THURSDAY, JUNE 22, 1899.

THE EXPERIENCES OF A ZOOLOGIST IN AUSTRALASIA.

In the Australian Bush, and on the Coast of the Coral Sea: being the Experiences and Observations of a Naturalist in Australia, New Guinea, and the Moluccas. By Richard Semon. With 86 illustrations and 4 maps. Pp. xv + 552. (London: Macmillan and Co., Ltd., 1899.)

ZOOLOGISTS have during the past few years reaped the benefit of Dr. Semon's travels in Australasia and in the Malayan Archipelago in the beautifully illustrated series of memoirs entitled "Semon, Zoologische Forschungsreisen in Australien und dem Malayishen Archipel," and published as part of the *Jena Denkschriften.* Five quarto volumes have already been published, running to some 1600 pp. and 113 plates, many of which are coloured. They contain memoirs on Ceratodus, Monotremes, Marsupials, Manis, the Dugong and other vertebrates, as well as important communications on various invertebrates; most of these have been contributed by well-known European specialists, Dr. Semon himself being responsible for the monographs on the development of Ceratodus, and of the Monotremes and Marsupials.

The large collections made by Dr. Semon having been carefully conserved, they have contributed considerably to our knowledge of tropical life from an anatomical as well as from a faunistic point of view.

On glancing over this monumental series of memoirs one is struck by the amazing activity of Dr. Semon both in the field and in the laboratory, and all zoologists must once more feel grateful to Dr. Paul von Ritter for his princely liberality in the cause of science.

But Dr. Semon has given us further cause for gratitude, as he has narrated his varied experiences of travel, and has recorded numerous observations on the habits of animals that would either have been unrecorded or buried in the obscurity of a technical treatise. More than this, Dr. Semon is not tainted with that half-cynical *fin-de-siècle* spirit which is too rife at present even amongst scientific men. There are men who appear to be ashamed of the interest they take in their own work, and who freeze younger men with a smile. The author of "In the Australian Bush," on the contrary, is not only a trained laboratory student, but he is a field naturalist as well. He revels in the varied aspects of nature, whether it be the monotonous Australian bush or a glorious tropical jungle, and he is not ashamed to let the reader share his joy and enthusiasm.

Dr. Semon left Europe in the summer of 1891 (in the preface it is 1892) for the purpose of collecting embryological material of the more interesting Australasian animals, and proceeded at once to the Burnett River; for it is only in the river systems of the Burnett and the Mary in South Queensland (latitude 25° to 26° S.) that the unique Ceratodus lives. This restriction of habitat is due to its avoidance of river heads, so that it cannot get conveyed by floods across a watershed; its being easily affected by sea-water, so that migration through the mouths of streams is impracticable; and to the eggs being so frail and tender that they cannot bear the most transient drying. Its survival in the Burnett and Mary Rivers is probably owing to some particularly extensive water-holes; should these ever dry up, this remarkable "living fossil" would become extinct. The fish is perfectly helpless out of the water, which it never leaves; neither does it form a cocoon, or indulge in a summer sleep like its African cousin Protopterus. The lungs enable it, by respiring air, to exist in the dry season in water-holes that are crowded with refugees from the river, and which soon become putrid by rotting animal and vegetable substances. Dr. Semon was greatly hindered in his collecting of embryological material by heavy floods, so he returned the following season, and was rewarded by obtaining a complete series of eggs and larvæ.

Of the habits of the Platypus (Ornithorhynchus), and especially of the Echidna, we have several interesting observations. A considerable number of eggs and embryos were obtained, and as much adult material as Dr. Semon cared to preserve. As the book is not intended for specialists, the author gives only sufficient anatomical information to enable the reader to appreciate the importance of his investigations, and all through the book we have short expositions of local problems of the geographical distribution of animals, which should enable the non-scientific reader to appreciate the chief reason why field-naturalists make such large collections.

Although most of Dr. Semon's investigations were concerned with land animals, he did some marine work in the Moluccas, where he went on a fruitless quest for the eggs of the nautilus during the months of January and February (1893). When at Ambon (the Amboyna of the Portuguese) he found that the nautilus is very rarely caught during the north-west monsoon, but that it was not unfrequently found during the south-east trade-wind. Two other instances have been observed by Dr. Semon of a periodical migration of marine animals from deep to shallow water for the purpose of depositing their eggs. The first was at Heligoland, in the case of the common starfish (*Asterias rubens*); the second was at Ambon, where the brilliantly coloured, flexible sea-urchin (*Asthenosoma urens*) wanders into shallow water only during the south-east monsoon. Interesting observations are recorded of the means by which sea-urchins are protected against the attack of certain rapacious marine snails that can spurt free sulphuric acid from their mouths in order to dissolve the calcareous spines and shells of these armoured echinoderms.

