THURSDAY, MAY 11, 1893.

A BOOK ON PHYSIOGRAPHY.

"*A. E. Brehm. Les Merveilles de la Nature.*" *La Terre, les Mers, et les Continents; Géographie Physique, Géologie et Minéralogie.* Par Fernand Priem. (Paris: J. B. Baillière et Fils, 1892.)

THE wonders of nature! The book would be worth having that would help us to realise, however imperfectly, what it is that underlies this hackneyed phrase. But the book that shall create and satisfy a craving for this result will not be easy to build up. It must be encyclopædic, but (need it be said?) not an encyclopædia. It must be accurate to the last degree of accuracy, but must have nothing of the pedant about it. Human interests must, wherever an opportunity offers, be interwoven with its narrative. The narrative itself must be, not the heavy didactic prosing of an old-fashioned schoolmaster, but the congenial living talk of a friend. Sound judgment must pick out what is to be told and what left unsaid. So far from looking upon all facts as of equal value, the utmost care must be exercised to present those only which are within the grasp of the lay mind; all that has significance for the specialist only will be out of place. Nothing will be inserted merely because it is curious or marvellous, for the object will be not to make the reader gape like an astonished clown at something which looks very extraordinary because he does not understand it; rather to use the emotion of wonder as a means to something beyond, as an inducement to look below the surface and find out how results so startling have been brought about. The right book must be neither shallow nor deep; fascinating as a poem, but sound as a scientific treatise; and it will be well if there run through all of it some one leading idea, which will serve to give it unity and string together into a connected whole the sections of which it is made up.

Under the title of "Les Merveilles de la Nature" a series of works is being published which seem to be intended for what is usually known as the "general reader." The preceding volumes have dealt with animal life, the volume now before us is devoted to Erdkunde. It will be possible, without pretending to deal with the whole of the bulky volume, to inquire how far it appears likely to meet the requirements of those readers for whom it seems intended. The work opens with "Données générales de la Géologie," and the commencement is promising; the treatment is broad, and illustrations are supplied of the general truths enunciated. But already, on p. 5, we see how little judgment has been exercised in the selection of materials. Of what interest or of what educational value to the general reader can be such technical details as a description of the way of measureing dip and strike in the field, and a figure of a pocket compass? A few pages further on we have a compressed summary of the succession and life of the main geological epochs, and some well-executed figures of their fossils. The account is far too meagre to be of any real use, and it is difficult to see what principle has guided the selection of the fossils. There is a "casualness" too about some statements calculated to mislead; as when we find no mention of Brachiopods in the Silurian and Carboniferous, but the emphatic assertion that the Devonian fauna is specially characterised by the presence of numerous Brachiopods. Again it is true enough that the Triassic fauna "diffère notablement de la fauna paléozoïque;" but the fact that it contains a mixture of palæozoic and mesozoic forms is at least of equal importance. These instances, picked at random, show how much of a compilation and how little of a masterly abstract is offered to the reader. A history of the progress of geology is one of those things specially suited to such a work as the present. We have one here interestingly written, though perhaps the salient points do not stand out as boldly as could be wished.

Further on, under the heads of mineralogy and petrology, we have a vast array of facts of very unequal interest or value for ordinary readers. What good can it be to any one to be told that there are six or seven systems of crystallisation, when he is never told what is meant by a "system"? Symmetry, which lies at the base of crystallographic classification, is barely mentioned, and most imperfectly explained. But what an attractive and instructive story may be made about crystals! Some of the more elementary facts about their symmetry and probable molecular structure are not hard to grasp, and furnish fascinating illustrations of law and harmony. Looked at in this light, these flowers of the inorganic world cease to be mere glittering gauds, and tell a tale that all would follow with delight. Out of Ruskin, checked by Miller, such might be constructed in place of this dull assemblage of barren and imperfectly explained facts. When we come to the microscopic examination of rocks there is much that is too detailed for the general public and not full enough for the specialist.

The nationality of the book must be the excuse for the survival of such statements as the following:—"Le granite est la roche éruptive la plus ancienne. . . . Ses éruptions se sont faites pour la plupart avant le dépôt des roches sédementaires: le plus récentes paraissent dater du cambrien." "Les porphyres pétrosiliceuse sont charactéristiques de l'époque permienne." But surely any one whose knowledge went beyond a few books would have thought it fair to say that these views were not universally adopted, though they are held by some of the most distinguished of his countrymen.

Turning to other branches of knowledge, the critic is still compelled to take serious objection to much that he meets with. Solar and stellar physics are scarcely up to date, though perhaps there is enough for a book of this class. It will be hard for any one who depends upon this book alone to gather how the shape of the earth is ascertained. It is all very well to copy out of a book that an arc of 1° is so long in Peru and so long in Lapland, but there is no word said as to how astronomers find out that they have travelled over 1° of latitude, nor of the trigonometrical survey requisite to measure the length of the arc. These points are easy enough of explanation, and if in place of the misleading cut on Fig. 64 a figure had been given with the necessary explanation, we should have had something of educational value instead of a mere transcript. Statements are made with great con-

fidence about the time of rotation of Mercury and the inclination of the axis of Venus and of the prodigious height of the mountains on these two planets; they certainly ought not to have been put down as well-ascertained matters of fact. Figs. 67 and 68 I confess are beyond me.

These samples, culled from different parts of the book, are enough to give a fair idea of its general character, and the impression made on my mind by a general perusal is that it is by no means an ideal performance. But there is much that is attractive about it. It is crowded with illustrations, many of them artistic and apposite, though in the case of some it is hard to see upon what they are intended to throw light. With children it will be deservedly a favourite. I think I know a boy, of some eight or nine years, not much addicted to reading, who will devour the "pictures" and render the life of his elders a burden by the countless questions they suggest. And the elders will, many of them, find in it much interesting matter; and if what they read is not always quite sound and here and there a little dismal, there is much that is lively and stirring and to which no exception can be taken on the score of accuracy. We may wish the book good speed till something better of its kind displaces it. A. H. GREEN.

SIR W. BOWMAN'S COLLECTED PAPERS.

The Collected Papers of Sir William Bowman, Bart., F.R.S. Edited for the Committee of the "Bowman Testimonial Fund," by J. Burdon Sanderson, M.D., F.R.S., and J. W. Hulke, F.R.S. In two volumes. (London: Harrison and Sons, 1892.)

NO more fitting record of a well-spent life could have been given to the world than these two volumes, containing "The Collected Papers" of the late Sir William Bowman.

In July, 1888, the "Bowman Testimonial Fund" was inaugurated. Its design was to make to Sir William Bowman some acknowledgment of the appreciation in which he was held on account of his high personal character and of his professional and scientific attainments. This took first the form of a portrait of himself by Mr. Ouless, R.A., and further of a republication at least in great measure of his various scientific memoirs. These memoirs have been edited, with the assistance of the author, by Prof. Burdon Sanderson and Mr. Hulke.

The first volume contains the whole "of the epoch-making researches which were accomplished by Sir William Bowman between forty and fifty years ago in the field which he himself designated as that of 'Physiological Anatomy,'" for he regarded the discovery and uses parts as the main purpose of anatomical investigation. This volume has been edited by Prof. J. Burdon Sanderson, and contains three memoirs from the "Philosophical Transactions" on the minute structure and movements of voluntary muscle; on the contraction of voluntary muscle in the living body; and on the structure and use of the Malphigian bodies of the kidney, with observations on the circulation through that gland; also the author's contributions to "The Physiological Anatomy and Physiology of Man." This work was published between 1839 and 1856, by Drs. Todd and Bowman, and we learn the interesting details that out of a total of 298 illustrations to the two volumes, 120 of these were from the drawings of Bowman. This volume concludes with four contributions to the "Cyclopædia of Anatomy and Physiology" on Mucous Membrane; on Muscle; on Muscular Motion; and on the Pacinian Bodies.

The second volume comprises a selection of "reprints," together with some papers, now first printed, under the headings miscellaneous, surgical, and ophthalmological. These have been selected from a large amount of material, and arranged with the assistance of the author. This volume has been edited by Mr. J. W. Hulke, who writes that, "read from the standpoint of the time when each was written, these memoirs, in addition to their intrinsic merits, have, as marking the views and opinions then prevalent, a distinct value for the student interested in the history of modern medicine."

The work is prefaced by a brief memoir by Henry Power, in which he reminds us that this man of many parts and much learning "had a clear idea of the relative value of the different branches of knowledge associated with medicine, and that he recognised the futility of any endeavour on the part of the student to make himself a profound chemist, botanist, or physiologist, believing that such an attempt necessarily leads to the neglect of the practical subjects which are the occasion for which these foundation sciences are studied. No one knew better than he that 'ex libris nemo evasit artifex,' the scene of the labours of the student, was, in his opinion, at the bedside of the patient." These ideas of Bowman are of especial importance in these days, when the tendency of the teaching in our medical schools is for each teacher to try to make his subject the one alone necessary, instead of its being but a small part of an important whole. The sketch, which is all too short, is appreciative and sympathetic. One little trait we miss; while the great physiologist's love of country life is hinted at, his love for and knowledge of flowers is passed over, and yet those who were privileged to know him in his days of well-earned rest and leisure will remember what a delight his garden was to him. Two portraits are given; both are photographs. One is of the painting by G. F. Watts, R.A., of Bowman when forty-eight years of age. This hardly does justice to the original painting, and one is of the painting by W. W. Ouless, R.A., which was done for the "Testimonial Committee Fund," in 1889, when Bowman was in his seventy-third year. This is an excellent and pleasing likeness.

OUR BOOK SHELF.

Aids to Biology. By Joseph W. Williams. (London: Baillière, Tindall and Cox.) (Students' Aids Series.)

THIS little volume of 142 pages, small octavo, is the second work which has reached us written up to the standard of the first examination of the Conjoint Board of the Royal Colleges of Physicians and Surgeons. The information which it contains is transcribed from the best sources available, and the author has woven the excerpts into a very presentable whole, written in good, clear style, and exceptionally free of gross errors. The pages of the volume are enlivened by thirty-nine small woodcuts and a well-chosen epilogue from Broca, and there are

added a useful "index glossary," and a series of "test questions," largely culled from examination papers of the past. The work is by no means destitute of small incongruities and an occasional misuse of technical terms; and the most serious errors which it contains, contrary to the general rule, involve leading rather than subsidiary topics. The description of "living matter" as existing in the "colloidal condition" and (two pages further on) as "a semi-fluid granular substance . . . unable to absorb colouring matters when living"; the alleged origin of the cœlome of "all animals above the cœlenterata" by "the splitting of the mesoblast"; the assumption that the contractile vacuole of the protozoa is a respiratory organ "pumping in oxygenated water," and "furnishing oxygen to the animal by means of its rhythmical dilatations"; the confusion under the term "paraplasm" between modified portions of the cell-protoplasm and products of its living metabolism, with the correlated description of the protoplasm of the egg cell as a "vitellus, or yolk"; and the description of sclerenchyma as "stony tissue," are cases in point. We note with satisfaction the prominence given to the physiological and more purely chemical aspects of the subject, too often neglected in minor works on general biology. Conspicuous among leading dogmas formulated is the assertion that with the exception of ascidians and some infusorians the animal "does not contain cellulose," with the implication that certain animals form chlorophyll. We venture to think that the time has now arrived when the investigations of Beyerinck, Famintzin, Von Graff, and Haberlandt, Ambronn, and others, which have lately revolutionised our knowledge on these vitally important topics, should find expression in the elementary class-book. The author remarks in his preface that "it must be remembered that biology can be learnt in no other way than with the scalpel and the microscope," and that his volume is intended "simply and solely for the purpose of revising" a practical knowledge which the student has gained under the guidance of his teachers, "especially during the few weeks previous to the time when he intends to cross the threshold of the examination hall." If this line of conduct can be ensured, the work will fulfil a good purpose; but it may be doubted whether the over-taught medical student of to-day will regard the book as anything but a cram one. It has been compiled at considerable pains and with marked success; but as the dispensation which it seeks to further cannot possibly endure, we wish we could congratulate the author upon a devotion to some more permanent and desirable object.

Public Health Problems. By John F. J. Sykes. Illustrated. (London: Walter Scott)

THE author of this volume—which forms one of the Contemporary Science Series—has sought "to bring to a focus some of the essential points in evolution, environment, parasitism, prophylaxis, and sanitation, bearing upon the preservation of public health." It was impossible for him to deal fully in the space at his disposal with any particular part of so vast a subject, but he has contrived to give a very clear and interesting idea of the main lines of inquiry with which workers in the public health service are chiefly concerned. First he treats of internal and external influences affecting health, these influences being heredity, physical influences (light and heat), chemical media, and biological agents. Then he discusses the following aspects of communicable diseases—causation, parasitism, dissemination, and modifications. Afterwards there are series of chapters on defensive measures against communicable diseases, and on the urban dwelling. Mr. Sykes, as medical officer of health for St. Pancras and honorary secretary of the Incorporated Society of Medical Officers of Health, has had ample opportunity for the study of the questions on which he discourses, and his book ought to be of good service in disseminating sound ideas as to the conditions on compliance with which the attainment of a higher standard of public health depends.

Galenic Pharmacy. By R. A. Cripps. (London: J. and A. Churchill, 1893.)

THE student of pharmacy will, no doubt, find plenty of instructive information in this book. It does not, however, call for an extended notice in this journal, as the author does not attempt a scientific treatment of the subject, but confines himself to dealing with it on the old lines. The various pharmaceutical operations of solution, infusion, &c., are fully described, but no attempt is made to arrange the facts on any than an empirical basis. The time has arrived, however, when pharmacy should be expounded in a more scientific manner, and many barbaric and obsolete processes excluded or re-modelled in the light of our present chemical and pharmacological knowledge.

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.*]

Mr. H. O. Forbes's Discoveries in the Chatham Islands.

IN a paper read before the Royal Geographical Society on March 12th, and again in an article on "The Chatham Islands and their Story" in the *Fortnightly Review* of this month, Mr. H. O. Forbes has described his very interesting discoveries in these islands, and has founded thereon certain conclusions as to the past history of the New Zealand group. The most startling new fact is the proof of the recent existence on the Chatham Islands of two birds whose nearest allies inhabited the distant group of the Mascarene Islands within the historical period. These are a flightless rail very closely allied to the Aphanapteryx of Mauritius, and a coot which is hardly different, except in its somewhat larger size, from the extinct *Fulica newtoni* of the same island.

It is on the flightless rail that Mr. Forbes mainly dwells in his deductions of past changes which it is supposed to imply, and it is on these deductions only that I wish to make a few remarks. He quotes Prof. A. Newton and his brother as stating that the solitaire of Roderiquez and the Dodo of Mauritius, being evidently of one stock, and there being analogous facts in the adjacent islands, they are compelled to believe that "there was once a time when Roderiquez, Mauritius, Bourbon, Madagascar, and the Seychelles were connected by dry land"; and he then argues that there must also have been a continuous land surface between this land and the ancient land comprising New Zealand and the surrounding islands. This connecting land he supposes to have been the Antarctic continent during a mild period and with great extensions over the southern ocean. When the Antarctic ice age came on the inhabitants of this continent had to migrate northwards, and some, "such as the genus Aphanapteryx, would seem to have split into parties, which, travelling by divergent roads, finally arrived in regions so far apart as Mauritius and the Chatham Islands, unaffected by the varying climates and surroundings they experienced, being of an ancient dominating type."

It is this tremendous hypothesis which appears to me to be not only quite unnecessary to explain the facts, but also to be inadequate to explain them. If one thing more than another is clear, it is that these comparatively small flightless birds were developed, as such, in or near to the islands where they are now found, since they could not possibly have arisen on any extensive land inhabited by carnivorous mammals and reptiles, and, if introduced into such a country, could not long survive. So far as I am aware, no doubt has ever been expressed on this point, the evidence for it being so clear and its explanation on the theory of evolution so complete; and I hardly think that Prof. Newton would now maintain that the affinities of the flightless birds of Mauritius, Bourbon, and Roderiquez implied the former union of these truly oceanic islands. Allied forms of ancestral flying birds may have reached the islands without such union;

and, owing to the total absence of terrestrial enemies and the abundance of food, may have developed into the allied flightless birds whose remains are found there.

But Mr. Forbes speaks of the genus Aphanapteryx itself, presumably therefore flightless, inhabiting the Antarctic continent, and migrating northwards by two routes of about 2000 miles each, in which case, this enormous extent of land must have been as free from all carnivorous land mammals and reptiles as New Zealand and Mauritius are now. If however, the birds in question lost their powers of flight in or near the islands where their remains are found, all difficulties of this kind disappear. The Aphanapteryx belongs to a family, the Rallidæ or rails, of world-wide distribution, while many of the component genera are also almost cosmopolitan, and are represented by closely allied species in distant regions. What difficulty, therefore, is there in the same or closely allied species of this widespread group finding their way at some remote epoch to Mauritius and the Chatham Islands, and, from similar causes in both islands, losing their power of flight while retaining their general similarity of structure? To put the matter briefly: if the common ancestors of the Aphanapteryx of Mauritius and the Chatham Islands were flightless, they could not have reached those islands from the Antarctic continent owing to the length of route and the presence of enemies; while if they possessed the power of flight no important change in land-distribution is required.

I have discussed this one point only, because it illustrates the very common practice of explaining each fresh anomaly of distribution by enormous changes of physical geography, when a much more satisfactory explanation can be given involving no such vast and unsupported revolutions in the earth's surface. I am aware that Mr. Forbes adduces many other facts and considerations in support of his view as to the former extension and habitability of the Antartic continent, some of which appear to me to be valid and others the reverse. On most of these I have already expressed an opinion in my "Island Life"; and I only write now in order to point out that the very remarkable and interesting facts, whose discovery we owe to Mr. Forbes's energy and perseverance, do not add anything to the evidence already adduced for that view, but may be best explained in a far simpler manner, and without requiring any important changes in the geography of the southern hemisphere.

ALFRED R. WALLACE.

Swarms of Amphipods.

ONCE last winter on entering the laboratory here after it had been shut up for a few days, we found the floor, tables, shelves, window-ledges, and even dishes on the highest shelves, covered with great numbers of dead amphipods. These were found to be *Orchestia gammarellus* (the shore-hopper). About ten days ago an unusually high tide occurred, and the curator and others who were working in the biological station noticed that the steps leading to the beach were swarming with amphipods. On investigating further it was found that the amphipods were coming up in great numbers from high-water mark, that they jumped up the steps, and that they climbed the vertical concrete wall surrounding the station to a height of several feet. Many of them were found about twelve feet above the sea, having come nearly all the way on artificial ground (concrete steps and wall), and they were so abundant on the platform outside the laboratory door that it was impossible to put a foot down without treading on many. Specimens were kept, and Mr. A. O. Walker, who is here with me now, finds that these also are *Orchestia gammarellus*. This species lives normally at or about high-water mark, and it is abundant here under stones at that line, but Mr. Walker tells me that he has taken it on the one hand nearly at low-water mark, and on the other hand under stones on grass, along with beetles, and we have found it near here far above high-water mark at the side of the road. However, these last are probably exceptional cases, and we are both inclined to think that the two amphipod invasions noticed here have been caused by the Orchestias being driven from their usual haunts by exceptionally high tides. But whether a panic arises on the flooding of their homes, or they lose their way on our concrete, the fact remains that whereas the sea was only a couple of feet higher than an ordinary high tide the amphipods ascended on the one occasion to about twelve and on the other to perhaps twenty feet above their usual level.

