exploration was carried on as far as was possible at the time, and the result has been that a large and representative collection of the bones and teeth of animals, including those of the hyena, mammoth, horse, cave-bear, cave-lion, rhinoceros, fox, &c., has been secured. Peculiar interest attaches to certain other bone fragments that have been identified as those of man, and to a small collection of chipped flints and rounded stones. A selection from these interesting objects was exhibited by the present curator, Mr. Herbert Bolton, at the British Association, and he also communicated the substance of the notes on the subject of the exploration, left by his predecessor, Mr. E. Wilson. The Council of the Association have shown their interest in the matter by making a grant of £30—towards any further expense, and the Chairman of the Committee (Mr. W. R. Barker) and Mr. Bolton are now associated with Prof. C. Lloyd Morgan, Prof. W. Boyd Dawkins, and others, in determining what further can be done.

THE Hayti earthquake of December 29, 1897, is the subject of an interesting paper, by Dr. G. Agamennone, in the last *Bollettino* of the Italian Seismological Society. The epicentre was situated in the valley of the river Yaque, in lat. 19½° N. and long. 71° W., and the intensity in this district was from 9 to 10 of the Rossi-Forel scale. The total disturbed area was not less than 125,000 square km.; but, as usual, the seismic waves were recorded by pendulums in distant observatories, the furthest being that of Nicolaiew, 9370 km. from the origin. The earlier tremors travelled with a velocity of about 10 km. a second, and the subsequent slow pulsations with a velocity of about 3 km. a second. The estimates of the period of the latter vary with the instrument employed, ranging from seven seconds at Rocca di Papa, near Rome, to eighteen seconds at Catania.

WE have received the first instalment of a "Catalogue of the Types and Figured Specimens in the Palæontological Collection of the Geological Department, American Museum of Natural History," issued as vol. xi. part 1 of the *Bulletins* of that Museum. The importance of the proper cataloguing of type-specimens of fossils needs no pointing out, and the work before us, prepared by Mr. R. P. Whitfield, assisted by Mr. E. O. Hovey, is a model of clear and careful arrangement. The specimens are arranged firstly according to geological systems, secondly in biological classes, and then alphabetically. Generic names appear in Clarendon type, species in Roman, and synonyms in italics. The catalogue is arranged in seven columns, stating in turn (1) the geological series (initials only); (2) catalogue number; (3) whether "type" or "figured"; (4) genus, species, and author; (5) reference—subdivided into five columns for work, volume, page, plate, and figure; (6) locality; and (7) remarks. The only improvement that we would suggest is the printing of the name of the geological system on *every* page, instead of only once. The present part covers the Cambrian and Lower-Silurian systems.

THE third instalment of the International Geological Map of Europe, which has recently been issued, is specially interesting to British geologists from its containing the three sheets that cover the British Isles (A4, B3, and B4). For the sake of symmetry, sheet A3 is added, but this resembles a certain famous map in "representing the sea without the least vestige of land"; while A4 contains such a small fragment of Ireland that the margin of B4 has been broken, and the fragment repeated there, the two sheets B3 and B4 thus including the whole of the islands. The British Isles, treated from the international point of view, present a somewhat unfamiliar aspect. This is due not so much to violet Trias and blue Jurassic as to the representation of Drift. Ireland, in particular, is one mass of stripes, indicating known older strata covered by quaternary. As no allowance is made in the Index of Colours for non-metamorphic pre-Cambrian beds, the Longmynd and Charnwood Forest have perforce to reappear as "Cambrian"; but the insertion of such comparative novelties as the Permian of Devonshire, and the Cambrian of the north-west Highlands clears the map of any suspicion of being out of date. Besides the British sheets the new issue includes C5, which forms by itself an excellent map of the Alps, and D5 and D6, which take in most of Austria-Hungary, the Balkan peninsula and Greece.

AT the Institution of Civil Engineers on March 7, two papers relating to recent advances in marine engineering were read. The first paper, on "Water-Tube Boilers for Marine Engines," by Mr. J. T. Milton, consisted mainly of a description of the various types of water-tube boilers most in use for marine purposes in this country. For all recent vessels of the Royal Navy water-tube boilers of different type had been adopted, while very few had been fitted in merchant steamers. The second paper, on "Machinery of Warships," by Sir A. J. Durston, K.C.B., and Mr. H. J. Oram, R.N., gave particulars and remarks on the construction of warship machinery and details of the results obtained since the date of the paper read at the Institution in November 1894. It was pointed out that further experience with water-tube boilers had led to their general adoption for warships. In considering the type most suitable,

the principal points to be considered were weight and space required, economy and durability. On account of the last two considerations, boilers of the large-tube type had been adopted for the larger vessels. The Belleville boiler was fitted in these vessels, and in recent cases these had been fitted with economisers, the number of tubes in the generators being reduced. Trials on shore showed 12 to 15 per cent. increase of economy due to the use of these economisers. In the smaller fast vessels, to reduce weight, boilers of the small-tube type were generally fitted. Experience had shown that the ordinary life of the tubes of the Belleville boiler, under ordinary circumstances, would be not less than two commissions. In small-tube boilers this life would generally be much less. Zinc slabs, though still of use in arresting corrosion, could not from the nature of construction of water-tube boilers be so effective as in water-tank boilers. The parts of the boiler near the feed-water inlet appeared to be very subject to corrosion, and this appeared to be due to the liberation of air and other gases from the feed-water at this part. It was endeavoured to minimise this action by using distilled water whenever possible.

MR. E. F. J. LOVE has drawn up, for the Sydney session of the Australian Association for the Advancement of Science, a report on our knowledge of the thermodynamics of the voltaic cell. In it the author shows how the general laws of thermodynamics have been applied to the determination of electromotive force, Helmholtz's law, the Peltier effect, dissociation, the calculation of the free energy of the current, polarisation, and the relation between electromotive force and external pressure. It is pointed out that the results here exhibited as deductions from the laws of thermodynamics can in some cases be obtained independently by totally different methods.

AN extremely interesting and suggestive memoir, dealing with some investigations on the bacterial diseases of plants, has been contributed by M. Émile Laurent to the *Annales de l'Institut Pasteur*. The majority of the experiments were made with potatoes, cultivating them on soil variously treated with manures, chemical and other, and then inoculating the tubercles with a certain micro-organism closely allied to the *B. coli communis* obtained from the air during the course of the investigations. Different kinds of potatoes were selected, and, as was to be expected, the various chemical manures employed affected the luxuriance of the growth very differently; but the chief interest of these experiments lies in the fact that apparently susceptibility to bacterial infection varies not only with the variety of potato, but also according to its conditions of cultivation. Thus the bacterial susceptibility of several varieties was increased by their being grown on land liberally treated with lime. According to M. Laurent, speaking generally, lime added to soil increases the susceptibility of potatoes to bacterial infection, and nitrogenous and potash manures have the same effect, only to a less extent; whilst the addition of phosphates distinctly diminishes this susceptibility, as also does common salt, only not so markedly. Some interesting experiments are recorded, showing how the virulence of this bacillus towards potatoes can be artificially increased by suitable conditions of cultivation. Incidentally, we are told that the typhoid bacillus attacks potatoes with extraordinary energy if the resistance of the latter has been reduced by treatment with an alkaline solution; this activity of the typhoid bacillus being more marked than was the case with other varieties of bacteria which had had a far longer training. The memoir is replete with suggestive work, and affords a fresh outlet for the energies of those bacteriologists who care to study the micro-organisms in their relation to plant-life.

THE February number of the *Quarterly Journal of Microscopical Science* is almost entirely devoted to Dr. Arthur Dendy's very interesting memoir on the development of the Tuatara (*Sphenodon punctatus*).

MESSRS. WILLIAMS AND NORGATE have just issued No. 70 of their Book Circular (Scientific Series), in which is to be found notes on, and the titles of, numerous new and forthcoming publications in all branches of science.

WE are glad to learn that owing to the fact that the circulation of *Science Abstracts* now exceeds 4000 copies monthly, the price is to be reduced from three to two shillings per copy. Mr. W. R. Cooper has been promoted from assistant editor to editor, and the *Abstracts* are now published by Messrs. E. and F. N. Spon.

THE *Journal of Applied Microscopy*, published monthly by the Bausch and Lomb Optical Company, Rochester, N.Y., has now entered on the second year of its existence, and continues to supply useful practical notes to microscopists on microtechnique, the preparation of microscopical objects, and other kindred subjects.