The natives of the various countries which Dr. Semon visited also attracted his attention, and he has given us his impressions in a pleasant manner; but he is less trustworthy when he passes from his own observations to general statements. For example, he says, "by far the most of the Queensland and New South Wales tribes are entirely devoid of religion" (p. 223). On the preceding page he asks, "Can one speak of religion to a people whose language possesses hardly any words for abstract expressions, and who have no sort of worship for any supernatural being, idolatry, sacrifice, and prayer being things unknown throughout Australia?" Worship of a supreme being, idolatry, and sacrifice may be unknown in Australia; but Howitt wrote fifteen years ago (*Journ. Anth. Inst.*, xiii. p. 459), "I venture to assert that it can no longer be maintained that they have no belief which can be called religious." It is probably more correct to say that religion is intimately connected with nearly every act of the daily life of the Australian aborigine than to deny its existence.

While Dr. Semon gives a vivid account of the natives on the coast of British New Guinea from Yule Island to South Cape, he inadvertently falls into a few errors. It is true that the cranium of the Papuan is decidedly dolichocephalous in certain regions, but along the coast visited by Dr. Semon brachycephalism is almost as common as the other extreme. On more than one occasion the petticoats of the women are said to be made of coco-nut fibre, whereas this is never employed; the shredded leaf of the sago palm, however, is a very favourite material.

In the account of the murder of George Hunter by his native wife and her accomplices, the impression is given that the wife was entirely to blame. There is another version to this story, which is supported by the petition of the white ladies residing at Port Moresby for the free pardon of the wife. Although, as Dr. Semon is aware, the bow is not used by natives south of Port Moresby, he speaks (p. 373) in general terms for the "whole of South New Guinea" of birds of paradise being killed by "well-directed arrows." But on the whole there are few mistakes, and only a small number of verbal misprints. The general impression created by the book is correct, and the author's personal attitude towards the natives is most commendable. He refers in a kindly spirit to the excellent missionaries of varied creed, and is justly loud in his praises of the administration of Sir William Macgregor.

The illustrations, as a rule, are not particularly good, the views being reproduced from touched-up photographs; but for this there is a valid excuse, as the camera Dr. Semon took out with him did not stand the climate. Most of the figures of animals are evidently process blocks from pen and ink drawings, and they are somewhat hard and flat. There must necessarily be some defects in a book of travels, and especially in one which embraces so many subjects as this does; but the present writer would rather insist on the real excellence of the book, which has recalled happy memories of many similar experiences.

AMERICAN NATURAL HISTORY.

Chapters on the Natural History of the United States. By R. W. Shufeldt. Pp. 480. Illustrated. (New York: Studer Brothers, 1897.)

ALTHOUGH bearing on its title-page the date 1897, for some reason or other copies of this work appear only recently to have been received in this country; and in reading the volume it is important that the date of publication should be borne in mind, as otherwise certain statements might be taken to indicate that the author was somewhat behind the time.

As a technical worker in several branches of zoology, Dr. Shufeldt has attained a well-merited reputation on both sides of the Atlantic; but, like many other naturalists of position, he is not above putting the results of some of his investigations and studies in popular form for the benefit of the "man in the street." And the present handsome and beautifully illustrated volume is in the main a reproduction of popular articles on various branches of natural history which appeared in American periodicals. Whenever he considered it necessary, the author has, however, made corrections and additions to the original text in order to bring it up to date. Although the greater portion of the matter relates to birds, the work naturally covers a wide field. We have, for instance, in addition to those on ornithology, chapters on the methods of study of natural history, classification of mammals, crayfish and crabs, sawfish, rays, and sharks, whales and manatees, various rodents, and bats and their habits. And in each and all of these the same level of interest, combined with instruction, that characterises the first is fully maintained.

Over many of his fellow naturalists, at least in Europe, Dr. Shufeldt has a very great advantage from the fact that he is an accomplished artist, both with the pencil and the brush, while he also makes full use of the camera. And in the first chapter of the volume he urges the extreme importance of the artistic power in the making of a good naturalist. Possibly he may lay an undue stress on the value of this capacity, but there can be no question that the "artistic eye" affords a guide in the correct diagnosis of allied animals that nothing else can replace.