Port Erin, April 29. W. A. HERDMAN.

A Difficulty in Weismannism Resolved.

WEISMANN'S essay "On the Significance of Sexual Reproduction in the Theory of Natural Selection," published in 1886, enunciates the thesis that the object of sexual reproduction is "to create those individual differences which form the material out of which natural selection produces new species." This thesis was developed in the essay, "On the Number of Polar Bodies and Their Significance in Heredity" (1887), and still further in "Amphimixis," published late in 1891.

While "Amphimixis" must have been nearly ready, I wrote to NATURE (vol. xliv. p. 613), under the heading, "A Difficulty in Weismannism," pointing out *a posteriori* the complete insufficiency of sexual reproduction, by merely shuffling ancestral germ-plasms, to effect indefinite specific variation on the lines adopted by Weismann. My friend, Mr. Poulton, wrote (vol. xlv. p. 52) accepting my summary of Weismann's views "as fair statements," but criticising the deductions is not allowing for the effect of different groupings of the ancestral plasms in the germ-cells, and regretting that I had not awaited the publication of "Amphimixis," as "Prof. Weismann tells me," he wrote, "that the points raised by Prof. Hartog are considered in this treatise." Mr. Trow also wrote (vol. xlv. p. 102), urging that I had not allowed for the simultaneous action of natural selection or for the combinations of germ-plasms. In reply to my rejoinder of the same date, Mr. Trow again urged that I had not taken natural selection into account, and that I had misunderstood Weismann's position. The controversy was then closed.

However, neither the German edition of "Amphimixis," nor the authorised English translation published about six months later, contained the solution of my difficulty that was anticipated by Mr. Poulton. There runs through the book like a red thread the conception of 1886, that sexual reproduction is the creator of the variations on which natural selection acts. A reference of mine to the inadequacy of this, Weismann's Theory of Variation, contained in an article in the *Contemporary Review* for July, 1892 ("Problems of Reproduction"), passed without answer or comment, so far as I know.

In "The Germ Plasm, a Theory of Heredity" (1893), Weismann devotes chapter xiv. to the consideration of heredity. Herein I find the following theses, in which I preserve the italics of the original (English edition):—

1. "*It* [sc. amphimixis] *is not the primary cause of hereditary variation*," p. 414.

2. "*The cause of hereditary variation must lie deeper than this* [amphimixis]. *It must be due to the direct effect of external influences on the biophors and determinants*" [sc. of the germ plasms or ids], p. 415.

3. "*The origin of a variation* is equally independent of selection and amphimixis, and is due to the constant occurrence of slight inequalities of nutrition in the germ plasm," p. 431.

Obviously the position of 1886–91 has been abandoned as untenable. If we ask why, the answer is probably contained in the following passage and annexed note ("Germ Plasm," pp. 434–5):—

"It has recently been maintained that as a consequence of my theory I must adopt one of two alternatives, and assume either that the germ plasm of the higher animals consists of ids of the primitive protozoan ancestors, or that every id is constructed in accordance with the existing character of the species; my real view, however, is intermediate between these two." The note runs: "Compare Marcus Hartog, NATURE, vol. xliv. p. 102." The reference omits my letter of October 31, 1891. The deductions made by this author from my former views are logically correct, but are no longer justifiable, since I myself have gained further insight into the problems concerned.

It follows from the above—

1. That Weismann has withdrawn his whole theory of specific variation as created by sexual reproduction.

2. That my account of his views on the point at issue in 1891 was both full and fair.

3. That in 1891 no one else, not even Prof. Weismann, had perceived that "logically correct" deductions from his general theory of the germ plasm were fatal to his theory of variation.

4. That the Weismannism of to-day regards the action of external forces as the one essential cause of variation, so far approximates to the teachings of the older evolutionists.

As no reference is made in the preface to this matter, nor even in the index (for which Prof. Weismann is not responsible),

I wish to draw attention to it—all the more since so competent a writer as "D. H. S." seems in a review in NATURE (April 27) to be unaware that the theory of variation by amphimixis[1] has ceased to exist as a "Difficulty in Weismannism."

Cork, May 1. MARCUS HARTOG.

Medical Biology.

G. B. H. HAS, I am glad to see, criticised effectively the syllabus of Elementary Biology put forth by the Conjoint Board (NATURE, vol. xlvii. p. 530). A less fortunate course of study could hardly have been devised. The students who take the course include a number whose previous education, energy and ambition are not sufficient to encourage them to attempt a university course, and the average quality is therefore not very good. They work through a number of unicellular types, which give no training for the hands, though they are no doubt useful in other ways. Then come Hydra and the Leech. Hydra is of course a good subject. The Leech is not instructive to a student who has no knowledge of similar animals, and the untrained man cannot possibly dissect it for himself. The rest of the course consists of parasitic worms and certain generalities. The parasitic worms commonly have the nervous system, heart, and sometimes even the alimentary canal absent or poorly developed, while the reproductive organs are of extraordinary complexity. From these the student has mainly to derive his notions of the plans of structure which are found among animals. Such a course of study looks practical, but it is almost pure waste of time. It does not teach the student to dissect, nor does it introduce him to those problems of Nature which are most accessible to a beginner. In fact, the whole course may be expected to evaporate shortly, leaving behind nothing more valuable than a recollection of the outward appearance of certain parasitic worms.

When the teacher attempts to introduce more instructive subjects, the class, solely bent upon satisfying the Conjoint Board, are too apt to scamp the work, with this excuse, that their prescribed course cannot have aroused any interest in Biology. Educationally, the syllabus of the Conjoint Board is a sin.

L. C. M.

Afterglows in Spain.

I HAVE read Mr. Backhouse's note in NATURE (vol. xlvii. p. 582) on the afterglows as seen by him in Spain during February last, and the doubts he expresses on the question whether this phenomenon has always occurred when the sun has been near the horizon. I have observed for many years the setting of the sun in Cadiz on the sea horizon with the purest sky, and never remarked the pink tint, but always the rosy tint in the west and the purple, or *Cegensghein*, in the east. After the Krakatão eruption, in the clear sky of Madrid, the pink colour of the segment was always more or less visible; and it has been more marked in these later afterglows. The phenomenon is of the same character as that of 1883, but much less brilliant. The apex of the segment rises frequently to 40°.

I have also many times observed the *green ray* (rayon vert) in very different conditions of the atmosphere, but nearly always with calm air; this is not precisely a ray, but a flash of green light that has a very perceptible duration of some tenths of a second. AUGUSTO ARCIMIS.

Madrid, April 24.

Soot-figures on Ceilings.

THE phenomenon noted by Mr. Poulton in NATURE (vol. xlvii. p. 608) is a matter of very common observation; except in the detail of the nail-heads it has been often noticed. The explanation is, I fancy, simpler than that suggested by Prof. Lodge. It is probably a simple case of *sifting of air*, as it passes by upward diffusion through the porous plaster, where its passage is not barred by contact of the plaster with the wood on the upper side. The plaster acts as the plaster of Paris plug does in the classical researches of Graham on the diffusion of gases, and as the plug of cotton-wool does in the common process of sterilising air in biological work. That warm air does stream up through a plaster-ceiling in this way is a matter of experience to every householder, when in the winter a bedroom over a sitting-room in which a fire is kept burning all day and a lamp or gas-flames for some hours in the evening, is always found to be drier and warmer than another room in the same house not so situated. We can scarcely classify dry wood and iron together as conductors of heat. A. IRVING.

Wellington College, Berks, April 29.

THE soot-figures on ceilings described by Mr. Poulton remind me of the appearance of very similar figures brought out by hoar-frost. The first time I noticed this effect was on the surface of a smoothly-boarded gate, where the parts behind which the bars of the framing ran were marked out by a much thicker coating of hoar-frost than the rest. Subsequently I noticed the same effect on a wooden pier where the planking was crossed by broad belts of white, exactly outlining the timbers to which the boards were nailed. On another occasion thick hoar-frost had formed on the roof of the after-cabin of the steam yacht *Medusa*, composed of a close pile of fine needles of ice about one-eighth of an inch high, inclined at various angles. At first the places where the thin teak boards were nailed to the cross-beams were covered only a little more thickly than the rest, but as the warmth of the day increased the ice spicules disappeared—evaporated rather than melted—from the unsupported parts, but remained in a broad band outlining each beam except above the nail-heads, over each of which a small clear space had melted.

At the time I satisfied myself that the phenomena were due to peculiarities of melting rather than of deposition. Supposing the whole surface to have been coated uniformly, the thicker parts would take longer to heat up by the sun, and so tend to prolong the life of the ice spicules resting on them. If this were so, conversely the thickened parts of the structure, cooling more slowly, should have received a lighter coating to begin with, but this I was never fortunate enough to observe. Is the similarity to the soot-figures accidental? HUGH ROBERT MILL.

1, Savile-row, April 28.

As this subject has been under discussion lately in NATURE, it seems worth while recording a striking instance which must be well known to many who have been in the large mess room of the Royal Engineers at Chatham. This room has a lofty, highly ornamented ceiling, which was for many years bordered with a deep cornice with a plain moulding either in plaster or papier maché, mostly stuck on one simple template, and coloured either white or some very pale tint. The room was lit by three sunlights in the roof, containing about 190 gas jets. In the course of time the whole of the white moulded cornice became grey with soot-deposit *marked at intervals with light bars*, which were apparently the outline of the wooden ribs carrying the mouldings. This pattern was fairly conspicuous, and was often a subject of discussion at mess (1885 to 1890). Dr. A. Lodge's explanation of the cause seems to be the true explanation. ALLAN CUNNINGHAM.

Kensington, April 28.

THE mapping out of the heads of nails driven into the joists of the ceiling at Felixstowe seems to be inexplicable by the theory of filtration, although this may very probably account for the more common cases of a deposit between but not upon the joists of a ceiling. I am endeavouring to get a photograph of the best part of the Felixstowe ceiling. Dr. Mill's observation seems to be due, as he suggests, to a different process.

E. B. POULTON.

THE APPRECIATION OF SCIENCE BY GERMAN MANUFACTURERS.

RECENTLY, when giving evidence before the Gresham University Commission, I had occasion to speak of the attention devoted in German chemical laboratories to higher studies, and when asked what were the results of this instruction I drew attention to an article published a short time before in that most enterprising of chemical periodicals, the *Chemiker-Zeitung*, edited by Dr. Krause. In this article a description is given of the research laboratory provided to accommodate *six and twenty skilled chemists*, attached to the works of the Farbenfabriken,

[1] As regards the origin of new species, the author, like Prof. Weismann, attributes the greatest importance to sexual reproduction, and especially to cross fertilisation" (see ante, p. 606).

vormals F. Bayer and Co., of Elberfeld, who are manufacturers of dye-stuffs and other products derivable from tars. I told the Commissioners that if, at the present time, it were desired to fit up a research laboratory for chemical purposes in London, we could not do better than take these plans and reproduce them in their entirety, and that we should then, I believed, have reason to congratulate ourselves on possessing the best-appointed public research laboratory in the world.

In addition to the two dozen skilled chemists in the research department at the Elberfeld works, a large number are engaged in other departments, the total number employed being, I believe, over *sixty!*

The Elberfeld works do not stand alone: the world-renowned Badische Anilin and Sodafabrik probably has in the aggregate far more laboratory accommodation than is provided even at Elberfeld. I learn from my friend Dr. Caro, that of the *seventy-eight* chemists in the employ of this firm fifty-six have the Ph.D. degree.

At many other works equally ample provision is made—in fact the colour works throughout Germany are simply laboratories on a very large scale.

As an antithesis, I may add that I told the Gresham Commissioners that I did not think that any English colour works had six skilled chemists in its employ; at all events six was the maximum number.

Is it then surprising that, notwithstanding that a very large proportion of the coal-tar used is of English origin, and that both the "aniline-colour" and the alizarin industry were first established here, according to a statement in the Chicago Exhibition Catalogue of the German Section, about nine-tenths of the total quantity of artificial colouring matters now produced is manufactured in Germany? Whatever the proportion, in 1891, Germany exported aniline-colours of the estimated value of no less than 44,269,000 marks, and alizarin valued at 12,906,000 marks—or little short of three millions sterling—a very large proportion of these manufactured colouring matters being sent to the East Indies, where they are fast displacing those of natural origin. Dr. Caro in a comprehensive monograph just published in the *Berichte* in which the gradual development of the coal-tar colour industry is fully traced out, speaks of it as a German *national industry*. *Manufactured in Germany* is certainly now the recognized trade mark for chemicals throughout the world.

Not many years ago Wurtz wrote, with reference to the origin of the science, "La chimie est une science française;" at the present day we may say, without fear of contradiction, that, whatever its origin, it is now a German science; that it is to this fact that the Germans owe their supremacy; and that it is to our failure to feel the pulse of the times, and to educate ourselves up to the proper point that we owe our downfall. It is to be feared, moreover, that unless we realise this without further loss of time, and hasten to fit ourselves to do our fair share of the work, other industries in which chemistry plays an important part, ere another twenty years are past, will also have quitted our shores. To do this we must put aside the idea that University extension and County Council lectures, or even polytechnics and technical schools for the multitude, are to bring about the necessary reform; and we must rise above the belief that a degree given for text-book knowledge and an acquaintance with the ordinary methods of analysis is evidence of competency. A true conception of what a chemist is—what he is called on to do and to know in this age of progress—must arise in high quarters and especially among our manufacturers.

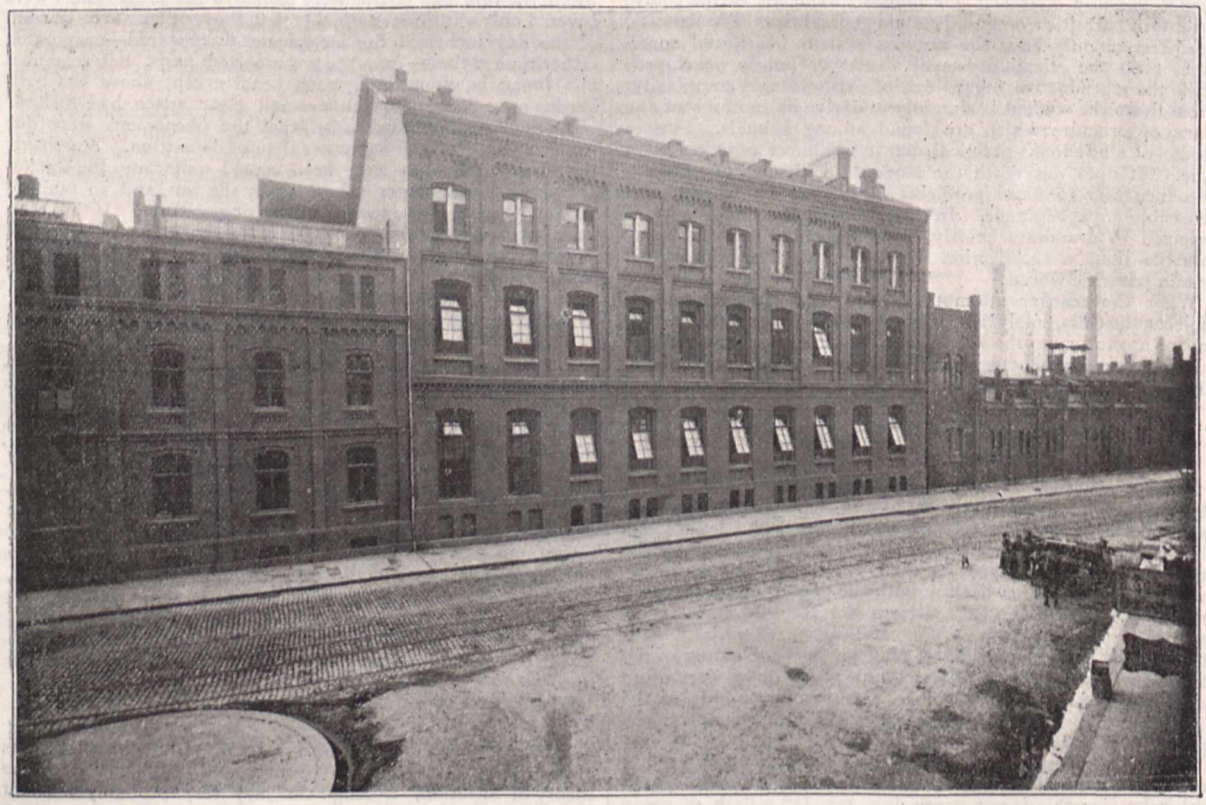

FIG. 1.—Laboratory as seen from the street; Works on right, Offices on left.

Our children must be properly taught at school and trained to work as well as to play, and we must cease to worry their lives at college by insisting on the study of a multiplicity of subjects, and no longer attempt to develope a Chinese system of examinations. Surely it is time that we realised that our examination system is a fraudulent failure. In Germany the victory has been gained wholly and solely through the agency of the Universities—here we are still dominated by influences which had their origin in the monkish cell, and our ancient Universities do nothing to help us. The intolerant individuality which has enabled us to conquer and to govern where other nations have failed is of little use in an industrial war against the most systematically instructed people in the world, whose weapons are scientific research and scientific method, and who have been careful to "organise victory," to use Huxley's expression in his remarkable letter to the *Times* at the time that the proposal to establish the Imperial Institute was under discussion. Huxley warned us six years ago of the fate that awaited our industries if we did not organise victory. I fear that so far as chemistry is concerned our insular conservatism still leads us to turn a deaf ear to all such warnings, and that the only change is that we are six years nearer to our fate.

The following particulars are mainly taken from the number of the *Chemiker-Zeitung* above referred to. I am indebted to the Farbenfabriken, vormals F. Bayer and Co., for photographs from which the illustrations to this article have been prepared. I may add that I have had the very great pleasure of inspecting the laboratory.

The opening passage of the *Chemiker-Zeitung* notice is very significant, and is as follows :—

In any industry at the present day standing still involves retrogression, and this is especially the case in the colour industry, which has developed to such an extent in our country during recent years, and which owes its development in the first instance to the extreme attention paid to chemical science in Germany at the universities and technical schools. Whereas formerly, however, the colour industry owed its progress almost entirely to the schools and their celebrated leaders, of late years knowledge in this great field has become so specialised that a determining influence can be exercised only by one who is within the industry. Since the colour works have begun to pay attention to derivatives of coal and wood tar not only in the dyers' interest, but have also placed them at the service of medical science; and since it has been recognized that the protection afforded by a patent does not retard, but, on the contrary, promotes an industry, and is therefore to the general good, and patent laws have been introduced into Germany, of which, in comparison with those of other countries, we have reason to be proud, competition has so increased that all the works concerned are forced to make every effort to prevent their destruction in the struggle for existence. Consequently all the larger colour works within recent years have erected laboratories in which a large number of disciples of chemical science are unceasingly engaged in the endeavour to meet the growing wants of the dyer by adding to the already large number of artificial coal-tar colours, not only with the object of producing colours of increased beauty, but also to meet the growing desire for colours of greater fastness, and especially with the object of entirely displacing the natural dye stuffs which were formerly exclusively used. These technical laboratories are necessarily arranged with special reference to the requirements of the industry, and therefore differ in many respects from the laboratories at the universities and technical schools which are used for teaching purposes.