FROM the Michigan State Agricultural College, we have received *Bulletins* Nos. 164 and 165 of the Farm Department:—Methods and results of tillage, and draft of farm implements, by M. W. Fulton; also *Bulletins* Nos. 5 and 6 of the Botanical Department:—Branches of sugar-maple and beech as seen in winter; and potatoes, ruta-bagas, and onions, by W. J. Beal.

SOME hydroids collected in Puget Sound are described and illustrated by Mr. G. N. Calkins in the *Proceedings* of the Boston Society of Natural History. The area examined was comparatively small, two points—Port Townsend and Bremerton—being the only localities represented in the collection. These two places, however, yielded no less than thirty species, a fact which promises well for the further investigation at different points on the Sound.

AN addition (No. 24) to the series of "Museum Handbooks," published in connection with the Museum of Owens College, Manchester, has been made by the publication of reprints from the *Journal of Conchology* of papers by Messrs. J. Cosmo Melville and Robert Standen, on the marine mollusca of Madras, and on marine shells from Lively Island, Falklands. This handbook is illustrated by two plates, one of which consists of a photographic reproduction of *Trophon geversianus*, from a specimen in the possession of Mr. Cosmo Melville.

LORD DELAMERE, during his recent expedition into East Equatorial Africa, made a valuable collection of zoological specimens, some of which he is presenting to the Natural History Museum. He succeeded in taking a series of photographs of most of the representative animals met with, including elephants, giraffes, zebras, antelopes, gazelles, &c. As the pictures show the characters of the country as well as the natural features and positions of the animals in their wild state, they are of scientific interest. They will be included in a volume entitled "Great and Small Game of Africa," to be published shortly by Mr. Rowland Ward.

IN the February number of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* is an interesting summary by Prof. Grehant of his researches on the products of combustion of lighting gas under different conditions. He has specially studied the formation of carbon monoxide, on account of the deleterious action upon the health of small traces of this poisonous gas. Two methods were independently employed for this purpose, one physiological, depending upon the analysis of the gas extracted from the blood of animals who had been breathing the vitiated air, and the other purely chemical, depending upon the reduction of iodic anhydride at

150° C. by traces of carbon monoxide. In an ordinary bats-wing burner, the amounts of carbon monoxide found were so small as to be possibly due to experimental error, and in any case negligible. The ordinary incandescent burner gives off traces of this gas, and in fact whenever a gas flame strikes an obstacle within a certain distance of the orifice through which the gas is issuing, small quantities of carbon monoxide are evolved, and on this account special attention to the upward draught in all gas stoves is essential. No lighting burner in ordinary use appears to give off sufficient carbon monoxide to render any special precautions necessary, the author pointing out that more of this gas will be introduced into a room through slightly defective gas fittings than is given out by any pattern of burner in ordinary use.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. W. White; two Great Bats (*Vespertilio noctula*), British, presented by Mr. E. Hilton; a Common Seal (*Phoca vitulina*) from the River Spay, Scotland, presented by his Grace the Duke of Richmond and Gordon, K.G.; a Common Hare (*Lepus europaeus*), British, presented by Miss Henrietta Holland; an Egyptian Jerboa (*Dipus aegyptius*) from North Africa, presented by Mr. F. Tomlin; a West African Love Bird (*Agapornis pullaria*) from West Africa, presented by Mr. C. W. Gameys; a Kiang (*Equus hemionus*) from Tibet, a Rose-crested Cockatoo (*Cacatua moluccensus*) from Moluccas, an Echidna (*Echidna hystrix*) from New South Wales, deposited; a Cabot's Tragopan (*Ceriornis caboti*) from China, five Crested Colins (*Eupsychortyx cristata*) from Mexico, purchased.

OUR ASTRONOMICAL COLUMN.

COMET 1899 *a* (SWIFT).—The number of observations of this comet has been sufficient to allow of the orbit being computed, and for this the following elements are found:—

T = 1899, April 13·26, G.M.T.

$\omega = 4^\circ\ 54'$
$\Omega = 23\ 9$ 1899
$i = 146\ 4$
$q = 0{\cdot}3447$

Ephemeris for 12h. G.M.T.

1899.	R.A. h. m.	Decl. ° ′	Br.
Mar. 16	2 56	11 53	1·00
17	2 52	−10 47	1·13
19	2 46	8 47	
20	2 43	7 55	
21	2 40	6 54	1·23
23	2 34	5 7	

The comet is brightening as it approaches the sun, and its rapidly decreasing southerly declination will render its observation more likely in these latitudes. It is said to be round, with a diameter of about 7′ of arc, having a central condensation and a short tail. It should be looked for immediately after sunset near η Eridani, and will move from that position towards the variable star *o* Ceti (Mira).

TUTTLE'S COMET 1896 *b*.—In *Ast. Nach.*, 3552, Mr. J. Rahts gives an improved ephemeris of this comet, together with the elements.

1899.	R.A. h. m.	Decl. ° ′
March 17	2 2	+28 49
21	2 18	27 42
25	2 33	26 30
29	2 48	+25 13

The comet is increasing in brightness.

NEW STAR IN AQUILA.—A circular from the Centralstelle at Kiel informs us of the present state of the new star discovered by Mrs. Fleming in March 1898, during the examination of the Harvard plates. The position of the star for epoch 1900 is R.A. = 18h. 56m. 13s.; Decl. = −13° 18′; this place is in the south-western border of Aquila, or on some charts in the north-west of Sagittarius. At the time of discovery the Nova was of the fifth magnitude, while now (March 10) Prof. Pickering gives it the magnitude ten, as determined from the photometric measurement of eight plates.

PHOTOGRAPHY OF CORONA.—For the past four or five years several astrophysicists have been attempting to obtain photographs of the Solar Corona without the aid of a total eclipse, but so far, however, without success. Sig. A. Ricco, director of the Catania Observatory, gives the history of the investigation as well as the results of his own attempts on the problem. [*Bulletin de la Soc.-Belgé d'Astronomie*, vol. iii. No. 4.] The first attempts described are those of Dr. Huggins, who employed a reflector having an extended cap provided with numerous diaphragms to minimise the amount of scattered light. A similar apparatus has also been used by A. Mascari at the observatory on Mount Etna. Certain corona-like forms do appear on the photographs thus obtained, but there seems to be no probability of their being real.

Later Prof. G. E. Hale, using a spectroheliograph at Mount Etna, attempted to photograph the corona by isolating the violet calcium line (K) of the spectrum, and traversing the sun's image given by a lens across the slit of the instrument. This was also unsuccessful.

Prof. Ricco then tried using a portrait lens, but with no better result; and the last attempts he describes were made with pin-hole cameras of various dimensions, these also failing to record any true image. Reproductions of the photographs obtained with all four types of apparatus are given, and examination of these shows that the only appearance photographed is the graduated halation effect radiating equally in all directions from the solar disc.

HARVARD COLLEGE OBSERVATORY.—In the Harvard College Observatory *Circular*, No. 39, Prof. E. C. Pickering presents some remarks on the work done with the new Bruce photographic doublet in comparison with other instruments of different design. He advocates that in future new large telescopes should be made of widely-varying types, so that the most appropriate form for any particular department of astronomical work may be obtained. The Bruce telescope was a new departure from conventional lines, and its complete success encourages the extension of the inquiry. In this case the instrument has a very short focal length, and Prof. Pickering proposes, if funds be forthcoming, to design an instrument of unusually long focus, say from 130 to 160 feet, with an aperture of from 12 to 14 inches. This he would place horizontally, and feed with light from a mirror. The diurnal motion would be counteracted by moving the plate by clockwork, as in the horizontal photo-heliograph now in use at Cambridge. With such an instrument he thinks much could be done in obtaining better photographs of the solar surface and the prominences; pictures of the moon could be got exceeding 12 inches in diameter without enlargement, and possibly photographs of the planets Jupiter, Saturn and Mars. It would also be useful in re-determining the solar parallax from the next approach of Eros in 1900, by observing the planet east and west of the meridian.