And here it may be well to draw attention to the thoroughness of the author's methods of research, and the importance attached by him to observations in the field. The following, for instance, he gives as the method of procedure for a naturalist to adopt in describing an animal:—

"Having obtained all the possible light upon its habits in nature, and its geographical distribution, and every fact and fiction that has appeared in regard to it in literature—then seize upon all the material obtainable, enough in any event in order to fully exhibit the extremes of variation in size; the sexual characters; the eggs, embryos, and young at all stages; the fossil forms, if any are known; and finally, an abundance of similar material representing all the apparent allies of the particular form, either near or remote."

Then the specimens are to be examined anatomically, both macroscopically and microscopically.

"Having accomplished all this, we are prepared to use our laboratory notes in writing out an account of the species; naming it if the form be unknown to science; and suggesting a place for it in the system."

With such detail in his mode of working, Dr. Shufeldt, it is almost needless to say, is not a "species-maker."

And in this connection his opinion in regard to the species-making now going on in the States should certainly be quoted. When writing of the common chipmunk, for instance (p. 405), he says:

"Some of the other forms resemble it quite closely, while others depart more or less from it in the matter of size and coloration; some are distributed over a considerable geographical area, others being more or less restricted in their ranges, thus offering descriptive zoologists abundant opportunities to describe the fine intergrading forms as new sub-species, an opportunity that has been fully availed of by a few ambitious mammalogists more anxious to add to a personal reputation than to be of any special use or aid to the science which they pretend to advance."

This is strong language, but there seems, in some instances, considerable justification for its use.

Of one of the above-mentioned chipmunks, a life-sized figure is given, which may be taken as a good example of the author's own sketches. Excellent as is this figure from a zoological standpoint, it cannot however compare in artistic effect with the reproduction of a photograph taken by the author of the deer-mouse (*Peromyscus leucopus*), which is perhaps the most exquisite in the whole book. The little creature is represented issuing from a maize-cob, on which it has been making a meal, and the half-frightened, stealthy expression of its head is most life-like. Although in our opinion the best of all, this is only one among a number of photographs of various beasts and birds taken by the author himself.

Of the few chapters devoted to mammals, all but one treat of the smaller representatives of the class; but, as if to make up for this, the one exception takes cognisance of the largest of living creatures—to wit, whales. After reading a statement in the introduction to the effect that technical matters were, so far as possible, excluded from the work, we confess to a feeling of surprise at finding nearly three pages of the chapter in question occupied by a technical list of American Cetaceans, many of the names in which are mere synonyms. Apart from this, the chapter is a remarkably interesting one, although it would have been better had some of the illustrations been reduced in size. In view of recent discoveries by the Prince of Monaco, we thought, on first reading the book, that the author was sadly behind the time in his statement that all the markings on Risso's dolphin are normal and not due to conflicts; but this apparent want of revision is fully explained by the date on the title-page. To the same cause may perhaps be attributed the author's relegation of *Zeuglodon* (misspelt, by the way, *Zenglodon*) to a position near the seals, as Prof. Damer's interesting memoir, in which its ancestral cetacean characters are so well brought out, was probably not published in time.

To refer to the other chapters would be to largely exceed our space; and all we can therefore do is to commend the work to the best attention of our readers as an admirable example of what popular natural history should be. Well printed and charmingly and profusely illustrated, it should be welcome alike to young and old, to the professed naturalist and to the non-scientific lover of nature. R. L.

THE SONGS OF BIRDS.

Cries and Call-Notes of Wild Birds. By C. A. Witchell. Pp. xi + 84. (London: Upcott Gill, 1899.)

IN this book the author carefully describes the cries of over a hundred of the commoner species of birds which are to be heard in or near gardens of towns, woodlands, uplands and riverside. No reader who is at all interested in birds can fail to be impressed with the diligence and patience shown in collecting so much detailed information, and with the extraordinary powers of ear which the author seems to possess.