The laboratory of the Farbenfabriken, vormals Friedr. Bayer and Co. at Elberfeld, opened towards the close of 1891, is the newest institution of its kind.

Fig. 1 is from a photograph of the building taken from the street. The object in view was to provide all necessary rooms for twenty-six chemists. In order to make full use of the site, however, rooms for certain other purposes were also included. The laboratory adjoins the offices of the firm and the dye house, and also the physiological laboratory. The new building is 35·66 m. long and 16·14 m. deep.

A large portion of the basement is fitted up as a store for apparatus, &c., and is connected with the laboratories above by a stairway and lift. Luxurious provision is made here for the comfort of the staff, two rooms being provided in which they can change their clothes, along one side of each of which there are twelve clothes cupboards, and a bench with cupboards for boots underneath extending along the opposite side; and also of twelve separate bath rooms with hot and cold water, and a lavatory with twenty-four basins. The heating apparatus for the baths, and a low pressure steam heating apparatus, are placed next to the wall at one end of the building, and here also niches are constructed for autoclaves—*i.e.* vessels in which materials can be heated under pressure.

The ground floor is 6 m. high from floor to floor, excepting at the eastern end, where it is 1·28 m. deeper. The eastern higher portion is divided by a floor into two low apartments fitted up for experimental dyeing. Next to this and beyond the stairway on either side of a corridor are two rooms, 2·96 × 5·61 m., one of which is a combustion room, the other containing balances and other physical apparatus. The whole of the remaining space, 24·18 m. long by 14·6 m. deep, is fitted up as a laboratory for twelve chemists, and comprises twelve separate working places, and two for large operations for common use. This arrangement has the advantage that each chemist has had placed at his disposal a separate laboratory for his own use without the room having been deprived of its uniform character. Fig. 2 is from a photograph of the laboratory, Fig. 3 representing one working place.

The first floor includes a room 8·13 m. by 3·21 m. for the use of the director of the laboratory; a room 9·82 m. by 5·61 m. used as a library;[1] a room 5·61 m. by 2·96 m. for special use; and a large laboratory corresponding to that on the ground floor with places for thirteen chemists. A gallery carried on iron brackets is constructed along the side of this room on the outside of the building, in which experiments involving the production of specially unpleasant odours can be made. This gallery is approached through a glazed doorway constructed in one of the window places, but experiments going on in it can be overlooked from the laboratory within, through the windows.

The second floor is divided into two by a partition wall, one part being occupied by the printers engaged in preparing the various labels, notices, &c., required by the firm; the other being used by the bookbinders who make up sample-books, &c.

The attics are used as store rooms.

The building is simply constructed of brick, stone being used only for the window-sills; in fact, it is characterised throughout by simplicity and solidity of construction. The basement floor is cemented; the remaining floors are covered with antilaeolith, a clay asphalt which withstands hot strongly acid liquids.

The drainage water is carried away in open channels constructed in the floor.

The electric light is used throughout, the large laboratories being each illuminated by means of four arc lamps, and the other rooms by glow-lamps.

It has not been thought necessary to introduce any

[1] Probably there are few, *if any*, libraries attached to educational institutions so fully provided with the current literature and works of reference as are the libraries at the chief colour works.

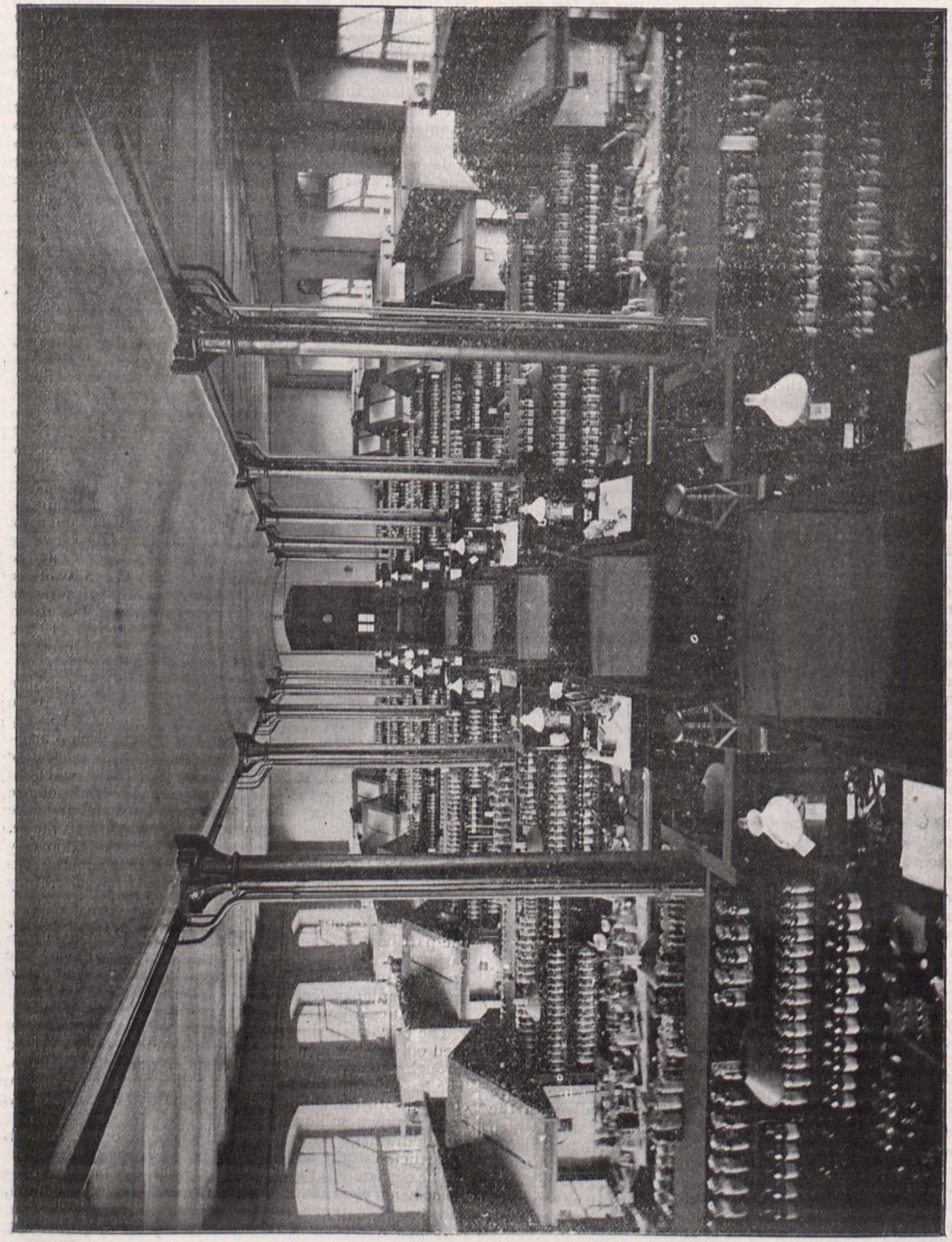

FIG. 2.—Laboratory for twelve chemists, six on either side of main passage.

mechanical system to secure general ventilation. Air is admitted through openings in the upper part of the windows, the foul air finding sufficient means of escape up a shaft in which there is a spiral staircase, at the end of the large laboratories, and which terminates in a large opening in the western gable. Special care, however, is taken to remove fumes evolved in the chemical experiments. For this purpose a large number of earthenware pipes, 15 ccm. in diameter, are built into the walls between the windows in the large laboratories and elsewhere; these are carried up and connected with asphalted flues, which eventually terminate in a large air shaft carried out above the roof; the necessary draft is secured by means of a large fan placed at the base of the shaft, and driven by the engine in the printing department. At right angles to the walls at both sides of the rooms, between the windows, hollow walls are built out about 2·5 m., on either side of which draft closets are constructed (see Fig. 2), flue pipes such as have been referred to being let into these walls.

Passing over numerous interesting details of construction, the arrangement of the laboratories may now be referred to. Each place is so arranged as to constitute a complete laboratory with every necessary provision, while at the same time there is nothing to prevent the various chemists working together or to hinder the general supervision of the laboratory. The arrangement is best understood by reference to Figs. 2 and 3, of which the latter shows a single working place. The two side benches are connected by the window bench, so that each chemist has command of a bench about 15 m. long! The bottles on the shelves of each place contain 180 different agents—among these being all the substances in use or produced in the works, so that, if desired, any combinations tried in the laboratory may at once be effected on the large scale in the works. The pipes for gas, water, compressed air and vacuum are carried in a space behind the shelving, and can be easily got at for repairs, the shelving being made removable. The benches, except at the windows, are covered with lead. Under the bench there are numerous drawers and cupboards, containing all apparatus that can possibly be required, and also chemicals such as salt, potassium chloride, sodium acetate, &c., which are used in large quantities. Thus in Fig. 3 a sliding stand will be seen projecting from a cupboard on the right-hand side, carrying measuring cylinders inverted over pegs. Each drawer or cupboard, in fact, has its special purpose, and is carefully labelled, the same arrangement being maintained throughout the laboratory, so that the attendants are able to see that each chemist is supplied with all necessary apparatus. On either bench next the window there is a closed draft-closet, and next to it a hood, it being possible to connect these by a moveable window. In one of the closets there is a large copper water bath, in which steam, previously cleaned from rust, condenses and can be drawn off as boiling distilled water; this bath has the usual openings above with rings, &c., and has within it a drying oven surrounded by boiling water, a wooden drying closet being placed below in which things can be dried by heat radiated from the water bath above. The waste water and steam pass away through the hollow wall at the back of the closet, in which there is a channel communicating with the drain.

On either side of the window a pipe connected to the general ventilation system is let into the wall, to which a funnel-shaped hood can be attached, so that experiments involving the evolution of fumes can be carried on at the

FIG. 3.—Working place of one chemist.

window-bench. This bench, however, is chiefly used for titration work, and therefore shelves are affixed to the wall some distance above it on either side, on which large bottles are placed containing the standard solutions.

It will be seen from Figs. 2 and 3 that a sink is placed at the end of the bench on the one side, and that there is a desk on the opposite side; adjoining this desk is an ice cupboard let into the bench, on the cover of which a balance for weighing out substances used in the experiments is placed. By the provision of such an ice cupboard at every place a great saving of ice has been effected: it is not only available for the storage of ice—nowadays an indispensable laboratory agent—but things can be kept cool in it even over long periods, over Sunday for example.

Four differently coloured pipes for water, gas, compressed air and vacuum run along the ceiling, and from these branch pipes are carried down the columns to the benches; taps are provided in a convenient situation, so that, if necessary, the supply of water, &c., to a bench may be at once shut off. The water pipes are covered with flannel to prevent the water which condenses on them from dropping down. Each working place is provided with 4 taps for compressed air, 4 vacuum taps, 11 water taps, 14 gas taps for heating purposes, and 9 gas burners in case of a failure of the electric light. A steam pipe runs along the wall, from which there are branch pipes connected with "purifiers," conveying steam to each of the large water baths before referred to, and to a valve under the hood adjoining the closet.

A shower bath depends from the ceiling at either end of each of the large laboratories for use in case of the clothes of any of the chemists or laboratory attendants catching fire.

Every bottle on the shelves is not only clearly labelled, but is also numbered, so that it is easy for the lad who has to keep the place clean and in order, however ignorant he may be, to arrange them properly, and moreover, each particular chemical occupies the same position in the row of bottles in every place in the laboratory.

Each chemist has a lad to assist him who washes all vessels, keeps the benches clean and the apparatus in order; in fact, does generally what he is told, even helping in the experiments. In addition, there are three lads under the supervision of an older laboratory servant in each laboratory, who at once avail themselves of any opportunity offered by the absence of the staff to "tidy up" in regions not specially committed to the charge of the young assistants. The order and cleanliness—extending even to keeping the leaden bench tops polished—thus secured is most remarkable.

Each chemist is so completely screened from his neighbour "next door," that he is not only able to work undisturbed, but practically in secret; he is only open to observation from the place on the opposite side of the main gangway, and the chemists are usually so placed that of the two working at these benches either the one is a junior under the direction of the other, or they are working in co-operation.

As a further illustration of the perfection of the arrangements I may quote from an account before me of a visit to the laboratory a description of the steps taken to put out a fire. A crack is suddenly heard and flames and a dense cloud of smoke are seen to ascend from one of the benches; all the chemists in the room at once rush to the spot. The particular chemist is found to be unhurt, but the clothes of his laboratory boy are on fire; instantly he is dragged to the shower bath, and the fire is at once put out. Meanwhile the laboratory servant has given the alarm by means of the electric fire alarm provided in the room, and within two minutes the twelve men on duty of the twenty-four members of the works fire brigade appear in full uniform. Those present, however, by turning on all the water taps in the neighbourhood of the fire and directing the water on to the burning bench had already extinguished the flames. The room is filled with a dense black fog, but by opening the windows and a valve in the main ventilation system near the ceiling this is very soon got rid of. The origin of the accident was simple enough: a young chemist, fresh from the University, unaccustomed to work with large quantities, had allowed his laboratory boy to heat a couple of litres of the hydrocarbon toluene, which he was using in recrystallising a substance, in a glass flask, over a bare flame.

Another striking feature in the large laboratories is a series of brass valves arranged along the wall under a hood opposite the bench for general use; the labels under these valves bear the names oxygen, carbon dioxide, chlorine, sulphur dioxide, phosgene, methyl chloride, hydrogen and ammonia. These various gases, compressed in cylinders enclosed in cupboards in the basement, can be used at any time by communicating through a speaking tube to the man in charge of the store department, who then opens the valve on the cylinder containing the required gas, so that it only remains for the chemist to open the valve in the laboratory.

In the lower laboratory one place only is distinguished from all the others, being fitted up for electro-chemical work with the necessary current-measuring instruments, a series of about fifty glow lamps being arranged as resistances.

In the balance-room, besides balances, there is a large arc lamp with special lenses designed by Prof. von Perger, of Vienna, used in ascertaining the effect of light on colours—in these days sunlight can no longer satisfy the needs of German industrial enterprise! Colorimeters, spectroscopes, and other apparatus are also to be found in this room. Colour chemists are not fond of making analyses if it be possible to characterise substances by any other means; the combustion furnaces are therefore but little used, and a number of ovens in which pressure tubes are heated have supplanted most of them.

Adjoining the research laboratories there is a "technical laboratory" full of apparatus exactly like that in use in the works, but of much smaller size. Here experiments are carried out on a somewhat larger scale than in the laboratory prior to the processes being effected on the large scale in the works; and the staff in this laboratory are also engaged in making many of the chemicals required to replenish the stores for use in the research laboratories.

The stores are in charge of two superintendents, one of whom is educated as a glass-blower. It is worth mentioning also that all thermometers, prior to their issue from the store, are there compared with a normal thermometer.

The laboratory was designed by my friend Dr. C. Duisberg, the director, the necessary architectural assistance being afforded by Herr Bormann, architect to the works.

The foregoing is but a very imperfect account of this marvellous works research laboratory. A more typical and concrete illustration of the appreciation of the value of science by German manufacturers, however, could not possibly be found, but yet it is only one of many that might be brought forward. Personally I can only say, that while lamenting the criminal short-sightedness of my countrymen, I am lost in admiration of the enterprise displayed by their foreign competitors: it cannot be denied that they deserve to succeed!

HENRY E. ARMSTRONG.

ELECTRO-OPTICS.

THE experimental and theoretical investigations of the last twenty years have lent a new interest to what, I venture to think, is one of the most fascinating branches

of physical optics, namely, the action of an electromagnetic field upon light. The discoveries which have hitherto been made may be classified under four heads: (1) Faraday's experiments, which show that when plane polarised light is transmitted through a *transparent* magnetised medium, a rotation of the plane of polarisation is produced; (2) Kerr's experiments, which show that the effect of electrostatic force on a *transparent* medium is to convert it into one which is optically equivalent to a uniaxal crystal whose axis is in the direction of the force; (3) Kerr's experiments on the reflection of plane polarised light at the surface of a magnetised iron reflector, which show that a rotation of the plane of polarisation of the reflected light takes place, which in certain cases is in the same and in others in the contrary direction to that of the amperean current which may be conceived to produce the magnetic force; (4) Kundt's experiments on the reflection of light from magnetised iron, cobalt, and nickel, and also on the transmission of light through thin magnetised films of these metals. There is also another series of experiments by Kundt, in which polarised light is refracted at the upper surface of a plate of glass, is then reflected at the lower surface, and again refracted at the upper surface. The results of these experiments show that the plane of polarisation of the ultimately emergent light is rotated in the *contrary* direction to that produced by an iron reflector.

There seems to be a fair amount of evidence to lead to the conclusion that Hall's effect is intimately connected with the action of a magnetic field upon light, but further evidence is required before it can be asserted that both phenomena are due to the same ultimate cause. Up to the present time Hall's effect has, I believe, only been detected in conducting media; but if it be assumed to be capable of existing in transparent media, theory furnishes results which, as far as they have been worked out, are in agreement with experiment. Hall's effect is capable of explaining the experiments of Faraday, and it also gives a result in accordance with Kundt's experiments on reflection and refraction from a plate of magnetised glass in the case in which the magnetisation and incidence are normal. It would be quite possible to apply this theory to the case of oblique incidence, but the work would be laborious and the final results complicated. The experiments of Prof. Dewar on liquid oxygen would seem to provide a more promising way of testing this theory, for, on account of the high susceptibility of this substance to magnetic action, it is possible that an effect might be observed in the case of *direct* reflection.[1] According to theory, Hall's effect ought to be positive in the case of glass and gaseous oxygen, and negative in the case of a solution of perchloride of iron; and a repetition of Kundt's experiments, in which the latter liquid is employed in the place of glass, ought to show that the rotation takes place in the *same* direction as that produced by metallic iron. Such experiments would be valuable as a further test of the theory, but they do not appear to have been made.

A paper recently communicated to the Cambridge Philosophical Society (May 1) still further confirms the view which I have put forward. In this paper I have transformed the formulæ for reflection at a magnetised *transparent* medium by assuming that the refractive index is a complex quantity. The resulting formulæ for the amplitudes of the reflected vibrations agree very well with Kerr's experiments so far as qualitative results are concerned, provided the values and signs of certain quantities are supposed to be determined by optical, as distinguished from electromagnetic methods. They are, moreover, the same *as regards their form* as those deducible from Maxwell's theory by taking into account the conductivity combined with Hall's effect; but unfortunately the values of certain constants, when expressed in terms of electrical quantities, differ from the values which are required by optical experiments, in a manner which prevents a perfectly satisfactory electromagnetic theory being constructed in this way, and I doubt whether it will be possible to attain the end in view until a theory based upon the mutual reaction of ether and matter has been discovered in which quantities, upon which the motion of matter depends, enter into combination with electromagnetic quantities.