Circular No. 40 gives a description of the methods adopted at the observatory for photographing meteors. In the case of determining the radiant point of bright meteors the usual method of intersecting trails is scarcely applicable, their number being so small. If, however, the meteor is simultaneously observed from *two* stations, the radiant can be determined just as correctly. Provision for this has been made, cameras provided with automatic exposing shutters having been installed at Blue Hill and Cambridge. The lenses are of wide angle, and point to the zenith. If two photographs of the same meteor are superimposed, the height at the instant of exposure can be found by a simple proportion. As the distance of the meteor on the two photographs is to the focal length of the lenses, so is the distance apart of the two stations to the required altitude. The positions of the trails in space can be found if stars are also photographed on the plates, the intersection of the two trails giving the declination of the radiant point of the meteor. The right ascension is, however, indeterminate unless time of appearance is known, or, as may be later, the camera be mounted equatorially.

The value of placing a prism in front of the lens to obtain spectra is also mentioned, and it is recommended that the plate be kept in vibration at a known rate. Prof. Pickering thinks that using three plates each night it would be possible to determine the altitude, radiant point, velocity and spectrum of one-third of all the bright meteors visible in any locality.

FORTHCOMING BOOKS OF SCIENCE.

MR. FÉLIX ALCAN (Paris) promises:—(Bibliothèque Scientifique Internationale) "La géologie expérimentale," by Prof. Stanislas Meunier; "La Nature tropicale," by J. Constantin. Médicine.—"Chirurgie de la plèvre," by Prof. Terrier and Dr. Reymond, illustrated; "Chirurgie d'urgence," by Dr. Cornet, illustrated; "L'Instinct sexuel, evolution," by Dr. Ch. Féré, illustrated; "Traité d'histologie pathologique," by MM. Cornil, Brault and Letulle, 3 vols., illustrated; "La profession médicale (Devoirs et Droits), by Prof. Morache; "La mécanothérapie," by Dr. F. Lagrange; "Études de chirurgie médullaire," by A. Chipault, Tome i. and ii., illustrated.

Mr. Edward Arnold announces:—"Dynamics for Engineering Students," by Prof. W. E. Dalby; "Elementary Natural Philosophy," by A. Earl; "An Elementary Chemistry," by W. A. Shenstone, F.R.S.; "Physical Chemistry," by Dr. Alexander Scott; "A Manual of Physiology," by Dr. Leonard Hill; "A Manual of Botany," by David Houston; "A Manual of Physiography," by Andrew J. Herbertson; "Wood: its Natural History and Industrial Applications," by Prof. G. S. Boulger.

Messrs. Baillière, Tindall, and Cox give notice of:—The Harben Lectures, 1898–99: "The Administrative Control of Tuberculosis," by Sir Richard Thorne Thorne, K.C.B.; "Arris and Gale Lecture, Royal College of Surgeons of England, 1899," by Dr. B. G. A. Moynihan; "The Analysis of Food and Drugs," by T. H. Pearmain and C. G. Moor, part ii., "The Chemical and Biological Examination of Water"; "The Pocket Pharmacopœia: including the Therapeutical Action of the Drugs with the Natural Order and Active Principle of those of Vegetable Origin," by F. Hudson-Cox and Dr. John Stokes; "Dictionary of Medical Terms," by H. de Méric, part ii., French-English; "Aids to Materia Medica," by Dr. W. Murrell, part ii.

Messrs. A. and C. Black's list contains:—"Human Geography," by A. J. Herbertson; "Physics," by A. T. Walden and J. J. Manley.

Messrs. Gebrüder Borntraeger (Berlin) give notice of:—"Symbolae Antillanae seu Fundamenta Florae Indiae Occidentalis," edited by Urban, vol. i., Fasc. i; "Werden und Vergehen," by Carus Sterne.

The list of Messrs. C. J. Clay and Sons (Cambridge University Press) includes:—"Collected Mathematical Papers," by Prof. P. G. Tait, vol. ii.; "The Scientific Papers of John Couch Adams," vol. ii., edited by Prof. W. G. Adams and R. A. Sampson; "Scientific Papers," by Lord Rayleigh, F.R.S.; "Scientific Papers," by the late Dr. Hopkinson, F.R.S.; "Scientific Papers," by Prof. Osborne Reynolds, F.R.S.; "The Strength of Materials," by Prof. J. A. Ewing, F.R.S.; "A Treatise on Spherical Astronomy," by Prof. Sir Robert S. Ball, F.R.S.; "A Treatise on Geometrical Optics," by R. A. Herman; "On the Kinetic Theory of Gases," by S. H. Burbury, F.R.S.; "Zoological Results based on material from New Britain, New Guinea, Loyalty Islands, and elsewhere, collected during the years 1895, 1896 and 1897," by Dr. Arthur Willey, part iii., illustrated; "Fauna Hawaiiensis," or the Zoology of the Sandwich Islands, being results of the explorations instituted by the Joint Committee appointed by the Royal Society of London for Promoting Natural Knowledge and the British Association for the Advancement of Science, and carried on with the assistance of those bodies and of the Trustees of the Bernice Pauahi Bishop Museum," edited by Dr. David Sharp, F.R.S., vol. i. part i.: *Hymenoptera Aculeata*, by R. C. L. Perkins; Cambridge Natural Science Manuals (Biological Series): "Fossil Plants," a manual for students of botany and geology, by A. C. Seward, F.R.S., vol. ii.; "The Soluble Ferments and Fermentation," by Prof. J. Reynolds Green, F.R.S; (Physical Series): "Electricity and Magnetism," by R. T. Glazebrook, F.R.S.; "Sound," by J. W. Capstick; (Geological Series), Crystallography, by Prof. W. J. Lewis; (Cambridge Geographical Series), "Man, Past and Present," by A. H. Keane; "Military Geography," by Dr. T. Miller Maguire.

Messrs. Georges Carré and C. Naud (Paris) announce:—"Matière Médicale Zoologique," by Prof. Henri Beauregard, illustrated; "Travaux Pratiques de Physiologie," by Prof. R. Dubois; "Résistance des Matériaux," by Prof. M. Duplaix, illustrated; "La Photothérapie," by N. R. Finsen, illustrated; "Leçons sur la Morphologie des Insectes," by L. F. Henneguy, illustrated; "Les Sanatoria Traitement et prophylaxie de la phtisie pulmonaire," by S. A. Knopf, illustrated; "Les Concours agricoles," by H. Marchand; "Cours de Géométrie élémentaire," by B. Niewenglowski and L. Gérard; "Distillation et Rectification des Alcools, by G. Sorel, illustrated; "L'éclairage à incandescence par le gaz et les liquides gazéifiés," by P. Truchot.

Messrs. Cassell and Co., Ltd., promise a new and revised edition of "Optics," by Profs. Galbraith and Haughton, and an enlarged issue of "Familiar Wild Flowers," by F. E. Hulme.

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In the list of Messrs. R. Friedländer and Son (Berlin) we find:—C. Clusius, "Icones Fungorum in Pannoniis," by Prof. Gy. de Istvánffi, Fasc. ii.; Gerberti, "Opera Mathematica," collected and edited by N. M. Bubnow; "Das Tierreich," Lieferung 5: Sporozoa, by Dr. A. Labbé; Lieferung 7: Sarcoptidae and Demodicidae, by Prof. G. Canestrini and Prof. P. Kramer; Leiferung 8: Pedipalpi et Scorpioninae, by Prof. K. Kraepelin; Trochilidae, by E. Hartert; Hydrachnidae and Halacaridae, by R. Piersig and Dr. H. Lohmann; Catalogus Mammalium tam viventium quam fossilium, by Dr. E. L. Trouessart, Fasc. vi., Addenda et Corrigenda, Index alphabeticus.

Mr. Henry Frowde announces:—"Annals of Botany," No. xlix.; Goebel's "Organographie der Pflanzen," translated by Prof. I. Bayley Balfour, F.R.S.; Pfeffer's "Pflanzenphysiologie," translated by Dr. A. G. Ewart.

Messrs. Gauthier-Villars et Fils (Paris), promise:—"Electricité on des hertziennes Rayens X," by E. Bouty; "Excursion électrotechniche," by Prof. Janet; "Principes et pratique d'Art en Photographie," by Frédéric Dillaye, illustrated; "Histoire abregée de l'Astronomie," by Prof. E. Lebon, illustrated; "Répertoire universel de Bibliographie des Industries tinctoriales et des industries annexes," by J. Garçon; "Dix leçons de Photographie élémentaire," by Eug. Trutat; "L'Objectif photographique," by P. Moëssard, illustrated; "Traité pratique de Photogravure en relief et en creux," by Léon Vidal, illustrated.