The cries of birds, as Mr. Witchell implies in his preface, are more readily distinguished from one another by differences of timbre than by differences of musical pitch. Owing to the fact that most birds sing at a very high pitch, it is exceedingly difficult for the human ear to recognise the intervals with certainty. Moreover, the vocal apparatus of a bird is such that he naturally produces several sounds within the compass of one tone of our musical scale; and it is for this reason that nearly all attempts to translate a bird's song into our musical notation are failures. Though familiar with the cries of most of the birds Mr. Witchell mentions, we have been quite unable to recognise several of the strains given in his book when played on the piano. Some of the musical illustrations would remind the hearer of the song if he were already familiar with it, but we doubt if they would convey much idea of it to any one else. Descriptions of the cries of birds by means of syllables and words are generally very difficult to interpret. It is easy to make the syllables fit the song when that is known, but the syllables give little idea of a song which is unknown to the reader, because there are no universally recognised rules for their pronunciation. Mr. Witchell has been at great pains, but we do not think really satisfactory results can be obtained in the representation of birds' cries by either of the methods he has employed.

There are few inaccurate statements in the book; but the author is mistaken when he writes concerning the song-notes of the great tit, "It is noteworthy that none of our other titmice have any of these cries." The coal tit sings a song not very unlike the ringing note of the great tit, which is represented by the words "chingsee, chingsee." We have spent many hours listening to grasshopper warblers; but we never yet heard one reel for five minutes without a break, nor for even half that time. And we think the author is unjust to the song of the mistle-thrush when he says, "the listener may be led to imagine that some very musical bantam or other such bird is crowing."

In the present work Mr. Witchell has not set himself to discuss the various problems concerning bird-notes, but he incidentally makes assumptions which seem to require more evidence to justify them. Thus he writes:

"In January and February the songs of the blackbird are much shorter than those heard in May, the young birds of the preceding year requiring some practice before attaining proficiency";

and again he says of the skylark:

"These autumn songs seem to be mostly those of young birds of the year, and consist mainly of repetitions of the call-notes, with the addition of a few more musical sounds."

We should like to have more evidence to show that these are songs of the young birds. It is well known that in February many chaffinches can be heard singing which apparently find it difficult to finish the song correctly. Mr. Witchell makes no mention of this; but surely he would not say that all these chaffinches are young birds.

There is yet another point on which we differ with Mr.

Witchell, and that is with regard to mimicry. Undoubtedly several birds are ready to mimic sounds which they hear about them, but it does not follow that every point of resemblance in the songs of two species is due to mimicry; it is quite as likely to be accidental. For instance, it seems to us fanciful to trace the origin of part of the song of a thrush in the following way:

"The 'kreeow' was given in the deliberate manner of the crow; the 'whilllillill' was similar to the note of the wryneck; while the 'tewy' was clearly the call-note of the chiffchaff."

In another place we read:

"The nightingale is sometimes inclined to mimic, and one of its strains, a rapid 'slip slip slip' prolonged, is much like the sound made by the young perching nightingale when the parent is feeding it."

It seems curious that the nightingale should mimic the young birds when they are not yet hatched, for, in spite of the fact that nightingales are heard singing in mid-June, we do not believe that they generally sing after their young are hatched; and Mr. Witchell gives no evidence that the birds he heard were not delayed in their nesting owing to the destruction of their first nest.

Mr. Witchell is well known as a specialist in bird-song, and many of his observations could not be made without a carefully trained ear; so his book cannot fail to be of interest. We are doubtful as to the amount of help it would give to a novice wishing to become familiar with the various cries of birds; but it gives a fuller description of these cries than is generally to be found in ornithological works, and suggests many points which are worth further investigation. H. C. P.

OUR BOOK SHELF.

Psychologische Untersuchungen über das Lesen. By Benno Erdmann and Raymond Dodge. Pp. viii + 360. (Halle, 1898.)

The Story of the Mind. By J. M. Baldwin. Pp. 263. (London: George Newnes, Ltd., 1899.)

PAINSTAKING records of psychological experiments are, as a rule, not the most entertaining form of literature. Yet an exception must certainly be allowed in the case of the work of Drs. Erdmann and Dodge, which is no less distinguished by literary charm than by the thoroughness and completeness of the investigations it records. The greater part of this admirable work is devoted to a careful and, in the judgment of the present reviewer, unanswerable refutation of the opinion which since Wernicke has been current among German pathologists, that in normal reading the letters are spelt out separately, one after another. By a series of elaborate experiments the authors seem to establish beyond a doubt that our apprehension of a written text takes place exclusively during the pauses between the movements of the eye along the lines, that six to seven letters can be clearly perceived during each such pause, and finally that a short *word* of not more than four letters can be read off in less time than a single letter. In the later chapters Cattell's well-known experiments on reaction-times for written symbols are submitted to a searching criticism; and it is shown from the absence, under normal conditions, of conflicting optical suggestions or of conscious sensory-motor "feelings of innervation" that no element of "discrimination" or "selection" enters into our ordinary apprehension of the meaning of the symbol. As this means that simple apprehension is *not* "discrimination" of any kind, the result is an important one, and may be commended to the attention of those psychologists who still talk glibly of "discrimination" as the essential feature in perception. Altogether the book is a model of what a psychological monograph should be, clear, well-arranged, and most accurate.