Although the sign of Kerr's effect in nickel is the same as in iron and cobalt, the sign of Hall's effect is different. This difficulty is apparent rather than real, for a theory based upon the mutual reaction of ether and matter might very well introduce a factor containing the free periods of the vibrations of the matter which would change the sign of the magnetic terms. Some light might be thrown on this point by determining the principal incidence and azimuth for nickel and cobalt.

The generally received theory, that reflection and refraction are materially influenced when any of the free periods of the vibrations of the matter fall within the limits of the visible spectrum, suggests that the sign of Kerr's effect may be different in the case of the ultra-violet and the infra-red portions of the spectrum from what it is in the luminous portion. Experiments on this branch of the subject are needed, and possibly the employment of a fluorescent substance, such as quinine, in the case of the ultra-violet waves, or of a solution of iodine in disulphide of carbon, in conjunction with Prof. Langley's bolometer,[2] when the infra-red waves are experimented upon, might furnish important information on this point.

The experiments of Kerr on the effect of electrostatic force suggest that if light were reflected from a strongly electrified metallic conductor, certain peculiarities would be observed. In the absence of experiments, which do not appear to have been made, it would be impossible to predict with certainty what these effects are likely to be; but it would seem probable that an electrified metallic reflector would behave like a doubly-refracting metallic medium having a *single* optic axis which is perpendicular to the reflecting surface. When light is reflected from the surface of a uniaxal crystal which is cut perpendicularly to the axis, the component vibration at right angles to the plane of incidence is reflected in the same manner as if the medium were isotropic. Under these circumstances we should anticipate that in the case of an electrified metallic reflector, the component vibration *in* the plane of incidence would be much more strongly affected by electrification than the component at right angles to this plane. If this speculation should be verified by experiment, it would follow that the principal incidence and azimuth, and also the difference between the changes of phase of the two components, would be affected by electrification in a manner which could be observed.

In conclusion I would point out that further experiments are required of the following nature:—

(1) Experiments on the reflection of light from magnetised *transparent* media, such as glass, perchloride of iron, and also if possible from liquid oxygen.

(2) Experiments on reflection from and transmission through magnetised metals, special attention being paid to the effects produced by the non-luminous portion of the spectrum.

(3) Experiments on reflection from *electrified* metallic reflectors.

A. B. BASSET.

[1] The effect produced by a *single* reflection from magnetised glass would be too feeble to be detected; but Dr. Kerr suggested to me that an effect might possibly be observed by employing the method of multiple reflections.

[2] I do not know whether the bolometer is more sensitive to heat than a pair of average eyes are to light; if it is, experiments on the infra-red waves ought to be easier than experiments on luminous waves.

NOTES.

THE annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, 25, Great George Street, London, on Wednesday and Thursday, May 24 and 25. On Wednesday business will be transacted; the Bessemer Gold Medal for 1893 will be presented to Mr. John Fritz, of Bethlehem, Pa., U.S.A.; and the president-elect, Mr. E. Windsor Richards, will deliver his inaugural address. The following papers will afterwards be read and discussed: "On the elimination of sulphur from iron and steel" (second paper), by J. E. Stead; "On the Saniter process of desulphurisation," by E. H. Saniter. On Thursday the following papers will be read and discussed:—"On the basic process of Witkowitz," by F. Kupelwieser; "Notes on puddling iron," by John Head; "On a recording pyrometer," by Prof. Roberts-Austen, F.R.S.

THE Royal Society *soirée* was being held as NATURE went to press yesterday evening.

A DINNER will be given by the Master and Fellows of Gonville and Caius College, Cambridge, on Wednesday, June 21, in the College Hall, to celebrate the tercentenary of the admission of William Harvey to the college.

THE annual dinner of the Royal Geographical Society will take place on Saturday, May 13, at the Whitehall Rooms, Hôtel Métropole, Sir M. E. Grant Duff, President of the Society, in the chair.

THE second annual Robert Boyle Lecture of the Oxford University Junior Scientific Club will be delivered in the University Museum on Tuesday, the 16th inst., at 8.30 p.m., by Lord Kelvin, P.R.S. His subject will be, "The Molecular Tactics of Crystals."

THE Geologists' Association has made arrangements for a geological excursion to Farnham on Saturday, May 13. During Whitsuntide there will be an excursion to Bradford-on-Avon and Westbury, in Wiltshire.

THE late Lord Derby has left by will to the Royal Society a sum of £2000. He has also bequeathed £2000 to the Royal Institution.

THE Royal Society of New South Wales offers its medal and £25 for the best communication sent in not later than May 1, 1894, containing the results of original research or observation upon each of the following subjects:—(1) On the timbers of New South Wales, with special reference to their fitness for use in construction, manufactures, and other similar purposes; (2) on the raised sea-beaches and kitchen middens on the coast of New South Wales; (3) on the aboriginal rock-carvings and paintings in New South Wales.

THE Royal Hungarian Academy of Sciences at Buda-Pesth has devoted the sum of 2000 fl. to the promotion of botanical investigations during the year 1893.

THE Committee of the Kew Observatory has issued its report for the year ending December 31, 1892.

THE Council of the Durham College of Science has resolved to offer to each county council in England the right of nominating a scholar who shall attend the course of instruction in the agricultural department of the college without the payment of fees, on condition that the county council pay to the scholar not less than £30 towards the cost of his board and lodging in Newcastle or the neighbourhood, and of such books or appliances as he may require for his study. The scholarships will be tenable in the first instance for one year, but may be renewed for a second year by the college council if the progress o the student is satisfactory. The object of the college council is twofold: to bring before the notice of county councils and others the advantages offered by its agricultural department, and to make some acknowledgment to the country generally for the contributions it has received from imperial sources through the Board of Agriculture.

THE Yorkshire Naturalists' Union is making a great effort to double its membership, and ought to have little difficulty in accomplishing its purpose, as it is one of the most vigorous of the provincial scientific societies. Its funds are at present insufficient to justify it in publishing all the important works it has in hand.

MR. M. A. Veeder writes to us from Lyons, New York, that Lieut. Peary, of the United States Navy, during his coming expedition to the northernmost Greenland, will record observations of the aurora, upon a plan that will enable comparisons to be made in detail with records from other localities. "The plan," Mr. Veeder says, "is already in operation, upon an international basis, and the results are proving to be important. Numerous observers widely distributed are desirable, and inasmuch as even those who have no special technical knowledge may make entries that will be of value any who feel so disposed may co-operate." Further information and supplies of blanks may be obtained from Mr. Veeder, who will be glad to receive also, any records of observations of the aurora whatever, for purposes of comparison.

MODERATE rains occurred in the north and west, in the early part of last week, owing to the advance of depressions from the Atlantic, and a small amount of rain fell in the midland counties, but over the southern and eastern parts of England there was no measurable quantity. The drought has continued with great persistency over the southern part of the kingdom, the period without rain, up to Tuesday the 9th inst., being fifty-three days at some of the stations reporting to the Meteorological Office. An anticyclone embraced the greater part of western Europe throughout the past week, and spread westwards over the British Islands, causing high atmospheric pressure, while in northern Scandinavia the barometer rose to nearly 31 inches. The temperature has been irregular; although high for the time of year, it has been lower generally than some weeks ago; in a few instances the daily maxima have exceeded 70°, but in parts they have been little above 50°. The *Weekly Weather Report* of the 6th instant showed a general decrease of bright sunshine. The percentage of possible duration ranged from 18 to 27 in Ireland, from 22 to 30 in Scotland, and from 41 to 57 in England; in the Channel Islands the high percentage of 81 was recorded.

AT the meeting of the French Meteorological Society on April 4 Dr. Fines presented a note on the violence of the storms which are occasionally experienced in the province of Roussillon (Eastern Pyrenees). On five occasions between 1860 and 1867 railway trains have been overturned on the line from Narbonne to Perpignan. A storm of great violence occurred from January 15 to 24 last, in which at one time the velocity amounted to 85 miles an hour. A large number of trees were uprooted and some loaded railway trucks were overturned on this occasion.

THE annual general meeting and *conversazione* of the Selborne Society were held at the rooms of the Royal Society of British Artists yesterday evening. The objects of this excellent society are: to preserve from unnecessary destruction such wild birds, animals, and plants as are harmless, beautiful, or rare; to discourage the wearing and use for ornament of birds and their plumage, except when the birds are killed for food or reared for their plumage; to protect places and objects of interest or natural beauty from ill-treatment or destruction; and

to promote the study of natural history. Many good writers on natural history contribute to the society's journal, *Nature Notes*.

A CAPITAL paper on the manufactures of India was read by Sir Juland Danvers before the Indian Section of the Society of Arts on April 24, and is published in the current number of the Society's Journal. Sir Juland is of opinion that, if all legitimate means are taken for opening the markets of the world to Indian commerce and for stimulating enterprise and energy by developing the country itself, India may become a large manufacturing as well as an agricultural country, and thus be enabled not only to support but to improve the condition of her vast population. The reading of the paper was followed by a most interesting discussion, in the course of which several high authorities expressed their cordial agreement with the views stated by Sir Juland Danvers. Sir C. E. Bernard said that short of vast discoveries of workable gold within her borders India's true and only way out of the silver difficulty that threatens her with bankruptcy is the rapid development of her home industries, especially her cotton and iron manufactures.

THE Trinidad Field Naturalists' Club prints in its Journal for April a valuable preliminary list of the mammals of Trinidad, by Mr. Oldfield Thomas, of the British Museum (Natural History). Mr. Thomas explains that he has prepared the list as a basis on which a complete scientific list of the mammals inhabiting Trinidad may be founded, and to show members of the society how extraordinarily little is definitely known of the mammals of the island. By known, of course, he means scientifically known in the sense of being published to the world, for he has no doubt whatever that many members of the society could off-hand add to the list many animals well-known to them and other inhabitants, but neither hitherto mentioned in scientific publications nor represented by specimens in the British Museum. He earnestly begs that all persons interested in the natural history of Trinidad will do what they can to obtain specimens and to send them home for identification. Every collection made at present is sure, he says, to contain species new to the island, even if not—as in the case of two bats recently received from Trinidad—altogether new to science.

A PAPER on "Recreation," read by Mr. William Odell before the Torquay Natural History Society, has been printed separately. It contains some very interesting letters from the head masters of public schools as to the effect of athletics on school work.

MR. FREDERICK J. HANBURY and the Rev. E. S. Marshall are engaged in the preparation of a Flora of Kent, which should prove an exceptionally rich county flora, though some districts have as yet been but imperfectly searched. Any assistance will be gladly received by the Rev. E. S. Marshall, Milford Vicarage, Godalming.

MR. A. T. DRUMMOND has been investigating the colours of flowers in Ontario and Quebec in relation to the time of flowering, and has contributed to the *Canadian Record of Science* an interesting paper on the subject. He finds that April, May, and even June and July are remarkable for the prevalence of white flowers, July and especially August of yellow, and September and October of purple and blue.

GOOD illustrations of the difficulty of determining plants or vegetable productions by popular or local names are given in a letter by Mr. B. B. Smyth, of the Kansas Academy of Science, published in the current Quarterly Record of the Royal Botanic Society of London. "The name Nightshade," he says, "is applied here to *Solanum nigrum* and *S. triflorum*; the name Woody Nightshade is applied to *S. Dulcamara*; the name Bittersweet is applied to *Celastrus scandens*, a twining woody plant with clusters of showy scarlet berries; the name Laurel is applied to the different species of Kalmia; the names Mock Orange and Syringa are applied (of course misapplied) to Philadelphus; the name Sarsaparilla is (mis)applied to Aralia; the name Snakeroot is applied to a dozen different species in half as many different orders; the name Mouse-ear is applied to Gnaphalium, Antennaria, and Cerastium."

WE have repeatedly called attention to the fact that the German publisher Engelmann is issuing an important series of small volumes consisting of papers which have marked an era in the history of science. A series of much the same kind has been begun, we are glad to note, by Mr. W. F. Clay, Edinburgh, and Messrs. Simpkin, Marshall and Co., London. The volumes in this series are to be known as "Alembic Club Reprints." The first volume consists of Joseph Black's paper, entitled, "Experiments upon Magnesia Alba Quicklime, and other Alcaline Substances."

THE Natural History Society of Marlborough College has issued its report for the year ending Christmas, 1892. The high standard of work in the sections is said to have been, on the whole, well maintained; but an exception is made in the case of the zoological section, the members of which showed "little disposition to exert themselves in work conducted on scientific lines." The library of the society is rapidly increasing. Among the works added to it during the year were the four splendidly illustrated volumes (privately printed) on excavations and archæological discoveries in or near Wilts, by General Pitt-Rivers. These were presented by the author, to whom special thanks are accorded for his "peculiarly interesting and valuable gift."

ARISTOTLE, it seems, knew almost as much about field voles as is known by those who have lately been studying the mischief done by these creatures in Thessaly and Scotland. In a passage quoted in the current number of the *Zoologist* from his "Natural History of Animals" he speaks of their power of destruction as "so great that some small farmers, having on one day observed that their corn was ready for harvest, when they went the following day to cut their corn, found it all eaten." "The manner of their disappearance also," he continues, "is unaccountable; for in a few days they all vanish, although beforehand they could not be exterminated by smoking and digging them out, nor by hunting them and turning swine among them to root up their runs. Foxes also hunt them out, and wild weasels are very ready to destroy them; but they cannot prevail over their numbers and the rapidity of their increase, nor indeed can anything prevail over them but rain, and when this comes they disappear very soon." This passage is quoted in the *Zoologist* by Mr. A. H. Macpherson. The editor adds a note showing that Aristotle was by no means the only ancient writer to whom the facts were familiar.

MR. G. LEWIS contributes to the current number of the *Entomologist* a list of coleoptera new to the fauna of Japan, with notices of unrecorded synonyms. Some of the list are well-known European species; others have hitherto been known from Siberia only. Mr. Lewis says that some years will elapse before the collection gathered by him in Japan can be completely worked out.

AN interesting paper on mining and ore-treatment at Broken Hill, New South Wales, was read at the meeting of the Institution of Civil Engineers on May 2, the authors being Mr. M. B. Jamieson and Mr. J. Howell. From this mine silver and lead of the value of over £8,250,000 sterling had been taken within seven years; and it continued to yield about

220,000 ounces of silver, and between 600 and 800 tons of lead per week. Speaking of the products of the refinery, the authors said they were thus disposed of:—The pure silver was sold in the colonies by tender at stated intervals, in parcels of between 100,000 ounces and 150,000 ounces, and was purchased by the banks usually at a price somewhat above the price current in London. The soft lead was shipped either to England or to China; the latter country was becoming gradually a larger buyer of the company's lead. The matte and other compound products were shipped to England. The small amount of gold in the ore was recovered in the refinery. It amounted to about 3·4 dwt. per ton of bullion.

MR. C. HEDLEY has contributed to the Proceedings of the Linnean Society of New South Wales (Second Series, vol. vii.) an interesting paper on the range of *Placostylus*, which he describes as a more fruitful subject of study than any other molluscan genus inhabiting the same area. Their large and handsome shells have attracted the attention of the most superficial and unscientific collectors, so that an extensive series has been brought to the knowledge of investigators from remote localities. In the summary of his results, Mr. Hedley remarks, first, on the essential unity of the *Placostylus* area as a zoological province, embracing the archipelagoes of Solomon, Fiji, New Hebrides, Loyalty, New Caledonia, Norfolk I. (?), Lord Howe, and New Zealand; a unity explicable, he thinks, only on the theory that they form portions of a shattered continent and are connected by shallow banks formerly dry land. This continental area he proposes to call the Melanesian plateau. He holds, secondly, that this Melanesian plateau was never connected with, nor populated from, Australia, but that its fauna was probably derived from Papua *viâ* New Britain. The presence of genera common to Australia and New Zealand he believes to be explicable on the ground that they migrated, not from the one territory to the other, but each from a common source, New Guinea. Thirdly, he thinks that New Zealand and New Caledonia were early separated from the northern archipelagoes and ceased to receive overland immigrants therefrom. Fourthly, the Fijis, according to Mr. Hedley, remained to a later date in communication with the Solomons, but were severed from that group before the latter had acquired from Papua much of its present fauna.

THE "Year Book of Australia" for 1893 has been published. It includes an interesting account of scientific work done in the various Australian colonies during 1892. This has been compiled from information supplied by the scientific societies of Australia.

SOME valuable reports on the Victorian coalfields, by Mr. James Stirling, of the Geological Survey of Victoria, have been issued by the Department of Mines in that colony. They are fully and most carefully illustrated.

A FRENCH translation of Lord Kelvin's "Popular Lectures and Addresses" has been published by Messrs. Gauthier-Villars et Fils. The translator is P. Lugol, who has added some notes. Translations of extracts from recent memoirs by Lord Kelvin, with notes, have been contributed by M. Brillouin.

A FRESH instalment of the Proceedings of the American Academy of Arts and Sciences (New Series, vol. xix.) has just been published. It covers the period from May 1891 to May 1892. Among the contents are some considerations regarding Helmholtz's theory of consonance, by C. R. Cross and H. M. Goodwin; a note on the dependence of viscosity on pressure and temperature, by C. Barus; what electricity is: illustrated by some new experiments, by W. W. Jacques; on a theorem of Sylvester's relating to non-degenerate matrices, by H. Taber; researches on the volatile hydrocarbons, by C. M. Warren; descriptions of new plants collected in Mexico by C. G. Pringle in 1890 and 1891, with notes upon a few other species, by B. L. Robinson; on some experiments with the phonograph, relating to the vowel theory of Helmholtz, by C. R. Cross and G. V. Wendell, and other papers.

A PAPER entitled "Further Studies of Yuccas and their Pollination" has been contributed by Mr. W. Trelease to the fourth annual report of the Missouri Botanical Garden, and is also published separately. It is well illustrated.

THE new number of the *Quarterly Journal of the Geological Society* includes the text of the anniversary address of the President, Mr. W. H. Hudleston, F.R.S. He deals with the work brought before the Society in the course of the last seven years, during which he has served the Society in one official capacity or another.

A FOURTH edition of "Practical Physics," by R. T. Glazebrook and W. N. Shaw, has been issued by Messrs. Longmans, Green, and Co. The authors have taken advantage of this opportunity to make some alterations and additions suggested by their own experience or that of their successors at the Cavendish Laboratory.

IN a recent number of the *Comptes Rendus*, M. Rigollot gives a further account of his experiments on the electrochemical actinometer. He finds that the electromotive force developed when light falls on a plate of oxydised copper immersed in a solution of a metallic iodide, bromide or chloride can be considerably increased if it has previously been dipped in some colouring matter, such as eosine or safranine. This increase of sensitiveness is different for rays of different wave lengths, and those rays which produce the maximum effect, for any one colouring substance, depend on the position of the absorption band in the light which is transmitted by that substance.