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Mr. Murray calls attention to:—The Progressive Science Series: "On Whales," by F. E. Beddard, F.R.S., illustrated; "The Stars," by Prof. Newcomb, illustrated; "Man and the Higher Apes," by Dr. Keith, illustrated; "Heredity," by J. Arthur Thomson, illustrated; "Bacteriology," by Dr. G. Newman, illustrated.

In the list of Messrs. Kegan Paul and Co., Ltd., we find:—"The Geography of Mammals," by Dr. P. L. Sclater, F.R.S., illustrated; "Experimental Physics," by the late Prof. von Lommel, translated by Prof. G. W. Myers, illustrated; "Sewage Analysis," by J. A. Wanklyn and W. J. Cooper.

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Mr. T. Fisher Unwin gives notice of:—"The Climbs of Norman Neruda," by Mrs. Norman Neruda, illustrated; "The Kingdom of the Ba-Rotsi—Upper Zambesia," by Alfred Bertrand, translated by A. B. Miall, illustrated; "Claude Bernard," by Prof. Michael Foster, F.R.S. (vol. vi. "Masters of Medicine" Series).

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UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 199th meeting of the Junior Scientific Club took place on Friday evening, March 10, at the Museum. In private business the officers for next term were elected, and there was a long debate on a motion of Mr. A. E. Boycott (Oriel) to confine the ordinary membership of the Club to members of the two Universities of Oxford and Cambridge and to persons engaged in scientific work in Oxford in connection with the University. Ultimately the amendment of Mr. A. F. Walden (New College) to delete the words "in connection with the University" was carried by a large majority, and the amended motion passed. In public business, Mr. F. W. Charlton (Merton) read a paper on "Gold mining," and Mr. A. F. Walden a paper "On the condition of dissolved substances in solutions other than aqueous."

The Robert Boyle Lecture of 1899 will be delivered in Eight's week of next term, by Prof. E. Ray Lankester, F.R.S.

CAMBRIDGE.—The grace for the establishment of a professorship of Agriculture will be offered to the Senate on May 11.

The researches in magnetism and electricity, presented by Mr. S. W. Richardson and Mr. J. Henry, advanced students of Trinity College, have been approved by the special Board for Physics as qualifying for the B.A. degree.

Mr. T. Andrews, F.R.S., has presented a valuable metallurgical microscope to the engineering laboratory.

The degree of M.A. *honoris causa* has been conferred on Dr. G. Sims Woodhead, Professor of Pathology.

Profs. Thomson, Forsyth, and Macalister, and Mr. F. Darwin have been appointed electors to the Allen Studentship for original research recently founded in the University.

IT appears from a useful table published in the *Library World* for February, that 363 towns and districts of the United Kingdom have adopted the Public Libraries Act. The progress of the movement was slow while the power of adoption remained in the hands of the ratepayers; but since it was transferred, in 1893, to the option of town councils and other authorities, the rate of progress has increased nearly threefold. Between 1850 and 1892, 256 places had adopted the Act—an annual average of about 6; but in the six years from 1893 to 1898, 107 places had established libraries—a yearly average of 16, excluding London, which still retains the public vote.

THE names of the present curators of patronage, by whom the appointment of a professor of physiology in the University of Edinburgh, in succession to the late Dr. Rutherford, are given by the *British Medical Journal* as follows:—Principal Sir William Muir, the Right Hon. J. P. B. Robertson, Lord Justice-General for Scotland; and Dr. Patrick Heron Watson, elected by the University Court, while the following four curators are elected by the Town Council; the Right Hon. Lord Provost Mitchell Thomson, Lieut.-Colonel Alexander Forbes MacKay, Sir James Alexander Russell, and Mr. George Auldjo Jamieson. It is stated that already the following gentlemen are candidates for the vacant chair: Prof. E A. Schäfer, F.R.S., Dr. William Stirling, Dr. Diarmid Noël Paton, Dr. E. Waymouth Reid, F.R.S, and Dr. E W. Wace Carlier, senior assistant to the late Prof. Rutherford. Dr. Carlier is at present giving the lectures in physiology in the University. The emoluments of the chair will in future be of the annual value of 1400*l.*

A GEODETIC observatory is a necessary part of the equipment of an institution giving instruction in geodetic methods of surveying. Such an observatory has lately been established in connection with the Massachusetts Institute of Technology. This observatory is intended primarily to be used in giving instruction in the most refined methods of determining latitude and longitude, and is also to be used in magnetic and gravity observations. A hill in the south-eastern part of Middlesex Fells was chosen for the site. Here was found a firm foundation for the most delicate instruments, free from the vibrations caused by railroad and highway traffic, and not too far from Boston. Much work has been done at the observatory that could not before be performed in any of the Institute buildings. This is especially true of the tests on delicate spirit-levels and the determination of constants depending on such observations. This is due to the freedom of the observatory from vibrations, while its distance from all magnetic disturbances renders it especially favourable for observation with the magnetometer and dip circle. It has been attempted to give the students in geodesy such practice as will not only illustrate the theory, but enable them to make satisfactory observations of paramount value with all the various instruments employed. The observatory will also be used by all civil engineering students in connection with their fourth year astronomy. The observatory, on account of its good position, will be a valuable magnetic station, and its observations will probably be incorporated in the general magnetic work of the United States Government.

IN the House of Lords on Tuesday, the Duke of Devonshire called attention to the subject of secondary education, and introduced a Bill dealing with it. The *Times* reports him to have said, in the course of his remarks, that by the Bill it is proposed to constitute a Board of Education of the same

character as the Board of Trade or the Board of Agriculture. Like the Board of Trade, and unlike the Board of Agriculture, the new department will have a Parliamentary secretary as well as a president; but the office of vice-president will cease to exist, although the present vice-president will continue to be a member of the Board. The Bill will give more elastic powers for the transfer of the educational functions of the Charity Commissioners to the new department. At first there will only be such an inspection and examination of local schools as will bring the endowed, municipal, private, and proprietary schools within their areas to some common local scheme. It is intended that the inspection shall be optional, except in the case of schools which are being conducted under schemes framed by the Endowed Schools Commissioners. In the first instance, no attempt will be made to impose upon the schools anything like uniformity in their course of instruction, but the inspection will be made in accordance with the advice given by the consultative committee. It is considered that the registers of teachers, both in elementary and secondary schools, may be most properly kept by the Department itself; but it is provided that the regulations relating to the registers shall be framed in accordance with the advice given by the consultative committee. The composition of that committee will not be stereotyped by the terms of the Bill, which provides, however, that two-thirds of the members shall be representatives of the Universities or of other teaching bodies. The organisation of the Science and Art Department will be revised, and the task will be undertaken by a departmental committee, which will be appointed as soon as the principle of the amalgamation of this Department with the Education Department has been approved by Parliament. The inquiry will occupy a considerable amount of time, and it is, therefore, proposed that the present Bill shall not come into force until April 1 next year.—The Bill was read for a first time.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 23.—"Deposition of Barium Sulphate as a Cementing Material of Sandstone." By Frank Clowes, D.Sc., Emeritus Professor, University College, Nottingham. Communicated by Prof. H. E. Armstrong, F.R.S.

Some years ago the author described the occurrence of a peculiar sandstone over a large area in Bramcote and Stapleford, near Nottingham (*Roy. Soc. Proc.*, vol. xlvi. p. 363). The sandstone was remarkable for its high specific gravity; and chemical analysis, supported by microscopical examination, proved that the high specific gravity was due to the existence in the sandstone of a large proportion of highly crystalline barium sulphate. In the rock itself the percentage of the sulphate varied from 33·3 to 50·1; and it evidently served as the binding or cementing material which held the sand grains together. The occurrence of this sandstone was stated by geologists to be unique in the United Kingdom.

Mr. J. J. H. Teall made an examination of the sandstone, and, after breaking up a portion of the rock, found that the small cleavage flakes gave the optical characters of crystallised barium sulphate. Mr. Teall further stated that the barium sulphate occurred in large irregular crystalline patches, which included the sand grains.

The author noted that in some parts of the rock the sulphate occurred in reticulated veins enclosing small patches of more or less loose sand grains; while in other parts of the rock the sulphate occurred in spherical or oval masses, between which looser sand was interspersed; occasionally, however, the barium sulphate was uniformly distributed.

The appearance presented by the weathered surface of the rock varied according to the mode in which the resistant sulphate was distributed. When it was uniformly distributed, it formed an almost complete protection against weathering: the reticulated distribution of the sulphate caused the surface of the weathered rock to present a fretted surface, with the thin veins of sulphate projecting from the surface; while when the sulphate had bound together spherical or oval masses in the substance of the sand, these were left in pebble-like forms as soon as the loose sand had been washed out from between them.