Prof. Baldwin's little book is a valuable addition to the series in which it appears, and should awaken the interest of not a few intelligent general readers outside the little world of psychologists by profession. It is remarkable that he should have been able in so few pages to introduce his readers to almost every side of psychology. The most excellent feature of the book is probably the abundant illustration, from Prof. Baldwin's own researches, of the meaning and nature of psychological experiment. If one were in a fault-finding mood one might, perhaps, complain that the curious attack upon the teaching of language at p. 222 is both exaggerated and irrelevant, and that the concluding chapter on "The Genius and his Environment" is hardly definite enough in its results to justify its being reprinted from the popular magazine in which, no doubt, it has made a previous appearance. A. E. TAYLOR.

Sewage Analysis. By J. Alfred Wanklyn and W. J. Cooper. Pp. xiv + 220. (London: Kegan Paul, Trench, Trübner, and Co., Ltd., 1899.)

Sewer Design. By H. N. Ogden, C.E. Pp. viii + 234. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1899.)

THE first of these two volumes is described as "a practical treatise of the examination of sewage and effluents from sewage." Many practical hints on the analysis and treatment of sewage are given; and the collection of original papers printed as an appendix contains useful notes and explanations on various analytical processes in chemistry. The object of the book is, however, stated to be to bring about a reformation in the analysis of sewage, and to point the way to its proper disposal. Apparently one of the chief reforms required, according to Mr. Wanklyn, is to induce chemists using the ammonia process of water analysis to express the readings of albuminoid ammonia in terms of parts per million, instead of parts per 100,000 and grains per gallon. But other reforms are urged; and as Mr. Wanklyn claims that "In some respects the opportunities enjoyed by my colleague and myself are absolutely unique," and remarks that "the severance of all relations with the London Chemical Society has operated to our advantage," the volume evidently contains criticisms and conclusions upon which a difference of opinion may be permitted.

Prof. Ogden's volume contains a course of lectures given in the College of Civil Engineering, Cornell University. It shows how the subject of sewer design may be dealt with scientifically, and therefore practically. Much scattered material upon points which have to be considered when preparing the design and making the plans for a system of sewers in a city, has been brought together by the author. Sanitary engineers will find the volume as serviceable for reference as students of sanitary engineering will find it helpful as a text-book.

The Hygiene of the Mouth, a Guide to the Prevention and Control of Dental Diseases. By R. Denison Pedley, F.R.C.S. Edin., L.D.S. Eng. Pp. 93. (London: J. P. Segg and Co.)

THE importance of taking care of the teeth of children cannot be too strongly emphasised or too widely understood. In this volume the author describes the measures to be adopted for the prevention of dental diseases in adult life, the progress and treatment of dental caries, and some of the consequences of neglect of the teeth. The facts contained in the book should be known to every parent.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Magnetic Compass and Nickel Cases.

IT is a common practice amongst instrument makers to put the magnetic compass needle of the pocket compass, or the marching compass used in the army, into an external case of nickel; the case is usually furnished with a lid, after the manner of a hunting watch, and is largely used by travellers.

Recently, while in South Australia, I used such a compass, which was lent to me, for the purpose of steering across a rather large "run." On comparing my position with that indicated by the map, I found that I had drifted considerably to the right of the point laid down; on examining the compass, while slowly shutting the lid, I noticed that as it closed the card of the compass was deflected. I next noticed that the case, which was much discoloured, and at first sight looked like bronze, was made of nickel; this revealed the source of error—when the lid was open, the nickel case, which is magnetic, was unsymmetrical with respect to the magnetic needle, and the needle was attracted by the lid from the true magnetic meridian, and the compass thereby rendered useless for steering purposes, and a source of possible danger, when long distances are traversed.