M. CHASSAGNY has a note in the current number of the *Comptes Rendus* on the influence of longitudinal magnetisation on the electromotive force of an iron-copper thermo-electric junction. Two couples were used, one being in the axis of a long magnetising helix, so joined together that they acted in opposite directions. The results obtained were:—(1) The effect of longitudinal magnetisation is always to increase the electromotive force. (2) This increase is independent of the direction of magnetisation. (3) For increasing fields the increase is at first very nearly proportional to the strength of the field, and attains a maximum value of 6·1 microvolts for a field of 55 C.G.S. units. After this it slowly decreases till for a field of 200 units it is 3·2 microvolts.

AT the meeting of the Société Française de Physique, held on April 21, M. P. Curie gave some of the results of his experiments on the magnetic properties of bodies at different temperatures. The body to be experimented on was placed in a non-uniform magnetic field and the force acting on it measured by the torsion of a metallic wire. An electric heater capable of raising the temperature of the body to 1400° C. was used, together with one of Le Chatelier's thermo-elements to measure the temperature. In the case of oxygen, the magnetic permeability is constant for magnetising forces of from 200 to 1350 units, and for pressures of from 5 to 20 atmospheres. The law of variation of the permeability with temperature is very simple, since between 20° and 450° it varies inversely as the absolute temperature. In the case of air, the permeability at a temperature t is given by the formula $10^6\mu_t = 2760/t^2$, which can be used to correct observations made in air at any temperature.

A NEW reaction, of wide general application and of considerable practical utility, by means of which the important organic compounds known as nitriles may be readily prepared in a state of purity, has been discovered by Prof. Michaelis and Dr. Siebert, and is described by them in the current number of *Liebig's Annalen*. As stated in our chemical note of last week, Prof. Michaelis has recently been studying the action of thionyl chloride, $SOBl_2$, upon the primary amines, and has shown that the product of the reaction is a thionylamine, a compound formed by the replacement of the two hydrogen atoms of the NH_2 group of the amine by the radical thionyl, SO. In seeking to ascertain whether a similar kind of compound to the thionylamines is formed when thionyl chloride is allowed to act upon the amides of the acid radicles, Prof. Michaelis and Dr. Siebert have discovered the new mode of preparing the nitriles. Instead of a compound of such a nature being produced, a nitrile is the main product, with sulphur dioxide and hydrochloric acid as bye products. As the two latter are gaseous substances, it is at once evident that the reaction must afford a particularly convenient mode of preparing the nitriles in a state of purity. The reaction, moreover, is quite general, and is applicable both in the fatty and in the aromatic series. When thionyl chloride is brought in contact with acetamide, $CH_3 . CO . NH_2$, a violent reaction occurs, with considerable rise of temperature. After a few minutes, however, the violence diminishes, and the liquid eventually becomes quiescent. In order to complete the interaction, the product should then be heated over a water-bath for a few hours, the reaction flask being provided with a reflux condenser. When the fumes of hydrochloric acid and the odour of sulphur dioxide are no longer perceptible, the reaction is completed in accordance with the equation—

$$CH_3 . CO . NH_2 + SOBl_2 = CH_3 . CN + SO_2 + 2HBl.$$

The dark-coloured liquid is then decanted from a small quantity of resinous products of decomposition and distilled, when pure acetonitrile, clear and colourless, passes over it at its boiling point, 82°. The yield of pure nitrile is about half the weight of acetamide employed. The violence of the reaction between thionyl chloride and acetamide is very much diminished by the addition of benzene; but owing to the difficulty of separating the resulting nitrile from the benzene by fractional distillation, it is preferable not to employ it. With care, the direct addition of the thionyl chloride may be made without loss. Propionamide reacts in a very similar manner with thionyl chloride, and almost the whole of the liquid product distils over quite colourless at the boiling point of propionitrile (98°). In like manner, pure benzonitrile may be obtained by the action of thionyl chloride upon the amide of benzoic acid. It is preferable, however, in case of such higher boiling nitriles which can be readily separated from benzene by fractional distillation, to conduct the operation in presence of benzene, the reaction then proceeding much more regularly and without the violence of the direct action. Upon subsequent distillation, the thermometer at once rises to 190° after the distillation of the benzene, and remains constant at that temperature until almost the whole of the benzonitrile has passed over.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Hydroid *Hydractinia echinata*, the Polychæta *Eunice Harassii* and *Siphonostoma uncinatum*, the Polyzoan *Pedicellina cernua*, the Opisthobranchs *Runcina coronata* and *Polycera Lessonii*, the Crustacean *Hyas araneus*, and the Echinoderms *Cucumaria Planci* and *Luidia ciliaris*. The quantity of gelatinous algæ in the Channel waters at length exhibits signs of diminution. Medusæ of the remarkable Hydroid *Corymorpha nutans* (of Allman) have been taken in the tow-nets on several occasions. The medusæ of *Aurelia aurita* are growing rapidly in size, and have now attained an average diameter of 1¼ inches. The *Megalopæ* of *Carcinus* are no longer commonly taken in the tow-nets, but are chiefly to be found in especial haunts at the sea-bottom. The following animals, not hitherto noted, are now breeding: the Hydroids *Plumularia setacea* and *Antennularia ramosa*, the Decapod Crustacea *Crangon fasciatus* and *Hippolyte Cranchii*, the Ophiurid *Amphiura elegans* (= *squamata*), the Ascidian *Styelopsis grossularia*, and several species of Amphipoda and Pantopoda.

THE additions to the Zoological Society's Gardens during the past week include two Mozambique Monkeys (*Cercopithecus pygerythrus*, ♀ ♀) from East Africa, presented respectively by Mr. Arthur James and Miss Maude Parkinson; a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Miss G. Lloyd; a Bonnet Monkey (*Macacus sinicus*, ♀) from India, presented by Mr. R. Hughes; a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, presented by Mr. F. Byfield; an Indian Buffalo (*Bubalus buffelus*, ♀) from India, presented by H.H. The Maharaja of Bhoonagar; a Common Hedgehog (*Erinaceus europæus*) British, presented by Mrs. E. Austen-Leigh; a West African Love-Bird (*Agapornis pullaria*) from West Africa, presented by Lady Theodora Guest; two Herring Gulls (*Larus argentatus*) British, presented by Mr. W. H. Aplin; two Egyptian Mastigures (*Uromastix spinipes*) from Egypt, presented by Mr. Edmund Lamb; a Moorish Tortoise (*Testudo mauritanica*) from North Africa, presented by Mr. T. W. Bayley; seven Green Tree Frogs (*Hyla arborea*) South European, presented by the Rev. C. D. Fothergill; a Silvery Gibbon (*Hylobates leuciscus*) from Malacca, a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, twenty Green Tree Frogs (*Hyla arborea*) South European, deposited; two Amherst Pheasants (*Thaumalea amherstiæ*, ♀ ♀) from Szechuen, China, a Swinhoe's Pheasant (*Euplocamus swinhoii*, ♂) from Formosa, three Cat Fish (*Amiurus catus*) from North America, purchased; a Common Crowned Pigeon (*Goura coronata*) from New Guinea, received in exchange; a Yak (*Poëphagus grunniens*), ♀), a Water Buck (*Cobus ellipsiprymnus*, ×), an Angora Goat (*Capra hircus. var.* ♂,), a Bennett's Wallaby (*Halmaturus bennetti*, ♂) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

MERIDIAN CIRCLE OBSERVATIONS.—At the meeting of the Royal Astronomical Society, held on April 14 last, the proceedings of which are recorded in the current number (No. 201) of the *Observatory*, the paper prepared by Messrs. Turner and Hollis (and read by the former) entitled, "Comparison of the Greenwich Ten-year Catalogue (1880) with the Cape Catalogue (1880)," was the means of instigating an interesting discussion with reference to questions relating to systematic error of meridian observations. The questions thus raised are of great importance, for, as Dr. Gill remarks, they "affect the objects for which public observatories were founded." Generally speaking the comparison of the catalogues above mentioned seems to have given very satisfactory results, but the series of differences obtained from the north-polar-distances, arranged in order of north polar distance, showed signs of small divergences. The source from which these differences could have arisen seems—since the accuracy of the N.P.D. places depends on the coefficient of refraction—to be at first sight apparent, and Mr. Stone's opinion is that this quantity is "practically mixed up with the question of refraction," his firm conviction being that in the Cape observations there are no systematic errors possible to account for 0″·4. Dr. Gill, in referring to the discussion generally, made some very striking remarks about meridian observations, and was of opinion that at the Cape there were sources of systematic error amounting possibly to half a second of arc. The differences obtained from the reflex and direct observations at the Cape, he says, have led him to the conclusion that they are caused by the fact that, "since the walls of the transit room are

about three feet thick, they retain for a long time the heat which they absorb during the day. The result is that there are layers of air of different temperature in the room at night." To improve fundamental astronomy, half a second of arc, he says, must be seriously taken into account, and this can only be done by employing a sound instrument and a properly-constructed observing-room, "and we have neither the one nor the other at the Cape nor at Greenwich. If we are going to fight for two-tenths or three-tenths of a second, we must set to work *de novo* with better instruments, better housed, for the determination of constant error."

THE LUNAR ATMOSPHERE.—Various are the methods that can be adopted for observing whether the moon has an atmosphere or not, but some of them, such as those that depend on solar eclipses, have been the least often attempted, since they are of an extremely delicate nature. In eclipses, whether partial or total, if the moon really had a moderately dense atmosphere, we should be able, by photographing the sun when partially covered by the moon, to note whether the delicate details on the solar surface in the region of the lunar limb had suffered any slight alterations in their forms. To note such variations it is needless to say that photography must be employed, and further that the photographs must be on a moderately large scale, for if indeed there be changes of form they will by no means be necessarily *very* apparent. For such observations as these no better scale could be used than that adopted by M. Janssen in those wonderful solar pictures that have done much to help us in extending our knowledge of the sun's surface. In fact M. Janssen, in *Comptes Rendus* for April 17 (No. 16) tells us that in order to try this method again several plates were exposed during the recent eclipse of the sun, but owing to the state of the sky the conditions were not very favourable, as these large photographs require a perfectly pure atmosphere. He mentions at the end of his note that he has already made some progress towards the solution of this question from the photographs that were taken at Marseilles during the partial eclipse of July, 1879.

GEOGRAPHICAL NOTES.

THE Berlin Geographical Society has awarded the Humboldt medal, the highest honour it can bestow, to Dr. John Murray, editor of the *Challenger* reports, in recognition of the great advances in physical geography which are associated with his name.

THE Paris Geographical Society has also awarded one of its gold medals to a foreigner, Dr. Fridjof Nansen. Other gold medals given by the Paris Society went to Captain Monteil, for his great journey to Lake Chad, M. Dybowski, for exploration on the Shari, and M. Lentheric for his monograph on the Rhone.

MR. GUY BOOTHBY has recently crossed Australia from north to south. He started from Normanton on the Gulf of Carpentaria in March, 1892, travelled leisurely on horseback or in a waggon to Bourke, and then descended the Darling in a boat, and later a river-steamer to Morgan, thence by rail to Adelaide. The journey occupied rather more than a year, and so far as appears little or no new country was traversed.

THE May number of the *Scottish Geographical Magazine* contains a paper on the people of the Lake Nyasa region, by Mr. D. J. Rankin, in which he makes some serious charges against Mr. H. H. Johnston, the British Commissioner. Mr. Rankin considers the rule of the commissioner to be too severe, and finds fault with his knowledge of the native tribes and their claims to the land.

MR. E. A. FLOYER has a long paper in the *Geographical Journal* on the Eastern Desert of Egypt, illustrated by some very characteristic pictures and a new map, the result of his surveys. The expedition of which he was the leader was sent out by the Egyptian Government in 1891, and surveyed 23,000 square miles of mountainous desert. The region is crossed by a ridge of high ground in the higher peaks of which a few shepherds find a precarious pasture for their flocks, which feed on the comparatively thick growth of acacias. The water-supply is in the form of natural reservoirs of rain, in many cases contained in limestone cavities which keep the wells supplied.

THE Columbus *fête* held in Paris on April 15, the 400th anniversary of the return of Columbus is reported at length in the current number of the *Revue de Géographie*, the main feature being an address by M. Ludovic Drapeyron, who presided. The novelty of such celebrations has passed, and it is difficult to see how the celebration of the fourth centenary of each episode of the life of Columbus after 1492 can be made serviceable to geography or of special interest to the public.

THE RECENT SOLAR ECLIPSE.

WE have already printed a number of telegrams relating to observations of the solar eclipse of April 16 in various parts of the world, and now reproduce from the *Nottingham Daily Guardian* of May 9 an article on the work of the British party in West Africa. This article is contributed by a special correspondent of that journal, who writes from H.M.S. *Blonde*, Las Palmas, April 28. It contains the first detailed information which has appeared on the subject. The writer says :—

The expedition left Liverpool on March 18 by the British and African Company's steamer *Teneriffe*, the company having most generously contracted to convey them to the Gambia at greatly reduced rates. Bathurst, near the mouth of the Gambia, was reached on March 31, when the observers and their instruments were at once transferred to H.M.S. *Alecto*, which had been kindly placed at the disposal of the expedition by the Admiralty. The *Alecto*, being specially designed for service on the West African rivers, was eminently adapted to the purposes of the observers, and, indeed, without some such aid the expedition would have been impracticable. On the afternoon of April 2 the *Alecto* proceeded with the observers to the Salum River, which lies some distance to the north of the Gambia, and Fundium was reached on the following morning. The village, by the way, is called Goundiougne by the French. The chief occupation in this part of Africa is the raising of ground nuts for export. On arrival it was found that M. Deslandres and a small staff from the Paris Observatory had already been at Fundium a fortnight, and had got most of their instruments into position. A neighbouring site, kindly offered to the British party by the Administrator, was at once accepted as satisfying all requirements. It had the advantage of being partially enclosed, and was quite near to one of the wharves, so that the instruments could be put ashore without difficulty. The land around Fundium is very flat, and a perfectly clear horizon was therefore obtained. The site having been selected, plans for the arrangement of the various instruments were at once drawn, and the concrete bases were laid down, the necessary cement having been brought from Liverpool. Huts for the instruments, which had likewise been brought from England, and the instruments themselves were also erected with the least possible delay. In this preliminary work Lieutenant-Commander Lang and his staff, with the readiness characteristic of the British Navy, gave the party all needful assistance.

As eclipse work was new to all the observers, with the exception of Prof. Thorpe, who was in charge of the expedition, the instrumental equipment was such as not to overtax any of them. Prof. Thorpe, assisted by Mr. P. L. Gray, was in charge of a 6-inch equatorial telescope, belonging to Greenwich Observatory, with the necessary accessories for determining the intensity of the light at different points of the corona. The photometer used was of the form in which the amount of light from a glow lamp necessary to cause the disappearance of a grease spot on a piece of paper was determined by measuring the strength of the electric current which illuminates it. A number of such spots were so arranged in the photometer that the image of the corona formed by the telescope fell upon them, while on the other side they were illuminated by a glow lamp, the whole, of course, being inside a dark box. I myself, representing Prof. Norman Lockyer, had the management of a 6-inch photographic telescope, provided with a large prism in front of the object glass for the purpose of determining the chemical constitution of the corona and prominences. With this method of work a separate image of each position of the corona or prominences is obtained corresponding to each kind of light which it emits, and this gives the clue to its chemical character. A duplex telescope for photographing the surroundings of the eclipsed sun was in charge of Sergeant J. Kearney, R.E., who has had the advantage of a long and varied experience in photographic matters.

The instrument was provided with two object glasses of 4-inch aperture, the tube carrying them having a partition down the middle. The image formed by one of the lenses was received directly on the photographic plate, but in the other case it was magnified about three times by one of Mr. Dallmeyer's new telephotographic lenses. The dark slides carrying the photographic plates were ingeniously arranged so that by a single operation two plates were exposed. Lieutenant Hills, R.E., one of the volunteer observers was in charge of two spectroscopes of the ordinary form provided with slits. These were mounted on an equatorial stand, and were each provided with a 3-inch condensing lens. Here, again, photographic plates replaced the eye. A piece of apparatus for determining the total light of the corona was in the hands of Mr. Forbes, the other volunteer observer. Lieut.-Commander Lang undertook to make a drawing of the faint outlying parts of the corona by following the plan initiated by the American astronomer Newcombe in 1878. This consists in erecting a wooden disc in line with the eye and the eclipsed sun, and at such a distance that it appears to cover all the bright inner corona. The eclipse itself is thus eclipsed, and the observer has an opportunity of studying the more delicate parts of the corona, his eye being protected from the brighter light by the wooden disc.

The weather, fortunately, was magnificent during the whole tay of the observers at Fundium, and almost cloudless skies were experienced both day and night. By April 10 the instruments had all been carefully erected and adjusted by observations of the stars, and all was in readiness for the eclipse. Rehearsals of the operations which were to be gone through during the eclipse were now begun, and continued daily. It was arranged that the commencement of totality should be announced by pistol shot, Prof. Thorpe giving the signal to fire. Quartermaster Hallet was then to record in a loud voice the lapse of the 250 seconds of totality by reading the 15 seconds sandglass, which is so commonly used with the ship's log. Several rehearsals were gone through at dusk, when it was estimated that the light was about equal to that which might be expected during totality.

At last the day of the eclipse arrived, and everything was in complete order. The morning was a little more hazy than usual, but all felt confident of obtaining at least a moderate view of the eclipse. The observers themselves were at their posts soon after noon, and driving clocks and other details were attended to. At five minutes past one the moon was seen to have encroached on the south-western limb of the sun, and as it gradually passed over the disc the temperature of the air as gradually fell. At two o'clock the officers of the *Alecto*, who were kindly assisting the observers, also took their places. The light now waned very rapidly, and the breeze felt cold. In appearance the light of day at these stages very much resembled that which precedes an English thunderstorm. All the observers were now in perfect readiness for the pistol shot. "Five minutes" was announced by Prof. Thorpe, and I began my spectrum photographs, exposing six plates before totality. Amidst almost breathless silence the sound of the pistol shot was awaited. Eventually a similar pistol signal adopted in the French camp was clearly heard, and that moment the shadow of the moon went sweeping past. Prof. Thorpe's signal to fire, however, was not given until at least 10 seconds later. As the last trace of bright sunlight disappeared out flashed a magnificent corona of silvery light, together with numerous red and white prominences. The corona was very evenly distributed round the dark moon, that is to say, there were none of the great extensions along the Equator which were seen in 1878 and 1889. The light of the corona was very bright, and the lamps which had been provided for the use of the observers during totality were quite unnecessary—indeed, the sky light was so bright that no stars became visible at all, but Jupiter and Venus, which happened to be quite near the sun, shone out most distinctly. At Bathurst, however, the sky appears to have been clearer, and some of the brighter stars were also seen. The various observations were made and the photographs taken with no hitch whatever beyond the loss of about 10 seconds at the beginning of totality. This caused me to lose three exposures during totality, and reduced the number of Sergeant Kearney's photographs from 12 to 10. To err on the right side, Lieutenant Hills very fortunately closed his dark slides soon after "25 seconds" had been called by the quartermaster. In this case the slightest flash of sunlight would have been disastrous. Five minutes after totality was over I exposed my last plate, and the actual work of the expedition was at an end. What was more, all were confident of success.