Dr. Bedson had shown (*J.S.C.I.*, vol. vi. p. 712) that barium chloride was present to the extent of 137·2 parts per 100,000 in some of the colliery waters of the Durham coal-field, and the ferrous sulphate and sulphuric acid derived from the iron pyrites in the beds of coal and shale caused the frequent deposition of barium sulphate from such water. The author of the present paper described some of these deposits (*Roy. Soc. Proc.*, June 1889), and suggested that the calcium sulphate present in the waters of the Nottingham district would in a similar way cause barium sulphate deposits from barium chloride spring water. But in the Nottingham district all evidence of barium chloride in solution was wanting.

Such a barium chloride water, derived from an artesian boring at Ilkeston, has recently been found by Mr. John White (*The Analyst*, February 1899). The Ilkeston boring has been made in the immediate neighbourhood of the Bramcote and Stapleford sandstone which contains the large proportion of barium sulphate. Since the barium chloride is found to the extent of 40·7 parts per 100,000 in the water from this boring, and seems to be a normal constituent of the water, it would appear that soluble barium salts are present in the district, and may therefore have given rise to the deposition of the barium sulphate in the original sand beds. The crystallisation of the sulphate around the sand grains would then cause it to act as a compact, insoluble cementing material.

Since the publication of his original paper on the occurrence of barium sulphate in the Bramcote sandstone, the author has continued his examination of samples of sandstone from the basement of the pebble beds of the Bunter, with the object of ascertaining whether the occurrence of barium, either as sulphate or in other forms of combination, was characteristic of the sandstones of that geological period. He had thus far failed to find any similar rock to that at Bramcote, and it therefore seems probable that the occurrence of barium sulphate, although it extends over a very extensive area at Bramcote and Stapleford, must be looked upon as being due to purely local causes. Such local causes, however, appear to have occurred in certain other districts, since Messrs. J. Lomas and C. C. Moore stated to the Liverpool Geological Society, on February 8, 1898, that large proportions of crystallised barium sulphate occurred in triassic sandstones at Prenton and Bidston. In different specimens of the sandstone the percentage of the sulphate varied from 12·4 to 33·8 per cent. It was described as being colourless and highly crystalline, and adherent to the sand grains in such a way as to show that it has been deposited *in situ* subsequently to the sand grains. Mr. Lomas stated that the occurrence of barytes in the trias was fairly common, and mentioned the following localities, in which its presence is well known: Beeston, Alderley Edge, Oxton, Storeton, and Peakstones Rock, Alton.

"Some Experiments bearing on the Theory of Voltaic Action." By J. Brown. Communicated by Prof. Everett, F.R.S.

The experiments were intended to test the theory which attributes the difference of potential observed near metals in contact to the chemical action of films condensed on their surfaces, from the atmosphere or gas in which they are immersed, by investigating the effect of removing the chemically active matters from this atmosphere. On the hypotheses the difference of potential should be reduced thereby to zero, and regain a value near its original, when air was re-admitted. Previous experimenters had not found this to be the case, but it was hoped that elaborate precautions in details might give more definite results than had been hitherto obtained.

A copper-zinc volta condenser with plates 101 mm. by 47 mm. was sealed up in a glass tube in an atmosphere of nitrogen exhausted to a few millimetres pressure, together with metallic potassium and sodium, to absorb any oxygen or other chemically active matters that might have remained in the nitrogen. The zinc plate of the condenser was carried on a glass support hinged to a prolongation of the copper plate, so that on tilting the tube the plates could be separated, in order to measure the difference of potential by a well known zero method. Platinum wires sealed into the tube made connections for this purpose. Three experiments were made.

In No. 1, lasting six months, the difference of potential fell gradually from 0·74 volt at starting to 0·33 volt. On admitting air it rose to 0·48 volt.

In No. 2, lasting eighteen months, the fall was from 0·7 volt to 0·52 volt, and on opening the tube this value did not sensibly change. The fall was therefore probably due to the well-known effect of tarnishing of the zinc surface.

In No. 3, potassium and sodium were fused together to form the alloy liquid at ordinary temperatures. The difference of potential was 0·75 volt at starting, and fell in the course of seven and a half years to 0·49 volt. On opening the tube there was little appreciable change in this value. The fall in this case also was therefore no doubt due to tarnishing of the zinc surface.

Experiment 1 is the only one of the three which lends some degree of support to the hypothesis which, however, from evidence in other directions, seems nevertheless to be the true theory. If so, the negative results here obtained are no doubt due to the difficulty of removing the last traces of active matter from the gas employed.

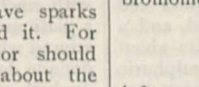
Experiments by C. Christiansen (*Wied. Ann.*, vol. lvi. p. 644), confirm this view. He shows that, if the metals be exposed for only a minute fraction of a second in hydrogen the difference of potential is very much lower than when the exposure is continuous in air. Here the active matters have not time to diffuse through the hydrogen to the metal in sufficient quantity to produce the full effect.