On talking over the matter with a leading instrument maker, I found that nickel is usually supposed to be a non-magnetic metal, and that nearly every traveller's compass case is made of nickel. It is somewhat remarkable, in an age of so many technical schools, that such ignorance can exist about a metal the properties of which were spoken of by Faraday in 1845 thus: "The magnetic characters of iron, nickel and cobalt are well known" (*Phil. Trans.*, 1846, p. 41). On looking through different price lists of leading firms selling marine compasses, I find that nickel enters into their construction also. In marine compasses the presence of a magnetic metal in the cases must be a source of some danger to the navigator. I would suggest that when selecting a magnetic compass, the magnet needle should be removed, and the case carefully tested for magnetic properties, and that should the case show any signs of magnetism it should be rejected. F. J. JERVIS-SMITH.

Oxford, June 13.

Historical Note on Recalescence.

IN his recent presidential address to the Iron and Steel Institute, Prof. Sir W. Roberts-Austen stated (NATURE, No. 1541, p. 43): "To Gore, and to Barrett, we owe the investigation of the nature of a fact which had long been well known to smiths, that iron on cooling from a bright red heat suddenly emits a glow."

I do not know what authority Sir W. Roberts-Austen has for this statement, but as this is not the first time it has been made, perhaps I may be allowed to ask if he has any documentary evidence in support of it. So far as I am aware the history of the matter is as follows:—At the meeting of the British Association in Bradford in September 1873, I read a paper entitled "On certain remarkable molecular changes occurring in iron wire at a low red heat"; this was subsequently published in the *Philosophical Magazine* for December 1873. In this paper, the phenomenon, for which I suggested the name *recalescence*, was first described, and was further investigated in other papers of mine, to which I need not here refer. At the time of the discovery it seemed to me highly probable that this remarkable after-glow in cooling iron and steel was likely to have been already noticed, but after considerable search I could find no previous record of it in scientific literature; nor could I, after persistent inquiry, discover a single smith or iron-master who had even casually noticed the effect until I pointed it out to them.

But the most curious thing was that the observation had entirely escaped Dr. Gore's attention; in 1869, Gore discovered that a momentary elongation occurred in a cooling iron wire after it had been heated to bright redness. Dr. Gore, however, did not pursue the matter further, and informed me in May 1872 that he had no intention of doing so (see *Phil. Mag.*, December 1873, p. 473). Writing to me, after the publication of my paper in 1873, in a letter which I happen to have kept, Mr. Gore says:—

"Edgbaston, Birmingham, December 2, 1873. Your new discoveries respecting the molecular changes in iron, described in the *Phil. Mag.* for this month, have greatly pleased me; especially the sudden development of heat attending the elongation during cooling, and the sudden shortening during heating. . . ."[1] And in a letter to me some years later after the delivery by Prof. Roberts-Austen of a lecture before the British Association in 1889—Dr. Gore naturally expressed his surprise that the discovery or investigation of recalescence should be attributed to him.

It is to M. Osmond more than any one else we owe the series of masterly investigations that has raised the discovery of recalescence into the importance which it now holds in the metallurgy of steel. The value of M. Osmond's work is well known, but I am glad of this opportunity of emphasising it, for M. Osmond's modesty has led him to attribute in his papers, and in his correspondence with me, more value to my own work than it probably deserves. For instance, in a letter addressed to me from Paris on December 13, 1889, M. Osmond writes:—"Vos observations sur la Recalescence sont de celles qui feront époque dans l'histoire de la métallurgie; elles ont été le point de départ de tout ce qu'on a fait pendant ces dernières années, et pour mon compte, j'ai tant travaillé sur vos traces qu'il me semble vous connaître depuis longtemps. . . ."

I feel sure my friend Sir W. Roberts-Austen will forgive my venturing to correct him in this trifling matter of scientific history. It is quite possible his statement, that recalescence "had long been well known to smiths" prior to 1873, may be derived from his wide metallurgical knowledge, which I do not presume to possess, or it may arise from the common and unintentional blunder of reading our present knowledge into the past. W. F. BARRETT.

Royal College of Science, Dublin, June 2.