Now, as to the results of the observations and photographs. Though it is much too early to attempt to state all that we may, except to learn from them, one point is clear. The general distribution of the corona is exactly what was expected, seeing that the sun is now in a very disturbed state. The sun spots, it is well known, have an eleven yearly period, and at the present time they are nearly at a maximum. This, in fact, made the recent eclipse one of the highest importance. It has been observed in previous eclipses that when the spots are at a minimum the corona is very much extended in the direction of the sun's equator, while, on the other hand, when the spots are at a maximum the corona is very much more evenly distributed. This supposed periodicity of the general form of the corona has received further confirmation by the recent observations. No unusual equatorial extension is shown on the excellent photographs taken by Sergeant Kearney, and none was observed by Lieut.-Commander Lang, who was specially looking for it. At Prof. Thorpe's suggestion Dr. Prout, the colonial surgeon at Bathurst, also erected a similar wooden disc, and his observations confirm those of Captain Lang. The prominences also follow the sun spots with regard to frequency, and, as already stated, a large number of them were seen. These are shown on Sergeant Kearney's photographs, and a complete record of the spectrum of each one is shown on the photographs taken by myself. The latter have the further advantage of showing the forms of the prominences as well as the spectra. Some of them chiefly show lines of hydrogen and calcium, while others again are almost crowded with lines of various metals. A complete record of the prominences has therefore been secured. With regard to the spectrum of the corona it seems doubtful at present whether our knowledge has made any great advance by the recent observations. The spectrum appears to have been very largely continuous, such as would be given by a mass of incandescent solid particles. One green line, which has previously been observed to be very prominent in the coronal spectrum, and the bright yellow line of the unknown substance, which is called helium, however, are shown in my photographs, and subsequent detailed examination may lead to the discovery of others. Lieut. Hill's photographs, which were specially exposed for the coronal spectrum, show a large proportion of continuous spectrum, and several lines which require further investigation. Much is to be hoped for, however, in another direction. The question of the constitution of the layers of the vapour which lie closest to the photosphere is one of the first importance to solar physicists. I had made arrangements to take two successive instantaneous spectrum photos as nearly as possible after the commencement of totality, but, as already stated, the opportunity was lost by reason of the lateness of the signal. The photos taken immediately after totality, however, promise to throw considerable light on the subject. Only two of these have been developed at present, and in addition to the ordinary spectrum of the uneclipsed part of the sun, they show large numbers of bright lines in the spectrum of those portions of the sun's atmosphere which were still left exposed by the moon. These, of course, also require a very detailed examination before any conclusion can be drawn. Of the thirty plates which I exposed only eleven have been developed so far, the facilities at Fundium not being very great. These were selected here and there from the whole series, and little doubt is entertained as to the good quality of the remaining plates. The photographic work was undertaken with the view of investigating the laws of variation in the brightness of the corona (1) according to the distance from the photosphere; (2) from one eclipse to another. Prof. Thorpe and Mr. Gray were successful in securing observations of the intensity of the light at sixteen different points of the corona, while Mr. Forbes made eleven measurements of the total light at as many different stages of the eclipse. All these observations were considered to be of a high degree of accuracy, but reduction to former standards and comparisons with measures at former eclipses have still to be made.

M. Deslandres' equipment consisted chiefly of spectroscopes of various forms, but in addition he was provided with instruments for photographing the eclipsed sun, one on a large and the other on a small scale. The haze somewhat interfered with his work, but he appears to have been fairly successful with such plates as were developed before the British expedition left.

The natives at Fundium were by no means alarmed during the eclipse, and there was fortunately no call for the guard of

bluejackets, which Captain Lang had taken the precaution to place in the immediate neighbourhood of the instruments; indeed both here and at Bathurst the natives were sufficiently well informed to watch the progress of the eclipse through smoked glass. The cause of the eclipse seems to have been ascribed to the Almighty, and not in any way associated with the presence of the astronomers. The members of the expedition themselves had no opportunity of studying the effect of the eclipse upon the brute creation, but trustworthy observers in Bathurst report that the usual state of alarm prevailed amongst fowls, cats, and other animals. Immediately after the eclipse the huts were partly dismantled, and the observers and their instruments were photographed by Prof. Thorpe, exactly as during the operations, the astonished natives meanwhile gathering in large numbers. After a short rest, the work of dismounting and packing the instruments was begun, and before sunset considerable progress had been made. By the evening of April 17, all was packed and safely aboard the *Alecto*, and the only material remnants of the expedition were waste paper and a slab of cement, prepared and inscribed by Lieutenant Hills, with the words, "British Eclipse Expedition, April 16, 1893." It is impossible to speak too highly of the assistance rendered to the expedition by the officers and men of the *Alecto*. As already stated, Lieutenant-Commander Lang made independent observations, with the assistance of Lieutenant Colbeck. Prof. Thorpe and Mr. Gray were assisted by Mr. Pym, and myself by Lieutenant Shipton and Chief Artificer Milligan, Lieutenant Hills by Dr. Moore, Sergeant Kearney by Sergeant Williams, and Mr. Collick and Mr. Forbes, by Mr. Willoughby, the engineer, and Mr. Murphy, one of the artificers.

The expedition left Fundium on April 18, and arrived at Bathurst on April 19, where H.M.S. *Blonde* was waiting under orders to convey the party to Grand Canary. Without this convenient arrangement, the expedition could not have left Bathurst before May 3 or 4. The homeward journey to England will be completed by a passage in the first available steamer.

THE ORIENTATION OF GREEK TEMPLES.[1]

THIS investigation is supplementary to Mr. Lockyer's examination of the orientation of the Egyptian temples, in the course of which he has cited passages translated from hieroglyphics, showing most distinctly that there was a connection between the foundation of those temples and certain stars. He has also shown that the structure of the temples demonstrates that the light from these stars must have been admitted at their rising or setting along the axis of the temples through the doorways, and that in certain temples the doorways have been altered in such a way as to follow the amplitude of the star as it changed, owing to the precession of the Equinoxes, and that in some cases a new temple had been founded alongside of an older one for the same purpose.

Although there does not seem to be any historical or epigraphical record of such a nature in Greece, the architectural evidence is not wanting. On the Acropolis of Athens there are two temples, both dedicated to Minerva, lying within a few yards of one another, both apparently oriented to the Pleiades, the older temple to an earlier position of the star group, and the other to a later one. At Rhamnus there are two temples almost touching one another, both following (and with accordant dates) the shifting places of Spica. In a temple at Ægina a doorway placed excentrically in the west wall of the cella was adapted for the observation of a setting star.

A clue is given for finding out the dates of the foundations of temples oriented to stars by means of the changes produced upon them by the precession of the Equinoxes; a movement which induces a divergence between the latitudes and longitudes of stars, and their places reckoned in declination and right ascension; so that after the lapse of 200 or 300 years a star which rose or set in the direction of the axis of a temple would have passed to a different amplitude, so as to be no more available for observation, as before, from the adytum.

In the earlier ages of Greek civilisation the only accurate measure of time by night was obtained by the rising or setting of stars, and these were more particularly observed when heliacal, or as nearly as possible to sunrise. For the purpose of temple worship, which was carried on almost exclusively at sunrise, the priests would naturally be very much dependent for their preparations on the heliacal stars as time warners.

The orientation of temples may be divided into two classes, solar and stellar. In the former the orientation lies within the solstitial limits; in the latter it exceeds them. In Greece there are comparatively few of the latter class.

In the lists of temples which follow, all the orientations were obtained from azimuths taken with a theodolite, either from the Sun or from the planet Venus. In almost every case two or more sights were observed, and occasionally also the performance of the instrument was tested by stars at night. The heights subtended by the visible horizon opposite to the axes of the temples were also observed.

The first list comprises twenty-seven intra-solstitial temples:

7	examples	from Athens.	1	example	from Sunium.
3	,,	Olympia.	1	,,	Corinth.
2	,,	Epidaurus.	1	,,	Bassæ.
2	,,	Rhamnus.	1	,,	Ephesus.
2	,,	Ægina.	1	,,	Platæa.
1	,,	Tegea.	1	,,	Lycosura.
1	,,	Nemea.	1	,,	Megalopolis.
1	,,	Corfu.	1	,,	Argos.

For all these the resulting solar and stellar elements are given, with the approximate dates of foundation, similarly to the following specimen, namely, that of the Temple of Jupiter at Olympia.

Olympia, lat. 37° 38′ *N.*

Temple of Jupiter	Orientation angle.		Stellar elements.	Solar elements.	Name of star.
	° ″ ′ 262 37 46	Amplitude, star or sun	° ′ ″ 8 38 0 N.	° ′ ″ 7 22 14 N.	
		Corresponding altitude	3 0 0 E.	1 42 0 E.	
		Declination	+8 40 0	+6 52 22	
		Hour angles	$6^h\ 11^m\ 37^s$	$7^h\ 34^m\ 52^s$	
		Depression of sun	...	14′ 12″	
		Right ascension	$23^h\ 40^m\ 0^s$	$1^h\ 3^m\ 5^s$	
		Approximate date	B.C. 740	Apr. 6.	

This example has been selected from the rest of the list because this temple has been chosen for the purpose of showing the method of procedure in working out the elements from the observations, those, namely, of the orientation angle, and of the height of the visible horizon.

A few general remarks, however, seem required respecting the Sun's and star's altitude, and the Sun's depression when the star is to be observed.

For a star to be seen heliacally, it is necessary that the Sun should be just sufficiently below the horizon for the star to be recognised. According to Biot, Ptolemy, speaking of Egypt, has recorded this to be about 11°. But where, as generally in Greece, there are mountains screening the glow which at such times skirts the true horizon, it seems fair at any rate for a first magnitude star to consider 10° as sufficient. I have myself seen Rigel in the same direction as the Sun when elevated 2° 40′ above the sea horizon, the Sun being less than 10° below. Obviously an observer looking from a dark chamber in a well known direction would be more favourably situated.

It is proper to allow about 3° of altitude for a star to be seen above low clouds and the hazy glow which skirts the horizon. The Sun's light, however,, seems to be very effective at a lower altitude, and when he appears over a mountain of 2° or 3° altitude the angle may properly be reduced by 20′ or 25′, partly for refraction, and partly because a small segment only of the disc is sufficient for illumination.

The method I have pursued in working out the example of the Temple of Jupiter at Olympia is as follows.

The orientation angle, measured from the south point round by way of west and north, is 262° 37′ 46″, which is equivalent to an amplitude of +7° 22′ 14″. The eastern mountain subtends an angle of 2° 4′. For reasons above given, the solar altitude

[1] Abstract of a paper (read before the Royal Society on April 27), "On the Results of an Examination of the Orientation of a number of Greek Temples, with a view to connect these Angles with the Amplitudes of certain Stars at the time these Temples were founded, and an endeavour to derive therefrom the Dates of their Foundation by consideration of the changes produced upon the Right Ascension and Declination of the Stars arising from the Precession of the Equinoxes." By F. C. Penrose, F.R.A.S. Communicated by Prof. J. Norman Lockyer, F.R.S.

may be taken as 1° 42′, but that of the star, 3°. Combining these values with the latitude, viz., 37° 38′, and using the formula

$$\sin \delta = \cos \text{zen. dist.} \times \cos \text{colat} + \sin \text{zen. dist.} \times \sin \text{colat} \times \sin \text{ampl.},$$

we obtain for the star a declination of +7° 40′, and for that of the Sun +6° 52′ 22″. This latter, with the ecliptic obliquity of about 800 years B.C., determines the Sun's right ascension to have been 1h. 3m. 15s.

The next step is to inquire if there be any bright star or star group which, at a date consistent with archæological possibility, would have had a declination near to the above-named place, and would also have been heliacal.

Such a star would have required about 6h. 8m. to pass from 3° altitude to the meridian, and it would have required to have been about 1¼h. in advance of the Sun to allow it to be seen. The approximate R.A. of such star would therefore be about 23h. 40m., and its declination, as already stated, must be about 7° 40′ N.

For trials I have used a stereographic projection of the sphere taken on the pole of the ecliptic, but showing also R.A. hours and parallels of declination. Any place on this projection may be chosen and marked on a superimposed sheet of tracing paper, and then if the tracing paper is turned round upon the pole of the ecliptic as a centre, so that the straight line drawn upon it, which in the first instance joined the two poles marked on the projection is carried round to an angle equal to the amount of precessional movement under consideration, if there be a suitable star marked on the projection the point selected for trial will pass over it or near it, and after the star has been thus roughly pointed out the more exact calculations may be proceeded with. By this process in the case before us the tracing-paper mark coincided almost exactly with the place of α Arietis, and for this star the particulars were carefully computed which have been given in the list of elements.

It should be noticed that there are in every case of intra-solstitial temples four possible solutions of this step. The Sun's amplitude may be due either to the vernal or the autumnal place, and the star might have been heliacal either at its rising or setting. In every instance all these four alternatives have been tried by the preliminary search method, and in every case in temples of old foundation an heliacal star has resulted from one or other of the trials, but never more than one.

The star which has been found as above for the Temple of Jupiter is no other than the brightest star of the first sign of the Zodiac, and therefore peculiarly suited to that god. The same star is connected with the early temple of Jupiter Olympius at Athens.

In intra-solstitial temples, by the nature of the case, the stars are almost entirely confined to the Zodiacal constellations, and consequently suitable stars are very much limited in number.

Another very great limitation arises from the consideration that, to have been of any service as a time warner, the star must have been heliacal, and when these two limitations are taken into account it becomes improbable to the greatest degree that there should always have been a suitable star unless it had been so arranged by the builders of the temple.

In about two-thirds of the cases which I have investigated the dates deduced from the orientations are clearly earlier than the architectural remains now visible above the ground. This is explained by the temples having been rebuilt upon old foundations, as may be seen in several cases which have been excavated, of which the archaic Temple of Minerva on the Acropolis of Athens and the Temple of Jupiter Olympius on a lower site are instances. There are temples also of a middle epoch, such as the examples at Corinth, Ægina, and the later temples at Argos and at Olympia (the Metroum at the last named), of which the orientation dates are quite consistent with what may be gathered from other sources.

Besides the list of intra-solstitial temples already given I have particulars of five for which I have been unable to find an heliacal star. They are all known to be of recent foundation, when other methods of measuring time had been discovered. The solar axial coincidences were no doubt in all these cases connected with the great festivals of these temples. It was clearly the case in two of them.

At the Theseum at Athens the date was either October 10 or March 2. The *Thesea* festival is reckoned to have been on October 8 or 9. For the later Erechtheum the day would have been April 8 or September 3. The great festival of this temple is put down for September 3.

Leaving the solar temples, we find that the star which was observed at the great Temple of Ceres must have been Sirius, not used, however, heliacally—although this temple is not extra solstitial—but for its own refulgence at midnight. The date so determined is quite consistent with the probable time of the foundation of the Eleusinian Mysteries and the time of year when at its rising it would have crossed the axis at midnight agrees exactly with that of the celebration of the Great Mysteries.

It is reasonable to suppose that when, as in the case of Sirius at Eleusis, brilliant stars were observed at night, the effect was enhanced by the priests by means of polished surfaces.

Herodotus, speaking of a temple at Tyre (B. II, 44), says:—"Καὶ ἐν αὐτῷ ἦσαν στῆλαι δύο, ἡ μὲν χρυσοῦ ἀπέφθου, ἡ δὲ σμαράγδου λίθου, λάμποντος τὰς νύκτας μέγαθος."

(Two shafts, one of pure gold, the other of emerald, which shone remarkably at night.)

Of a list of seven extra-solstitial temples which are named, five are more particularly noticed, viz. :—

A temple at Mycenæ and one near Thebes, which are built nearly north and south, but which probably, as was the case at Bassæ, had eastern doorways. The star, α Arietis, which suits the first, seems to point out the dedication of this temple to Jupiter. The other is very remarkable, and connects the Bœotian Thebes with the great Egyptian city; the star was γ Draconis. Thebes was called the City of the Dragon, and tradition records that Cadmus introduced both Phœnician and Egyptian worship. Three of the temples lay more nearly at an angle bisecting the cardinal points; these are Diana Propylæa at Eleusis, a small temple (not yet named) lately discovered at Athens, and the Temple of Venus at Ancona, recovered by means of the walls of a church built upon its traditional site. In these temples the star observed at the first seems to have been Capella, the time of the year when it shone axially at midnight agreeing with that of the celebration of the Little Mysteries, and in the other two the star was Arcturus.

EXPLORATIONS IN THE KARAKORAM.

MR. W. M. CONWAY gave an account of his recent exploring expedition in the Karakoram mountains at the last meeting of the Royal Geographical Society. The paper was illustrated by lantern slides, and a series of paintings by Mr. McCormick, who accompanied the expedition, was also exhibited. Mr. Conway said:—We left Srinagar on April 13, 1892, and came to Gilgit. Arrived at Gilgit we found the condition of the mountains, from a climber's point of view, too backward for our purposes. We therefore spent a month in mapping and exploring the fine Bagrot Valley, which slopes southwards from Rakipushi and its immediate neighbours along the main ridge. We hoped to be able to force a passage over this ridge into Nagyr; but the persistent bad weather baulked our efforts when they were on the point of succeeding. When the traveller has emerged from the inhospitable defiles which sunder the valley of Hunza Nagyr from Gilgit, and has climbed the vast ancient moraines near Tashot, which form the final rampart of the fertile basin (fertile, of course, only by reason of artificial irrigation of admirable complexity and completeness), he stands surrounded by an astonishing view. The bottom of the valley is, as usual, deeply filled by *débris*, whose surface is covered by terraced fields, faced with cyclopean masonry, and rich with growing crops and countless fruit trees. The mountains fling themselves aloft on either hand, with astounding precipitancy, as it were into the uttermost heights of heaven; so steeply, in fact, that a spring avalanche falling from the summit of Rakipushi on the south must almost reach the bottom of the valley. Rakipushi is 25,500 feet high; the Hunza peak is about 24,000 feet high. Their summits are separated by a distance of 19 miles. Both mountains are visible from base to summit at one and the same time from the level floor of the valley between them, which is not more than 7000 feet above the sea. No mountain view that I saw in the Karakorams surpasses this for grim wonder of colossal scale, combined with savage grandeur of form and contrast of smiling foreground.