Physical Society, March 10.—Prof. Oliver Lodge, F.R.S., President, in the chair.—Mr. A. A. Campbell Swinton described and exhibited the Wehnelt current-interrupter. A glass cell contains a large cylindrical negative electrode of lead, and a small positive electrode consisting of a platinum wire about 1/16 inch or ¾ inch in length, in a solution of one part sulphuric acid to about five parts water. The platinum wire may project from the top of the shorter arm of a J-shaped ebonite tube, so that it can point upwards immersed in the solution. Or it may be fused into a similar glass tube; but glass is apt to crack in the subsequent heating. Wehnelt's interrupter replaces the make-and-break apparatus of an induction coil; it also replaces the ordinary condenser of that apparatus. In its present form it requires rather a strong current. The resulting spark at the secondary terminals differs in character from the ordinary spark of an induction coil: it is almost unidirectional, and in air takes a V-form, bright, continuous, and inverted—somewhat like a pair of flaming swords rapidly crossing and recrossing one another at their points. By blowing upon the V it breaks up, and then more nearly resembles the customary discharge of a coil. The sound emitted by the spark has a pitch that varies with the conditions of the circuit. As the self-induction of the circuit is diminished, the spark-pitch rises; it becomes infinite when the self-induction vanishes, *i.e.* the Wehnelt interrupter will not work in a circuit devoid of self-induction. As the applied potential-difference diminishes, the spark-pitch diminishes. In Mr. Campbell Swinton's experiments, twenty-five volts was the minimum primary voltage at which his apparatus would work. The spark-pitch also varies with the length of the platinum wire electrode in the solution. If the circuit is closed by dipping this electrode into the solution, the apparatus will not work; the wire must be dipped in before closing the circuit. After working for about a quarter of an hour the action often ceases; this fatigue-effect is not due to heating of the solution, for it is not obviated by keeping the temperature constant by a water-bath. It is supposed that the oxygen generated at the platinum electrode forms a more or less insulating film which interrupts the current until absorbed by the surrounding water. The fact that oxygen is more easily absorbed than hydrogen may explain why it is necessary to connect the platinum electrode to the positive pole of the battery or dynamo. When the platinum electrode is dipped gradually into the solution, the wire gets red-hot, and the interruptions do not take place. Again, when the apparatus stops, from fatigue, the platinum gets red-hot. The action is further complicated by a series of small explosions, and by the formation of a kind of electric arc at the platinum electrode. The coil exhibited was connected to the 100-volt electric-light mains at Burlington House; in this case the potential difference at the terminals of the primary was 30 volts, and that across the interrupter 150 volts—a total of 180 volts, showing the effect of impedance. For Röntgen-ray work the apparatus would be very effective, but unfortunately the sparks produce great heating, so that the kathodes of tubes are melted. Mr. Campbell Swinton suggested that as the sparks were more nearly continuous than ordinary discharges, they might produce Hertz waves less rapidly attenuated than those now applied to wireless telegraphy; the trains of waves would also follow one another at shorter intervals than those from the sparks at present employed. The President said he was rather surprised that the self-induction of the primary coil was not sufficient of itself to form the induction factor in the impedance necessary for perfect working. He would like to know how the apparatus behaved when an alternating current was used. Did the secondary coil become damaged by over-heating? Did reversal of the current assist the recovery from the fatigued condition of the apparatus? The natural period of the circuit depended upon its capacity and its self-induction. There was undoubtedly capacity at the surface of the platinum electrode in the liquid; this capacity acted together with the auxiliary self-induction, and the self-induction of the rest of the circuit, in the orthodox way, and there was automatic adjustment of resonance to the frequency of the interruptions, probably by variations of the capacity at the electrode. The heating effect, when a wire was made to close a circuit with a liquid, was discovered many years ago. Prof. G. M. Minchin thought that the usefulness of the apparatus would be greatly increased if it could be made to work with less current. He had himself succeeded with 12 applied volts, but not with 10 volts. As a tentative experiment he had used a horizontal lead plate, with disastrous effect, for the apparatus went suddenly to pieces. Explosions were frequently obtained, but they were not attended with much real danger. In a later and safer apparatus he used a platinum wire about ¾ inch long, projecting from a glass tube around which the lead plate was bent. There appeared to be a definite depth of immersion of this wire, at which the apparatus worked with minimum current. In his apparatus this critical position was when half the wire was below the surface of the liquid, the other half projecting into the air. He attributed the fatigue to the presence of gas about the electrodes, for he observed that a mechanical tap to the base of the apparatus restored the working condition. Mr. Rollo Appleyard pointed out that the improved result at half immersion, observed by Prof. Minchin, taken together with the phenomena described by Mr. Campbell Swinton as to the effect of dipping the electrodes into the solution, suggested that the liquid immediately around the submerged part of the wire was at some instants in the spheroidal state. The breaking-down of the spheroidal state would be facilitated by heat lost by the immersed part to the non-immersed part of the wire. The capacity for heat of the non-immersed part, and the degree of roughness or smoothness of the immersed part, would thus appear as factors in the explanation. No doubt the evolved gases were the primary cause of the interruption of current, but the wire having once become red-hot the spheroidal condition would introduce a further cause of electrical separation between the wire and the liquid. Prof. Vernon Boys asked whether it was the liquid or the electrodes that became fatigued. Experiments should be made to determine the effect of variations in the hydrostatic pressure around the platinum electrode. Mr. T. H. Blakesley said that the rise of potential at the terminals of the interrupter proved that the arrangement possessed capacity. Such a rise of potential could not occur without there being capacity, any more than it could without self-induction. Mr. D. K. Morris described experiments he had made with a Wehnelt interrupter, using a 1 kilowatt transformer with a transformation of 4 to 5, intended for 10 amperes at 100 volts. The anode of the interrupter was designed to have an adjustable surface to correspond with the load on the secondary—a platinum wire at the end of a copper wire could be projected more or less through the drawn-out lower end of a glass tube containing oil. The best results with the interrupter were obtained with about 45 volts on the primary circuit. At this pressure, an average current of 1 ampere sufficed to give 125 (alternating) volts very steadily on the secondary. As measured by an electrostatic instrument, the "no-load" loss was only 45 watts. The secondary could then be loaded up with lamps, provided that the exposed surface of platinum wire was proportionately increased. The energy delivered to the lamps, however, was not at any load much greater than 45 per cent. of that taken from the mains. By connecting the interrupter with a condenser of ½ microfarad, the efficiency at small loads was increased to nearly 60 per cent. He had observed that the fatigue of the interrupter could be temporarily remedied by reversing the current. Mr. C. E. S. Phillips asked whether Mr. Campbell Swinton had tried other liquids than dilute sulphuric acid. So far as his own experiments went, he had only obtained good results with that electrolyte. Mr. Campbell Swinton, in reply, said that with the apparatus arranged in a simple circuit, an alternating current applied

to the primary of an induction coil through a Wehnelt interrupter produced only about half the effect of the corresponding direct current—apparently, only half the alternations got through. But if two interrupters were connected in parallel circuits it was possible so to arrange them that one took one-half and the other the second half of the alternations. It might, therefore, be possible to design an induction coil with two primary windings to correspond to the two interrupters, so as to give an additive effect. The induction coil he had used had suffered no damage from the currents employed in the experiments exhibited; there was extremely little heating of the secondary. He could not with his apparatus restore the working condition by any mechanical disturbance of the interrupter. Hydrochloric acid failed, but a saturated solution of potassic bichromate gave fair results. The President, in proposing thanks, said he did not agree with Mr. Campbell Swinton's remarks as to the chances of improving Hertzian telegraphy by the use of these interrupters. The rate of interruption with this apparatus was something like 1000 per second, but the vibrations corresponding to Hertz waves were of the order 100,000 per second. The wave-trains from oscillators excited by the new interrupter would still be a series of damped vibrations; the amplitudes would not be maintained. It might be advantageous to have sparks following one another so rapidly, but he doubted it. For Hertzian telegraphy, the spark at the oscillator should "crackle"; to produce the best effect, the air about the oscillator should be in a non-electric condition.—A paper by Mr. A. Griffiths, on an apparatus for the determination of the rate of diffusion of solids dissolved in liquids, was then read. The apparatus consists of a cylindrical glass vessel subdivided about midway by a horizontal non-porous partition, into which are fitted a number of vertical tubes. The lower section of the vessel is filled with a liquid, such as an aqueous solution of cupric sulphate, and the upper one contains pure water. The method consists in determining by chemical analysis the quantity of cupric sulphate transmitted up the tubes. The paper gives the theory of the method, with very few experimental results. Ordinary diffusion observations are affected by the flow of liquid in the tubes due (1) to changes of temperature of the apparatus as a whole; (2) to differences of temperature throughout the liquid; (3) to local variations in volume produced by the process of diffusion; (4) to inequalities in the lengths of the tubes. Equations are given for determining the magnitudes of the sources of error, and certain numerical cases are worked out.—The same author also contributed a note on the source of energy in diffusive convection. Diffusion tends to produce local changes of density, causing gravitational currents, which currents can be made to do work. By "diffusive convection," the author means these gravitational currents. The heat equivalent of the work done is determined in a particular case, *i.e.* for a subdivided vessel, as in the above paper, having two tubes of unequal length. He points out that the heat absorbed, owing to diffusion through one of the tubes, is independent of the mechanical motion of the liquid in that tube, and it is also independent of the length of the tube.—The President proposed a vote of thanks, and in doing so described an apparatus he had used for a thermostat. A double-walled cylinder of copper sheet, with a little water in the inter-space, is exhausted at atmospheric temperature until the water boils. It is then sealed. Water-vapour is a powerful equaliser of temperature, and a vapour-jacket of this kind is very efficient when it is required to maintain uniform temperature—not constant temperature. Mr. Watson described the method of Mr. E. H. Griffiths, who used tap-water as a negative source, and a gas-flame as a positive source, with extremely good results as a thermostat for constant and for uniform temperature.—The meeting then adjourned until March 24.

Entomological Society, March 1.—Mr. G. H. Verrall, President, in the chair.—Mr. J. J. Walker exhibited a specimen of a rare British beetle, *Quedius longicornis*, Ktz., recently taken at Cobham Park, Kent. Mr. M. Jacoby exhibited a Halticid beetle from Sumatra, of the genus *Chaloenus*, Westw., and called attention to the remarkable position of its eyes, these organs being placed at the end of two very distinct lateral processes of the head, somewhat resembling the stalked eyes of crabs and other Crustacea. He said this character was peculiar to the male sex, and was very exceptional in Coleoptera, not being met with in any other genus of Phytophaga, and only occurring in a few Anthribidæ, and in isolated cases in one or two other families. He also showed a beetle from Peru, which was sent to him in a collection of Phytophaga, and, superficially, was very like certain members of that group; but from the structure of the antennæ and other characters, it appeared to be out of place in the Phytophaga, and probably belonged to some other family. Mr. Gahan remarked that this beetle, to whatever family it might prove to belong, was very interesting, not only from its structural peculiarities, but also from the fact that it had the colour and markings characteristic of certain species of Galerucidæ, a family to which it undoubtedly was not in any way closely related. This fact seemed to show that it was a mimetic form, and thus helped to explain the present obscurity surrounding its affinities.—Mr. G. J. Arrow contributed a paper "On Sexual Dimorphism in beetles of the family *Rutelidae*," and sent for exhibition a series, including both sexes, of six species of *Anomala*, selected to illustrate the subject of his paper.