Having been beaten back on June 24 from an attempt to

reach the Bagrot Pass from the north, we returned to Nagyr, and started inwards towards the wholly-unknown region. We left Nagyr behind on June 27, and in a mile or two came to the foot of the Hopar Glacier. This glacier was once joined by the Hispar Glacier, and their united moraines were deposited at Nagyr, the town being actually built upon their crest. Now the foot of the Hispar Glacier has retreated some twenty miles into the mountains. The Hopar Glacier is greatly shrunken in width, and in its shrinkage it has left a fine, almost level area, beside its left bank, which is covered by the fields of Hopar.

We were delighted to find an enormous and almost unsuspected series of glacier basins above Barpu. In order to get some idea of them we spent a day mounting to the crest of the ridge north of our camp, which divides Barpu from the Hispar Valley. The view was of peculiar interest to us, for we looked for the first time into the Hispar Valley and beheld the long avenue of peaks that lined the way up the Hispar Glacier towards the unknown snowy regions through which lay our intended route into Baltistan. We reached the summit of the Hispar Pass on July 18, and Askole on the 26th, our slow progress being caused by the exigencies of the survey in weather that was oftener bad than fair.

We left Askole on July 31 and returned to it again on September 5, the intervening time having been spent over our expedition up the Baltoro Glacier and the ascent of Crystal and Pioneer Peaks. On September 10 we embarked on a skin raft, which carried us down the Shigar River to the Indus. We landed, and in half an hour reached the scattered villages of Skardo, capital of Baltistan. Of our journey from Skardo to Leh to verify our instruments, and from Leh back to Srinagar, it is unnecessary to speak. We reached Abbottabad on October 28, exactly seven months from the day on which we left it.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—During this term Prof. Clifton is lecturing on the optical properties of crystals, and other lectures and practical instruction are given by Mr. Walker and Mr. White at the Museum, by Mr. Baynes at Christchurch, by Sir J. Conroy at Balliol, and Mr. F. J. Smith at Trinity. In chemistry, Mr. Fisher and Mr. Watts are lecturing on inorganic and organic chemistry respectively, and Messrs. V. H. Veley and J. E. Marsh are demonstrators at the Museum. Mr. Vernon Harcourt is lecturing on inorganic chemistry at Christchurch, and Mr. D. H. Nagel at Trinity.

The professor of geology announces a course of lectures on economic geology and geological excursions. Prof. Ray Lankester is giving two courses, on embryology, and on the protozoa, rotifera, and urochorda; and supplementary lectures are given by Dr. Benham, Mr. J. Barclay Thompson, Mr. Bourne, and Mr. Minchin.

Prof. Burdon Sanderson is lecturing on the central nervous system, and has the assistance of Dr. Haldane and Mr. Pembury.

Prof. Vines is lecturing on outlines of classification, and has appointed Mr. P. Groom, of Cambridge, as demonstrator.

At the end of last term a sum of £3500 was voted by Convocation towards the renewal of a portion of the buildings and hothouses in the Botanic Garden. Prof. Vines made a full report on the condition of the houses at the end of last year, showing that all were old, of faulty construction, and so dilapidated as to entail a heavy annual expenditure for repairs. At the same meeting of Convocation a sum of £1000 was placed to the credit of the delegates of the University Museum, to be employed at their discretion for the maintenance and improvement of the collections in the Museum.

At a meeting of the Ashmolean Society on Monday, May 1, under the presidency of Mr. E. B. Poulton, Prof. A. W. Rücker, F.R.S., gave an interesting lecture on the electrical conductivity of thin films, which was largely attended.

On the 16th inst. Lord Kelvin will give the annual Boyle lecture to the Junior Scientific Club, and on the 18th the Romanes lecture will be given in the Sheldonian theatre by the Right Hon. T. H. Huxley.

CAMBRIDGE.—The term for which Mr. J. Y. Buchanan, F.R.S., was appointed to the University Lectureship in Geography expires at the end of the present term. The Committee of Selection for the appointment of a Lecturer to hold office for the next five years, will meet at Gonville and Caius Lodge on May 31. The stipend of the Lecturer is £200 a year, and he is required to deliver courses of Lectures in Geography during two terms at least, and to give informal instruction and assistance to students attending his lectures, and to promote the study of his subject in the University. The retiring lecturer is re-eligible. Candidates are to send their names and testimonials to the Master of Gonville and Caius College, on or before May 27.

The first Arnold Gerstenberg Studentship, of the value of £90 a year for two years, will be competed for in May, 1894, by men or women who have obtained honours in either part of the Natural Science Tripos, and whose first term of residence was not earlier than the Easter term 1888. The subjects of examination are Logic and Psychology, and the successful candidate must undertake to pursue a course of philosophical study.

Applications for permission to occupy the University's tables at the Zoological stations of Naples and Plymouth are invited; they should be addressed to Prof. Newton, and reach him on or before May 25.

The names of Prof. John Couch Adams, and of William, seventh Duke of Devonshire, have been inserted in the list of Benefactors of the University, recited at the annual Commemoration Service.

The plans for the Sedgwick Memorial Museum of Geology, prepared by Mr. T. G. Jackson, A.R.A., were approved, by a large majority, in the Senate on Thursday last. The work of construction cannot however be begun until the finances of the University, which this year show a deficit of some £4000, are in a more satisfactory state. A proposal to raise funds, by increasing the capitation-fee paid by undergraduates from 17s. to 40s. a year, is now before the Senate.

Alfred Eichholz, B.A., first class in both parts of the Natural Science Tripos 1891–92, with distinction in physiology, has been elected to a Fellowship at Emmanuel College. Mr. Eichholz has already published papers of interest on physiological and anatomical subjects, and his election reflects great credit on his college.

SCIENTIFIC SERIAL.

Bulletin of the New York Mathematical Society, vol. ii. nos. 5, 6 (New York, 1893).—The earlier number opens with an account of the theory of substitutions (pp. 83–106), by Prof. Oskar Bolza. This is a warmly appreciative notice of Dr. F. N. Cole's translation of Netto's "Theory of Substitutions and its Applications to Algebra," to which attention has recently been drawn in our columns (see NATURE, pp. 338, 339).—Dr. M. Bôcher in a bit of mathematical history (pp. 107–109) calls attention to a remarkable memoir by Euler ("De motu Vibratorio Tympanorum," 1764).—No. 6 contains a paper read before the New York Mathematical Society by Dr. T. Craig on some of the developments in the theory of ordinary differential equations (pp. 119–134). This is likely to be useful to students. Another paper read before the same Society is one entitled "On a General Formula for the Expansion of Functions in Series," by Prof. Echols (pp. 135–144), which is intended to be a brief exposition of a general theorem which forms the basis of a series of papers on certain determinant forms and their applications.—A short note follows by Dr. E. McClintock on the early history of the non-euclidian geometry (pp. 144–147), in continuation and part correction of his previous note in No. 2 of this volume. It discusses the claim to priority, brought forward recently by Prof. Beltrami, of Saccheri (1733) in his "Euclides ab omni nævo Vindicatus" as against Lobatschewsky.—"Notes" and "new publications" complete each number.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 16.—"On a Portable Ophthalmometer." By Dr. Thomas Reid, Glasgow. Communicated by Lord Kelvin, P.R.S.

The object of this instrument is to measure the curvature of the central area of the cornea, the polar or optical zone, and as this polar zone is the part of the cornea utilised for distinct vision, the instrument furnishes all the data practically requisite for the diagnosis and measurement of corneal astigmatism. Its use

may be extended to the measurement of convex and concave reflecting surfaces within the limits of this instrument, *i.e.* from 6 to 10 mms. of radius.

The theory of its construction is based on a particular application of the following well-known optical law :—that when two centred optical systems are so combined that their principal foci coincide, the ratio of the size of the object to the size of the image formed by the combined systems is equal to the ratio of the principal foci of the two optical systems adjacent respectively to object and image. The two optical systems in this case are a convex lens and the cornea as a reflecting surface, the object being in the principal focus of the convex lens.

The instrument is composed of the following parts : an aplanatic lens of 26 mms. focus, a rectangular prism neutralised in the visual axis by a smaller prism, one side of the rectangular prism being adjacent to the lens and an iris diaphragm being opposite to the other side in the principal focus of the lens. Behind the prism is a telescope with a double image prism fixed in front of the object glass of the telescope, which has precisely the same focus as that of the aplanatic lens. Cross wires at its principal focus are viewed by a Ramsden eye-piece.

Before using the instrument it is essential that the cross wires should be distinctly seen at the punctum remotum of the observer. The adjusted instrument is held in the observer's left hand, which rests on the forehead of the patient, the diaphragm being directed to a luminous source to the right of the observer. When the observed eye is directed to the central or fixation point of the instrument, the image of the diaphragm in the cornea can only be distinctly seen, when the principal focus of the lens coincides with the principal focus of the cornea, the point of coincidence of the principal foci being found by moving the instrument to and fro. The image of the diaphragm by means of the double image prism appears as two images in the centre of the field, when the visual line of the observer's eye is perpendicular to the surface of the cornea, through which it passes. If these images are not seen in the centre, their position indicates the direction of the angle *a*. The size of the corneal image being constant (2 mms.) the images are brought into exact contact by suitable variations of the iris diaphragm. By using a circular object, the circular, elliptical or irregular form of the image reveals at once the condition of the surface. When the images are elliptical, the minor axes of the two images are to be brought into the same straight line by a rotation of the telescope, and similarly with the major axes.

Equal differences in the size of the diaphragm correspond to equal differences in dioptric power, each millimetre of difference in diameter corresponding to three dioptres. The amount of astigmatism in dioptres can thus be read off on a graduated scale fixed to the instrument.

This instrument reads certainly to within half a dioptre, which between 7 and 8 mms. of radius of curvature is equivalent to ·088 mms. of difference of radius.

April 20.—"The Potential of an Anchor Ring," by F. W. Dyson, Fellow of Trinity College, Cambridge, Isaac Newton student in the University of Cambridge. Communicated by Prof. J. J. Thomson, F.R.S.

This paper is a continuation of some researches on rings published in the Phil. Trans. 1893. A system of solutions of Laplace's equation applicable to space *inside* an anchor ring is found. By means of these and the value of the potential at external points found in the previous paper, the potential of a ring at internal points is found. The stability of the annular form of rotating gravitating fluid is discussed ; the ring form is shown to be stable for fluted and twisted disturbances, but unstable for long beaded ones. The potential of a ring of gravitating matter whose cross section is elliptic is obtained. Applying the result to Saturn's system, it is shown that for his ring to be continuous fluid its density would have to be 100 times that of the planet. The steady motion of a single vortex-ring of finite cross section in an infinite fluid is discussed, and also the motion of a number of vortex rings on the same axis. Numerical calculations are entered into for the particular cases of a vortex ring followed by another of equal strength, a vortex ring approaching an infinite plane, and one passing directly over a spherical obstacle.

Physical Society, April 28.—Prof. W. E. Ayrton, F.R.S., Past-President, in the chair.—Adjourned discussion on the viscosity of liquids, by Prof. J. Perry, J. Graham, and L. W. Heath. Prof. Perry read a communication he had received from Prof. Maurice Fitzgerald on the subject, in which the latter discusses the corrections necessary for reducing the results obtained by circular motion to the corresponding motion in plane layers. He shows that in addition to the circular motion, the effect is complicated by radial flow due to "centrifugal head," which causes the liquid to pass outwards near the bottom of the trough and inwards across the edge of the suspended cylinder, with continuations along the sides of the trough and cylinder. Taking this motion into account the formula $v = Ar^{1+\frac{c}{\mu}} + \frac{B}{r}$ is deduced, where v is the velocity, μ the viscosity, A and B arbitrary constants, and c a constant depending on the radial flow. When $c = 0$ the formula reduces to equation (5) of the paper, whilst if $c = -2\mu$ it becomes $v = \frac{C}{r}$. The subject of critical velocities in non-turbulent motion is referred to, and some probable effects of the anomalous variations of density and viscosity of sperm oil noticed by the authors of the paper are pointed out. Prof. Perry, in further reply to Prof. Osborne Reynolds' comments, said he understood Prof. Reynolds to have proved that friction was proportional to velocity when the motion was steady. Experiments he (Prof. Perry) had made with discs of iron and glass in revolving mercury seemed to show that this was not the case. On replacing the mercury by sperm oil he found that up to a certain speed friction was strictly proportional to velocity, whilst above that speed friction varied as $v^{1\cdot25}$. Coloured streaks in the liquid remained unbroken even at the highest speeds. He therefore concluded that continuity of the streaks was not necessarily accompanied by a linear law of friction.—Mr. E. C. Rimington read a paper on luminous discharges in electrodeless vacuum tubes. The luminous rings produced in exhausted bulbs and tubes by discharging Leyden jars through coils surrounding them, had, he said, been attributed by Mr. Tesla (*Elec. Eng. of New York*, July 1, 1891) to the electrostatic action of the surrounding wire rather than to the rapidly varying magnetic induction through the rarefied gas. The present paper describes several experiments bearing on this point which lead the author to conclude that varying magnetic induction is the chief cause of the luminous rings. They also show that a superposed electrostatic field greatly assists the production of the luminosity. Most of the experiments described were performed before the meeting, some of the effects being particularly brilliant. In one experiment an exhausted bulb was placed within a coil connecting the outside coatings of two Leyden jars and placed between two metal plates, which could be connected at will with the outside of either jar. The spark gap between the inner coatings was then arranged so that no luminosity was seen in the bulb. On connecting one or both the metal plates with the jars in such a way as to increase the electrostatic field through the bulb, bright rings immediately appeared. An electrostatic field produced by a small induction coil connected to a piece of tin-foil on the bulb caused the rings to form at irregular intervals when the discharge of the jars and coil happened to be properly timed. In another experiment two loops of wire in series were used, and when put on the bulb in such a way as to produce a large magnetic effect but small electrostatic field, bright rings appeared, but if the magnetic effects of the coils opposed each other, whilst the electrostatic field was increased, no rings were seen. The subject is treated mathematically at some length in the paper, the times at which the maximum values of the current, the potential difference between the outside of the jars and the rate of change of current occur, as well as the values of their successive maxima being determined. The influence of size of jars is next considered, and the time-integral of rate of change of current on which the effect on the eye depends, expressed as a geometrical series. Taking an approximation the author shows that the time-integral is roughly proportional to the fourth root of the capacity. Large jars are therefore theoretically only slightly better than small ones, and this agrees with observation. On the subject of apparently unclosed discharges, such as are seen when discharges pass through a coarse spiral wound on an exhausted tube, the author said he had observed that the discharges were really closed, but the return part much diffused and of feeble intensity. Experiments were exhibited showing that under some circumstances an exhausted bulb acted like a closed metallic circuit, whilst under other conditions dissimilar effects were produced. Another experiment was shown in which a faint luminous ring, produced by a single turn of insulated wire round a bulb, was

apparently repelled on touching the wire with the finger. The author also showed that fan-shaped luminosities could be produced by rotating an exhausted tube in the electrostatic field produced by a charged ebonite or glass rod. Dr. Sumpner, speaking of the apparently unclosed discharges, pointed out that they might be closed through the wire forming the primary circuit, in the same way as the coil of a transformer might be arranged to act partly as primary and partly as secondary. Mr. A. P. Trotter, after referring to Dr. Bottomley's researches, said it was important in discussing such experiments to distinguish between electrostatic and electromagnetic effects. In Mr. Campbell Swinton's experiments the luminosity always appeared to get as far away from the wire as possible and to be at right angles to it, whereas in Mr. Rimington's the luminous portions were close to the wire. With a view to puzzling the discharge in Mr. Swinton's tubes he had made a right-angled bend in the spiral surrounding the tube, the result of which was to make the luminosity discontinuous, one end of the break being bifurcated. In all Mr. Swinton's experiments brush discharges surrounded the wire. Prof. S. P. Thompson thought an electrostatic field would aid a discharge even if its direction was not the same as the E.M.F. due to varying magnetic induction. Planté had found that vacuum tubes through which 800 cells were insufficient to produce a discharge, immediately allowed a discharge to pass when a rubbed ebonite rod was brought within about 10 feet distance. This effect was found to be independent of the direction of the disturbing field. Analogous effects had also been observed by Prof. Schuster, and described in his Bakerian lecture. Mr. E. W. Smith regarded the stresses set up in the medium as cumulative, a very slight cause acting on a substance already strained nearly to breaking point, being sufficient to cause breakdown. Mr. Blakesley inquired if the effects were the same if the induction coil, used in one of the experiments, was replaced by an electric machine, and whether the direction of the field so produced influenced the result. Mr. W. R. Pidgeon said closed circuits were necessary, and he had found it very difficult to produce discharges in tubes unless the ends of the primary wire were brought together. In his reply Mr. Rimington said each turn of the luminous spiral formed a complete circuit of itself. The phenomena observed by Mr. Campbell Swinton were quite different to those he had shown, and due to different causes. Mr. Swinton's spirals were reversed, and were due to phosphorescence of the glass.

Zoological Society, April 18.—Sir W. H. Flower, F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the Society's menagerie during the month of March, and called special attention to three White-tailed Gnus (*Connochætes gnu*) from the Transvaal (a male and two females), obtained by purchase March 7, and to three Springboks (*Gazella euchore*) from South Africa, deposited by H.R.H. the Prince of Wales.—Mr. Sclater exhibited and made remarks on a specimen of a curious variety of the Pig-tailed Monkey (*Macacus nemestrinus*) from the Baram River, Sarawak, lately living in the Society's menagerie.—Mr. Sclater read a communication received from General Sir Lothian Nicholson, Governor of Gibraltar, respecting the Barbary Apes (*Macacus inuus*) living on the Rock of Gibraltar, which were stated to have increased of late years, and were now supposed to be nearly sixty in number.—Mr. W. L. Sclater made some remarks on the principal animals noted in the Zoological Gardens of Antwerp and Amsterdam, which he had lately visited.—A communication was read from Mr. A. E. Shipley containing an account of the anatomy and histology of two Gephyrean worms of the genus *Sipunculus* from Zanzibar, together with a few observations on Sipunculids in general.—Mr. Oldfield Thomas gave an account of a small collection of Mammals obtained in Central Peru by Mr. J. Kalinowski. Amongst several species represented in this collection, either new or of such interest as to deserve a record was especially noted a new form of Rodents of the family, Muridæ, proposed to be called *Ichthyomys stolzmanni*.—Mr. H. J. Elwes read a communication from Mr. W. Warren describing a large number of new species and new genera of Moths of the family Geometridæ in Mr. Elwes's collection, from Sikkim and other districts of India. Notes on the localities and on other points were added by Mr. Elwes.