Chemical Society, March 2.—Prof. Dewar, President, in the chair.—The following papers were read:—Bromomethylfurfuraldehyde, by H. J. H. Fenton and M. Gostling. The substance which gives rise to the purple coloration when ketohexoses are treated with hydrogen bromide in ethereal solution is a bromomethylfurfuraldehyde of the constitution



it has a golden yellow colour and seems only to be produced from ketohexoses or substances capable of yielding them by hydrolysis.—The reaction of alkyl iodides with hydroxylamine. Formation of alkylated hydroxylamines and oxamines, by W. R. Dunstan and E. Goulding. The hydriodide of trimethyloxamine $(CH_3)_3N : O$, is obtained by the action of methyl iodide on hydroxylamine; the base yields the iodide of trimethylmethoxyammonium by treatment with methyl iodide. The reactions of these substances are described, and also the products of the interaction of hydroxylamine with other alkyl iodides.—Derivatives of αα′-dibromocamphorsulphonic acid, by A. Lapworth. On heating ammonium α-bromocamphorsulphonate with bromine and water an αα′-dibromocamphorsulphonic acid, $C_{10}H_{13}Br_2O . SO_3H$, is formed; its acid bromide loses sulphur dioxide on heating, yielding αα′π-tribromocamphor, $C_{10}H_{13}Br_3O$.—Ethylic ββ-dimethylpropanetetracarboxylate, by W. T. Lawrence. Ethylic ββ-dimethylpropanetetracarboxylate, $CMe_2[CH(COOEt)_2]_2$, is obtained by the interaction of ethylic isopropylenemalonate with ethylic sodiomalonate; on hydrolysis with potash it yields ββ-dimethylpropanetricarboxylic acid.—The action of metallic thiocyanates on certain substituted carbamic and oxamic chlorides; and a new method for the production of thiobiurets, by A. E. Dixon.—A reaction of some phenolic colouring matters, by A. G. Perkin. A number of metallic derivatives of colouring matters containing hydroxyl groups in relatively ortho-positions are described.—Note on the optical activity of gallotannic acid, by O. Rosenheim and P. Schidrowitz.

Royal Microscopical Society, February 15.—Mr. E. M. Nelson, President, in the chair.—The President called the attention of the Fellows to a beautifully made microscope by the late Andrew Ross, which had been presented to the Society by Messrs. Watson and Sons. It had a rotating foot, into which the standard was fixed eccentrically; this was not, however, an original idea, having been used by Cuff in 1760.—Mr. Beck exhibited a very ingenious and compact reversible compressorium designed by Mr. H. R. Davis. Dr. Tatham said that being made chiefly of ebonite, it was comparatively light, and in his opinion would be found a useful accessory by the naturalist.—Messrs. Watson and Sons exhibited a new model of their Van Heurck microscope, designed to give complete rotation to the stage, a feature which the President described as a step in the right direction, the great desirability of which he said had been insisted upon by Dr. Dallinger and Mr. Michael. Messrs. Watson also exhibited a new cover-glass clip devised by Mr. Pakes, of Guy's Hospital, for making blood films. Dr. Hebb thought it likely to be of use, especially as the technique of the blood was coming more and more into notice.—The President referred to the Martin microscope presented to the Society last year; he had come to the conclusion that it was not made by Benjamin Martin, but it was a very good imitation, probable date about 1850.—The President read a letter he had received from Mr. Keeley, of Philadelphia, with a slide of diatoms mounted on edge, and some photo-

graphs of the latter. The President said he had examined the slide, and could corroborate Mr. Keeley's description of the structure of the diatoms. With regard to the coscinodiscus and triceratium, he believed Mr. Morland was the first to work out and correctly describe these structures, and Mr. Keeley's observations confirmed those results; but he believed the account of the structures of heliopelta and auliscus now given was original. While he was on the subject of diatoms he wished to mention a very interesting discovery made by Mr. Morland, who found that the bracket which strengthened the "plate" in arachnoidiscus was neither more nor less than what an engineer would call a bead-headed girder, in the invention of which the engineer had only copied what nature had already accomplished in the strengthening girders of this diatom.—Dr. Hebb said the fourth part of Mr. Millett's paper on the Foraminifera of the Malay Archipelago had been received, but, owing to its technical character, he proposed that it should be taken as read.—The President read a paper descriptive of the Powell iron microscope, constructed by Hugh Powell in 1840; the instrument, which was exhibited in the room, was still in constant use by the President. Mr. Vezey suggested that an exhibition should be held of historic microscopes, showing the various stages of the development of the instrument; and the president said he hoped the Society would see its way to arrange for an exhibition of the character proposed by Mr. Vezey.—Mr. Rheinberg read a paper in explanation of the chief features of the exhibition of objects shown under multi-colour illumination, arranged under twenty-seven microscopes. The President said he believed one of the chief values of this method of illumination was that it might make it possible to use a larger axial cone than heretofore, and that if they could only combine the Gifford screen with this new method, he thought an advantage would be secured, but caution would be necessary in the selection of the colours. In photomicrography Mr. Rheinberg's method would prove useful.

CAMBRIDGE.

Philosophical Society, February 20.—Prof. H. Lamb, F.R.S. (Trin.), Victoria University, was elected a Fellow of the Society.—The following papers were communicated to the Society:—A semi-inverse method of solution of the equations of elasticity, by Dr. C. Chree. The usual procedure in attacking an elastic solid problem is first to determine expressions for the displacements involving arbitrary constants, thence to deduce expressions for the strains and stresses, and finally to determine the values of the arbitrary constants by the aid of the surface stress equations. In two papers published in 1895 the author obtained a complete solution for an isotropic elastic solid ellipsoid under certain important force systems, employing a semi-inverse method in which expressions for the stresses formed the basis of departure. Some little time ago the author noticed that not only was this method applicable to the corresponding problems in aeolotropy, but that the first stages of the work were absolutely the same for all kinds of homogeneous elastic material. The semi-inverse method thus leads at once to the solution of such a problem as that of an ellipsoid of any shape and any degree of aeolotropy rotating about a principal axis and self-gravitating. The procedure is perfectly straightforward, the only practical difficulty being the complication of the expressions for the three fundamental arbitrary constants which appear in the general formulæ for the stresses. In the present paper the aim has been to illustrate the method by applying it to a variety of the more interesting special cases, and not to chronicle general results of forbidding length and complication. For comparison with results found for rotating elongated or flat ellipsoids, the corresponding problems have been solved by a similar method for long cylinders and thin discs. Some of the results may interest those who are concerned with speculations about the structure of the earth, while others may prove of value to engineers.—On change of independent variables and the theory of cyclicants and reciprocants, by Mr. E. G. Gallop. The problem considered is the change of a system of n independent variables in a partial differential coefficient. The solution was given in a fully expanded form by Sylvester, and deduced by Cayley from a theorem due to Jacobi on the reversion of series. In this communication Jacobi's formula is developed in a manner somewhat different from Cayley's method, and a result obtained which leads on the one hand to Sylvester's expanded form, and on the other to a symbolical formula which is also applicable to any function of differential coefficients. This form involves n^2 quadro-linear partial differential operators analogous to the annihilator of ordinary pure reciprocants, and $n(n-1)$ lineo-linear operators of the type occurring in the theory of invariants. The formula can also be applied to the differentiation of implicit functions, and it is shown how a solution of the general equation of infinite degree, or of a set of such equations, can be exhibited in symbolical form. The method is then applied to the case of the general linear transformation and to the theory of cyclicants as developed by Prof. Elliott. Attention is also drawn to another class of reciprocants in n variables which, perhaps more naturally than cyclicants, may be regarded as generalisations of Sylvester's reciprocants in one variable. Conditions are obtained which ensure that a function of differential coefficients may be a reciprocant in this sense of the term.—On the combustion of carbon in electrolysis, by Mr. S. Skinner. A cell consisting of a carbon electrode in potassium permanganate and a lead peroxide electrode in dilute sulphuric acid produces a current flowing in the external circuit from the lead peroxide to the carbon. The permanganate ion is therefore brought against the carbon plate and becomes reduced, forming mainly carbon dioxide gas and permanganic acid. Such a cell has an electro-motive force of 0·33 volt. To find the relation between the carbon dioxide set free and the current, a voltameter containing potassium permanganate solution with a carbon anode and platinum kathode, was connected in series with a water voltameter and a current passed through them. With certain precautions it was found that one volume of carbon dioxide was set free for two volumes of hydrogen, and the author gives reasons for considering this result as determining the electro-chemical equivalent of carbon. The carbon dioxide produced in this way is not quite pure; it contains small percentages of oxygen and carbon monoxide.—On the ionisation of a gas by "Entladungsstrahlen," by Prof. J. J. Thomson. The paper contains an account of a series of experiments which show that the "Entladungsstrahlen" discovered by Prof. E. Wiedemann cause a gas through which they pass to become a conductor of electricity. The experiments show that with the discharge through a gas at a low pressure the region near the kathode produces more "Entladungsstrahlen" than the positive column, while none could be detected from the dark space between the positive column and the negative glow.

PARIS.

Academy of Sciences, March 6.—M. van Tieghem in the chair.—On some peculiarities of the theory of shooting-stars. Possibility of repetition of activity of certain radiant points. Existence of so-called stationary radiant points, by M. O. Callandreau. The observations of Mr. Denning on the existence of families of shooting-stars which diverge from the same point in the sky, with a maximum every three months, have been called in question by M. Tisserand, but in the author's opinion these observations cannot but be regarded as accurate, and their theory is discussed by the formulæ of Tisserand. The conditions necessary for the formation of the so-called stationary foci are also discussed mathematically, with application to the Orionids; shooting-stars from a fixed point near ν-Orionis having been observed by Denning over a period of twelve days.—M. Helmert was elected a Correspondant for the Section of Geography and Navigation in the place of the late Sir George Henry Richards.—Measurement of the diameters of the satellites of Jupiter and of Vesta by interference methods, carried out with the large equatorial of the Observatory of Paris, by M. Maurice Hamy. The numbers obtained were in general agreement with those of Michelson, the latter being slightly higher for satellites I., II., and III. The value for the minor planet Vesta (0″·54) agrees exactly with the micrometric observations of M. Barnard.—Absolute determination of directions making an angle of 45° with the horizon. Application to the measurement of latitudes, by MM. J. Perchot and W. Ebert. A mirror is floated upon an annular ring of mercury, and making an angle of $(45+x)°$ with the horizontal, x being the small error of setting. The method described allows of an exact determination of x. For most European observatories, not far removed from latitude 45°, the method has important advantages, the error due to flexure, in particular, being practically eliminated.—On the fundamental problems of mathematical physics, by M. W. Stekloff.—On analytical prolongation, by M. E. Goursat.—On an extension of the calculus of linear substitutions, by M. Cyparissos Stéphanos.—On the arithmetical nature of the number e, by M. Emile Borel.—On conjugate bundles, of which a system of curves are geodesics, by M. C. Guichard.—On certain systems of equations of

Laplace, by M. Tzitzéica.—On Green's and Cauchy's theorems, by M. Chessin.—On a simple relation giving the molecular weight of liquids as a function of their densities and their critical constants, by M. Daniel Berthelot. By combining two laws found experimentally by S. Young and Mathias respectively, the author deduces the expression

$$M = 11{\cdot}4dT_c/p_c\left(2 - \frac{T}{T_c}\right),$$

where M is the molecular weight, d the density at any temperature T, T_c and p_c the critical temperature and pressure respectively. This formula is applied to a considerable number of substances, and a comparison of the molecular weights determined in this way with those obtained from the gaseous density shows that in general the molecular weights in liquids and gases are identical, water, acids, and alcohols being exceptions. The deviations found are probably due to the difficulties of ascertaining the correct critical pressures.—On tungsten bisulphide, by M. Ed. Defacqz. Two methods of preparation are described, the action of hydrogen sulphide upon the hexachloride, and that of sulphur upon tungsten trioxide at a high temperature. The physical and chemical properties are given.—Action of formaldehyde upon menthol and borneol, by M. André Brochet.—Estimation of copper and mercury in grapes, wines, lees, and grape skins, by MM. Léo Vignon and Barrillot. As a consequence of the application of salts of various metals for the destruction of parasitic diseases of the vine, it is necessary to examine the fruit products for traces of these metals. Suitable methods for estimating these minimal quantities are described, and satisfactory test analyses given.—Contribution to the study of the forms and conditions under which the chlorine of the soil usually enters into vegetables, by M. P. Pichard.—On the fermentation of galactose, by M. Dienert.—On some peculiar deformations of the blood corpuscles of fishes, by MM. J. Kunstler and A. Gruvel.—On the casting of the skin in insects, considered as a means of defence against animal and vegetable parasites. Special functions of the casting of the trachea and intestine, by M. Künckel d'Herculais.—Researches on the defensive glands of the Carabides, by M. Fr. Dierckx.—On some new Madagascan fossils, by M. Marcellin Boule.

DIARY OF SOCIETIES.

THURSDAY, MARCH 16.

ROYAL SOCIETY, at 4.30.—The Croonian Lecture: On the Relation of Motion in Animals and Plants to the Electrical Phenomena which are associated with it: Prof. J. Burdon Sanderson, F.R.S.—Experiments in Micro-metallurgy: Effects of Strain: Prof. Ewing, F.R.S., and W. Rosenhain.

LINNEAN SOCIETY, at 8.—A Further Contribution to the Freshwater Algæ of the West Indies: W. West and G. S. West.—On So-called "Quintocubitalism" in the Wing of Birds: P. Chalmers-Mitchell.—Some Facts concerning the so-called "Aquintocubitalism" in the Bird's Wing: W. P. Pycraft.

CHEMICAL SOCIETY, at 8.—Influence of Substitution on Specific Rotation in the Bornylamine Series: Dr. M. O. Forster.—Rotatory Power of Optically Active Methoxy- and Ethoxy-propionic Acids prepared from Active Lactic Acid: Prof. Thomas Purdie, F.R.S., and James C. Irvine.

FRIDAY, MARCH 17.

ROYAL INSTITUTION, at 9.—The Electric Fish of the Nile: Prof. F. Gotch, F.R.S.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Backwater or Hæmoglobinuric Fever: Dr. W. H. Crosse.

QUEKETT MICROSCOPICAL CLUB, at 8.

SATURDAY, MARCH 18.

ROYAL INSTITUTION, at 3.—Mechanical Properties of Bodies: Lord Rayleigh, F.R.S.

MONDAY, MARCH 20.

VICTORIA INSTITUTE, at 4.30.—Marks of Mind in Nature: Prof. Duns.

TUESDAY, MARCH 21.

ROYAL INSTITUTION, at 3.—The Morphology of the Mollusca: Prof. E. Ray Lankester, F.R.S.

SOCIETY OF ARTS, at 4.30.—The Commercial Development of Germany: C. Rozenraad.

ZOOLOGICAL SOCIETY, at 8.30.—Contributions to the Osteology of Birds. Part III. Tubinares: W. P. Pycraft.—On the Marine Copepoda of New Zealand: G. Stewardson Brady.—On the Breeding of the Weka Rail and Snow-Goose in Captivity: F. E. Blaauw.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Papers to be further discussed: Water-Tube Boilers for Marine Engines: J. T. Milton.—Recent Trials of the Machinery of War-Ships: Sir. John Durston, K.C.B., and H. J. Oram, R.N.—Paper to be read, time permitting: Alloys of Iron and Nickel: Robert Abbott Hadfield.

ROYAL STATISTICAL SOCIETY, at 5.—Causes of Changes in Pauperism in England, chiefly during the last Two Intercensal Decades: G. Udny Yule.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Automatic Adjustment of the Half-Tone Screen: W. Gamble.

WEDNESDAY, MARCH 22.

SOCIETY OF ARTS, at 8.—Electric Traction: Philip Dawson.

GEOLOGICAL SOCIETY, at 8.—Relations of the Chalk and Drift in Möen and Rügen: Prof. T. G. Bonney, F.R.S., and Rev. Edwin Hill.—A Critical Junction in the County of Tyrone: Prof. Grenville A. J. Cole.

THURSDAY, MARCH 23.

SOCIETY OF ARTS, at 8.—London Water Supply: Walter Hunter.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Hissing of the Electric Arc: Mrs. Ayrton. (Illustrated by Experiments.)

FRIDAY, MARCH 24.

ROYAL INSTITUTION, at 9.—Transparency and Opacity: Lord Rayleigh, F.R.S.

PHYSICAL SOCIETY, at 5.—On the Criterion for the Oscillatory Discharge of a Condenser: Dr. Barton and Prof. Morton.—The Minor Variations of the Clark Cell: A. P. Trotter.

SATURDAY, MARCH 25.

ROYAL INSTITUTION, at 3.—The Mechanical Properties of Matter: Lord Rayleigh, F.R.S.

BOOKS, PAMPHLET, and SERIALS RECEIVED

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