Geological Society, April 26.—W. H. Hudleston, F.R.S., President, in the Chair.—The following communications were read:—The origin of the crystalline schists of the Malvern Hills, by Dr. Charles Callaway. This paper was the third of a series of three. In the first of these, published in the *Quarterly Journal* in 1887, the author contended that many of the gneisses and schists of Malvern were formed out of igneous rocks. In the second, which appeared in the Journal in 1889, he discussed the origin of secondary minerals at shear-zones in the Malvern rocks, and arrived at the conclusion that all the mica and much of the felspar, to say nothing of quartz and other minerals, were of secondary origin. In the present paper the author first pointed out that some of the most important mineral changes described in his second communication—such, for example, as the conversion of chlorite into biotite—had since been confirmed by independent investigators. He held that, as a whole, the gneisses and schists of Malvern had been formed by the crushing and shearing of consolidated igneous rocks; but he did not deny the possibility that here and there the foliated structure might have been produced in a fused mass. In the first stage of metamorphism the diorite or granite was crushed and decomposed. This slightly compressed rock could be traced step by step into a typical gneiss or schist. The signs of pressure progressively increased, and the mineral and chemical changes became proportionately greater. Reconstruction set in. The process of metamorphism did not always follow the same lines. Felspar was sometimes crushed into seams of fragments, and these, by partial re-fusion and pressure, were converted into gneissose lenticles of quartz and felspar. Intervening chlorite was changed to biotite, or even to muscovite or sericite. Thus a typical gneiss, consisting of quartz-felspar lenticles in a felt-work of mica, was formed out of a diorite. Sometimes the felspar was reconstituted without becoming fragmental; and it was then deposited on, or it included, idiomorphic mica. Or a soda-lime felspar might, by a process of corrosion, be converted into quartz, or a soda-felspar, or both. In an early stage of metamorphism, the rock was often dirty and rotten through the abundance of chlorite and disseminated iron oxide. The former being changed to mica, and the latter being either absorbed in the production of biotite, or reconstituted in a crystalline form, a sound clear gneiss was the result. In the completed product, the signs of crushing and shearing were often entirely wanting. Even strain-shadows were rare in it. The metamorphism, however, was demonstrated in numerous localities by tracing the gradations inch by inch, and by the subsequent study of large numbers of microscopic slides, in which the transition was still more clearly seen than in the field. The classification of the Malvern schists originally proposed was somewhat enlarged, the injection-schists being subdivided into —(1) Schists of primary injection, in which one rock was injected into another, and (2) Schists of secondary injection, formed by the infiltration of secondary minerals along shear-planes. One of the most important of the chemical changes produced in the conversion of a diorite into an acidic schist was the elimination of magnesia. This was proved by analysis. The recent researches of Mr. Alexander Johnstone had shown that even in the laboratory, and at the ordinary temperatures, carbonated waters were able to remove magnesia from certain of its combinations with silica. The reading of this paper was followed by a discussion, in which the President, Prof. Bonney, Mr. Harker, Mr. Rutley, Prof. Hull, and the author took part.—Supplementary notes on the metamorphic rocks around the Shap Granite by Alfred Harker, and J. E. Marr, F.R.S. This paper contains some additions and corrections to the work submitted to the Society by the authors on a previous occasion (see *Quart. Journ. Geol. Soc.* vol. xlvii. p. 266). In the present communication special attention is paid to the alteration of a group of basic volcanic rocks by the granite. Some remarks were made on this paper by the President, Mr. Rutley, Mr. Teall. Mr. Harker and Mr. Marr replied.

Linnean Society, May 4.—Prof. Stewart, President, in the chair.—Dr. R. B. Sharpe exhibited some new and rare birds from Borneo, and made remarks upon the singular distribution of the genera to which they belonged. On behalf of Miss E. M. Sharpe he also exhibited both sexes of the larvæ and cocoons of a rare silkworm moth, *Gonometa fascia* from Lagos. Prof. J. B. Farmer exhibited under the microscope some preparations showing attraction spheres in Hepatic spores, and gave the result of his recent researches on the subject.—Mr. Thomas Christy exhibited some curious variations in foliage in plants of a *Sterculia* from Brazil, reared from the same pod, and showed also a specimen of *Erythroxylon Coca* in fruit.—Mr. W. B. Hemsley showed two British plants which were interesting on account of the localities, namely *Empetrum nigrum*

from Dorset (where Mr. C. B. Clarke had seen it growing on Poole Harbour Spit though it had not been included hitherto in the county flora), and *Scilla nutans* with prolonged bracts, usually regarded as an introduced garden form, which had been found growing apparently wild in a wood near Ashford, Kent. —Mr. Alfred Sanders then read a paper on the nervous system of *Myxine glutinosa*, a fish allied to the Lampreys.

DUBLIN.

Royal Dublin Society, April 19.—Prof. A. A. Rambaut, Astronomer Royal for Ireland, in the chair.—Dr. J. Joly, F.R.S., described a method of detecting the existence of variable stars by continuous photometric observations from night to night on groups of stars, by receiving the image of the group upon a photographic plate having a slow eccentric circular motion within the telescope, so that the images of the individual stars appear as circular traces upon the plate. Variations in the intensity of any trace, not common to all the linear images, indicate a variability of luminosity in the particular star describing the trace.—Prof. A. A. Rambaut read a paper on the distortion of photographic star images due to refraction.—The usual formulæ of refraction by which the relative position of one star with regard to another may be corrected for this effect, such as those published lately by the author in the *Astronomische Nachrichten*, No. 3125, are strictly applicable only to one definite instant of time. It is possible to keep only one star absolutely fixed on the plate by means of the slow motions in R.A. and declination, and the changes in the amount of the differential refraction will cause any other star to alter its position on the plate if the exposure is continued for any considerable time. The effect of this change is that all stars on the plate, except that used to guide by, are more or less distorted. The paper contains tables giving the amount by which the refraction changes at various declinations and hour angles, and from these the amount by which a star image on the plate is distorted in passing from any hour angle to any other can be readily computed. For instance, it is shown that an equatorial star whose distance and position angle from the guiding star are 1400″ and 45° would, in passing from an hour angle of 4h. to one of 5h., be distorted in R.A. by 5″·86 and in declination by 7″·98. It appears, however, that if the zenith distance does not exceed 60° and the exposure is limited to a quarter of an hour, the distortion will not exceed 0″·2, and that if the corrections are computed for the middle of the exposure and the measures made from the middle of the slightly distorted image no error will arise.—Prof. T. Johnson, exhibited *Gomontia polyrhiza*, Born. et Flah., a green alga, perforating the shells of various molluscs. Specimens were collected at different localities on the west and east coasts of Ireland; Galway (April, 1891) being the first locality in which the plant was observed.

PARIS.

Academy of Sciences, May 1.—M. Loewy in the chair.—The motion of liquids studied by chronophotography, by M. Marey. The water whose motion was to be studied was contained in a long tank bent into an elliptic shape and returning upon itself. One of the branches had both sides closed by panes of plate-glass, behind which was placed a screen of black velvet. A centimetre scale was fixed to the inner pane, and the tank was illuminated by sunlight reflected from below. The camera was placed at a distance in front of the glass, screens being arranged so as to keep off all light except that coming from the water. When the water was clear, the only thing photographed was the meniscus formed by its surface against the glass, which appeared as a bright straight line. When the surface was disturbed by waves, the nature of the disturbance was indicated by the successive shapes assumed by the meniscus. To study the internal motions of the liquid, small globules were constructed of wax and resin, silvered like certain pills, and so proportioned as to be slightly heavier than water, so that they could be made to float in neutral equilibrium by adding salt water. Stationary waves were then produced by rapidly changing the immersion of a solid cylinder on the opposite side of the tank, when the meniscus was thrown into the species of trochoidal curve already deduced from hydrodynamical theory. This curve appears in the photographs in great perfection. A wave of translation was also photographed fourteen times per second, and its velocity, as calculated by the scale, was 2·24 m. per second. Streams and eddies were also produced in the tank, and traced by means of the bright balls. On letting the water flow past an obstacle in the form of a fish, more obtuse on one side than on the other, it was proved that no perceptible eddies were formed if the water first encountered the obtuse side, but that it was greatly disturbed if the acute end was presented to the stream.—Determination of the specific heat of boron, by MM. Henri Moissan and Henri Gautier.—On mineral phosphates of animal origin, and on a new type of phosphorites, by M. Armand Gautier.—On the sanitary system adopted by the Dresden Conference for establishing common measures to safeguard the public health in times of epidemic cholera, without placing useless obstacles in the way of commercial transactions or the movements of travellers, by M. Bronardel.—Observations of the comets, Brooks (1892, VI.), Holmes (1892, III.), and Brooks (1893, I.), made with the great equatorial of Bordeaux, by MM. G. Razet, L. Picart, and F. Courty.—On a general case where the problem of the rotation of a solid body admits of uniform integrals, by M. Hugo Gyldén.—On the displacement of the temperature of maximum density of water by pressure, and the return to the ordinary laws under the influence of pressure and temperature, by M. E. H. Amagat.—Researches to establish the bases of a new method of recognising the adulteration of butter by margarine employed either singly or mixed with other fatty materials of vegetable or animal origin, by M. A. Houzeau.—Observation of the solar eclipse of April 16, 1893, at the observatory of the Société Scientifique Flammarion at Marseilles, by M Léotard.—On a class of differential equations, by M. Vessiot.—On the structure of finite and continuous groups, by M. Cartan.—On the ordinary differential equations which possess a fundamental system of integrals, by M. A. Guldberg.—On the reduction of the problem of tantochronics to the integration of a partial differential equation of the first order and the second degree, by M. G. Kœnigs.—On the densities and molecular volumes of chlorine and of hydrochloric acid, by M. A. Leduc.—On the diminution of the coefficient of expansion of glass, by M. L. C. Baudin.—On the systems of dimensions of electrical units, by M. E. Mercadier.—On the influence of longitudinal magnetisation upon the electromotive form of a copper-iron couple, by M. Chassagny.—Optical phenomena presented by secondary wood in thin sections, by M. Constant Houlbert.—Decomposition of oxalic acid by the ferric salts under the influence of heat, by M. George Lemoine.—Contribution to the study of the Leclanché cell, by M. A. Ditte. On the fluorides of the alkaline earths, by M. C. Poulenc.—On the quantitative determination of phosphoric acid, by MM. A. Villers and Fr. Borg.—On licarene derived from licareol, by M. Ph. Barbier.—On a vegetable nucleine, by M. P. Petit. On an earthquake shock felt at Grenoble on April 8, by M. Kilian.—The month of April, 1893, by M. E. Renou.—On the emission of a sugar-containing liquid by the green parts of the orange-tree, by M. E. Guinier.—On a new genus of conifers found in the Albian of the Argonne, by M. Paul Fliche.—Discovery of two skeletons at Villejuif and at Thiais, their age and ethnic character, by M. Zaborowski.—Periodic form of the doriferous power in the fatty series, by M. Jacques Passy.—Researches on the employment of tree leaves in the feeding of cattle, by M. A. Ch. Girard.

BERLIN.

Physiological Society, April 7.—Prof. du Bois Reymond, President, in the chair.—Dr. Engel gave an account of the outcome of his researches on the development of blood corpuscles. By using appropriate staining reagents, and fixation of the corpuscles by drying, he had found, in the embryos of mice in various stages of development and in leukhæmic children, that at first spheroidal nucleated cells make their appearance, metrocytes, which subsequently divide karyokinetically into daughter-metrocytes. From the latter some non-nucleated cells containing hæmoglobin are developed, as also some red-coloured cells, from which are then formed the red corpuscles, the nucleated white corpuscles and platelets. In the discussion which ensued Prof. Ehrlich confirmed the above results from personal observations, but regarded the origin of white blood-corpuscles from the red cells as not yet definitely established. Prof. Kossel spoke on a new saccharine substance called Dulcin, describing its chemical constitution and its effect on rabbits and dogs. Dulcin is two hundred times as sweet as sugar. Rabbits were unaffected by daily doses of 2 grm. (= 400 grm. sugar), but dogs were found to lose their appetite by prolonged taking of the above dose, recovering it soon when the drug was no longer administered. Prof. Ewald had tried the effect of dulcin upon both

healthy and sick people, observing no ill effect with doses equal to the amount of sugar ordinarily consumed. Prof. Heymans, of Ghent, reported that employing Golgi's method he had observed numerous branching nerves in the muscles of the wall of the cardiac ventricle, and particularly in the apex of the heart. Dr. Lilienfeld had studied the relationship of cell-elements to certain colouring matters, and exhibited a mixture of the latter, which appeared of an equally brownish-violet colour, both in aqueous and alcoholic solution. On shaking up in this crystals of nucleinic acid, the chief constituent of the nucleus, they were at once coloured bright green, whereas white of egg assumed an intense red colour.

April 21.—Prof. du Bois Reymond, President, in the chair.—Dr. Goldscheider reported upon experiments on the sense of touch in the blind, as made by Hocheisen on eight individuals, of whom some were born blind, while others became blind in early youth. The results obtained showed that the muscular sense of the blind is far more acute than of those who can see, being more acute in the youthful blind than in those who are older; in the latter the sense is scarcely more acute than that of those who can see. Similarly the power of localising was more acute in the young than in those who are older, and did not differ appreciably from that of those who can see. By practice both the above senses can be so sharpened in those who possess sight that they are ultimately as acute as for the blind.—M. Krüger spoke on the chemical constitution of adenin and hypoxanthin, and described the reactions which led to the establishing of their constitutional formulæ.

Physical Society, April 28.—Prof. Kundt, President, in the chair.—Prof. Neesen spoke on a new mercurial pump he had constructed on the principle of a Sprengel pump. Dr. Fröhlich developed his views on the theory of the electromagnet, which by bringing Hopkinson's theory into accord with conceptions of magnetic resistance and ideas on saturation had led to a considerable advance in generalisation. The discussion which ensued was chiefly taken up by Dr. Du Bois, who urged that the views propounded were rather of technical than scientific interest.

[*Note.*—In the report of the Physical Society (see NATURE, April 27, p. 624), in line five from the top, for "pressure" read "thickness," and in line six from the bottom for "Wren" read "Wien."]

DIARY OF SOCIETIES.

LONDON.

THURSDAY, MAY 11.

MATHEMATICAL SOCIETY, at 8.—On some Formulæ of Codazzi and Weingarten in Relation to the Application of Surfaces to each other: Prof. Cayley, F.R.S.—On the Expansion of Certain Infinite Products: Prof. L. J. Rogers.—A Theorem for Bicircular Quartic Curves and for Cyclides Analogous to Ivory's Theorem for Curves and Surfaces of the Second Degree: A. L. Dixon.—On the Linear Transformations between Two Quadrics: H. Taber.—The Collapse of Boiler-flues: A. E. H. Lowe.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—On the Prevention of Sparking, Compound Dynamos without Series Coils or Magnets; and Self-exciting Dnamos and Motors without Winding upon Field Magnets: W. B. Sayers.

ROYAL INSTITUTION, at 3.—The Atmosphere: Prof. Dewar, F.R.S.

FRIDAY, MAY 12.

PHYSICAL SOCIETY, at 5.—The Drawing of Curves from their Curvature: C. V. Boys, F.R.S.—The Foundations of Dynamics: Oliver Lodge, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 8.

ROYAL INSTITUTION, at 9.—Isoperimetrical Problems: Lord Kelvin, Pres.R.S.

AMATEUR SCIENTIFIC SOCIETY, at 8.—Geological Time (with Special Reference to Mr. Mellard Reade's Paper in the *Geological Magazine* for March): W. H. Davis.

SATURDAY, MAY 13.

ROYAL BOTANIC SOCIETY, at 3.45.

ROYAL INSTITUTION, at 3.—Johnson and Swift: Dr. Henry Craik, C.B.

TUESDAY, MAY 16.

ZOOLOGICAL SOCIETY, at 8.30.—On the Atrium and Prostate of the Oligochætous Worms: F. E. Beddard, F.R.S.—Descriptions of Fifteen New Species of Pleurotomidæ: G. B. Sowerby.—List of Mammals inhabiting the Bornean Group of Islands: A. H. Everett.—On a Second Collection of Mammals sent by Mr. H. H. Johnston, C.B., from Nyassaland: O. Thomas.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Monthly Ballot for Members.—Reception by the President and Council.—Wreck-raising in the River Thames: C. J. More.

ROYAL INSTITUTION, at 3.—Modern Society in China: Prof. R. K. Douglas.

WEDNESDAY, MAY 17.

ROYAL METEOROLOGICAL SOCIETY, at 7.—Mean Daily Maximum and Minimum Temperature at the Royal Observatory, Greenwich, on the Average of the Fifty Years from 1841 to 1890: William Ellis.—Suggestions, from a Practical Point of View, for a New Classification of Cloud Forms: Frederic Gaster.—Notes on Winter: Alex. B. MacDowall.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Exhibition with the Projection Microscope: Sir David L. Salomons.—Notes on Rotifers: C. Rousselet.

THURSDAY, MAY 18.

ROYAL SOCIETY, at 4.30.

CHEMICAL SOCIETY, at 8.—Observations on the Production of Ozone during Electric Discharge through Oxygen: W. A. Shenstone and M. Priest.—The Relative Strengths or Avidities of some Weak Acids: Dr. Shields.—The Boiling Points of Homologous Compounds, Part I.: Dr. James Walker.

ROYAL INSTITUTION, at 3.—The Geographical Distribution of Birds: Dr. R. Bowdler Sharpe.

FRIDAY, MAY 19.

ROYAL INSTITUTION, at 9.—Poetry and Pessimism: Alfred Austin.

SATURDAY, MAY 20.

ROYAL INSTITUTION, at 3.—Johnson and Wesley: Dr. Henry Craik, C.B.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Future of British Agriculture: Prof. Sheldon (W. H. Allen).—The Nests and Eggs of British Birds: C. Dixon (Chapman and Hall).—Theorie der Optischen Instrumente: Dr. S. Czapski (Breslau, Trewendt).—Practical Astronomy, 2nd edition: P. S. Michie and F. S. Harlow (K. Paul).—An Analytical Index to the Works of the late John Gould, F.R.S.: Dr. R. B. Sharpe (Sotheran).—The New Technical Educator, vol. 1 (Cassell)

PAMPHLETS.—Determinations of Gravity with Half-second Pendulums on the Pacific Coast, in Alaska, and at Washington, D.C., and Hoboken, N.J.: T. C. Mendenhall (Washington).—The Photoscope (Liverpool, Sanders).

SERIALS.—Medical Magazine, May (Southwood).—Quarterly Journal of the Geological Society, vol. xlix. Part 2, No. 194 (Longmans).—Journal and Proceedings of the Royal Society of New South Wales, vol. xxvi. (K. Paul).—Verhandelingen der Koninklijke Akademie van Wetenschappen te Amsterdam, Erste Sectie, Deel. 1, Nos. 1, 2, 4, 5, 6; Tweede Sectie, Deel. 1, Nos. 1, 4, 10 (Amsterdam, J. Müller).—Journal of the Chemical Society, May (Gurney and Jackson)—Proceedings of the Royal Society of Edinburgh, vol. xix. pp. 193–295 (Edinburgh).—Himmel und Erde, May (Berlin, Paetel).—Jahrbuch der k.k. Geologischen Reichsanstalt, Jahrg. 1892, xlii. Band 3 and 4 Heft (Wien).—Journal of the Scottish Meteorological Society, third series, No, ix. (Blackwood).—Proceedings of the American Academy of Arts and Sciences, new series, vol. xix. (Boston, Wilson).—Report of the Marlborough College Natural History Society, No. 41 (Marlborough).

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