IN the Presidential address referred to, I attempted to review the progress made in connection with iron and steel during the past century. I felt that, notwithstanding the very limited space at my disposal for recording the work of individuals, the name of Barrett must find a place, and I greatly regret that my friend considers the reference to him to be infelicitous. As regards the first point raised by him (to take the class of smith's work with which I have most experience), those who have to conduct the very delicate operation of hardening dies for coinage have long been familiar with what is now known, thanks to Prof. Barrett, as "recalescence" in cooling steel. Of course the artificers were ignorant of its true cause, and they usually describe the effect of the sudden glow in steel as being due to "the heat coming from inside the metal." The fact that this industrial knowledge existed, does not in the least diminish the interest of Prof. Barrett's own observation (1873), nor lessen the vital importance of his work in showing that "Gore's phenomenon" (1869) is a reversible one. The relation of the work of Barrett to that of Gore was, moreover, indicated by me nearly ten years ago in the pages of NATURE (November 7, 1889, p. 16) as concisely as I could. In a recent number of NATURE (April 13, 1899, p. 567), a curve obtained by a method of my own is published, and it shows that there are no less than six points at which heat is evolved as iron cools down from 1150° C. to the ordinary temperature. I wish that Prof. Barrett, with his great experimental skill, had hastened the advance of our knowledge by continuing, during the past twenty-five years, investigations which would have led him to the discovery of the several very important points in carburised iron in which, as the

[1] In a note to the Iron and Steel Institute in 1890, and in correspondence with me subsequently, Dr. Gore points out that the discovery of the "sudden shortening during heating" the here attributes to me is more or less implied in his own paper in the *Phil. Mag.* for September 1870, where a molecular change occurring in iron during the process of heating is clearly mentioned. But the only evidence Gore gives of a molecular change during the *heating* of iron is the production of an induced current in a surrounding coil of wire when the iron core reaches a certain temperature; this he correctly attributes to the well-known change in the magnetic state of iron at this temperature. In fact, quoting from his previous paper, Dr. Gore states (the italics are his): "The iron during cooling . . . suddenly elongated by diminution of cohesion . . . a corresponding but reverse phenomenon did *not* occur during the process of *heating* the wire" (*Phil. Mag.*, September 1870, p. 171). In an interesting research on "The changes in length and temperature of iron and steel during recalescence," published in the *Phil. Mag.* for August 1898, M. Svedelius of Upsala supports the historical view I have here taken.

metal cools, the evolution of heat cannot be detected by the unaided eye. I may add that I fully share with M. Osmond, with whom I have so long worked, his appreciation of the value of Prof. Barrett's investigation.

Royal Mint, June 9. W. C. ROBERTS-AUSTEN.

Harvesting Ants.

IN the spring of 1878 I was much amused with watching the apparent want of common sense displayed by the harvesting ants in storing the little fruits of the plane-tree (*Platanus orientalis*) in one of the avenues at Mentone. It was with much interest, on revisiting the Riviera in May this year, that I observed the same clumsy methods still being adopted by these ants under the plane-trees, not only at Mentone, but also at Hyères and Alassio.

Comparing the fruits to an umbrella in which the ribs are represented by the parachute of long hairs springing from the base or narrower end, while the upper and broader end is frequently surmounted by the remains of the style forming the handle of the umbrella, the ants in bringing the fruits to the nest, hold them pointing out in front, carrying them by the handle. On reaching the entrance, one would naturally suppose they would push them in as one pushes an umbrella into a stand, with the hairs pointing upwards. This would be comparatively easy, as the hairs in question would close round the fruit and offer no obstruction. Instead of doing this, the ants take the trouble to turn round and reverse the fruits, and then attempt to drag the tiny umbrellas in by the handle, the ribs pointing downwards and catching against the sides of the aperture. A large amount of time and energy is wasted by the ants in tugging and struggling with the fruits in order to make them go in, and very often a considerable number of ants are kept waiting about the entrance laden with similar spoil until their turn comes. Occasionally when the aperture is large the fruits go in more easily, but this is exceptional. The considerable "midden" of hairs outside the nests is evidence that the ants remove and reject the hairs after taking all this trouble.

I have never seen the ants carry a fruit into their nests with the hairs pointing upwards, except when I have thrust one well into the aperture in this position, and I have known the ants to reverse the fruits after I have tried to make matters easier for them. The present observations show (1) that after twenty years' experience in the same avenue at Mentone the ants have not learnt such a simple lesson as the proper way to get plane-tree fruits into their nests; (2) that this apparent lack of ingenuity is not restricted to the ants of one particular place, but is shared by the harvesting ants all along the Riviera; (3) that the ants know one method, and one method only.

June. G. H. BRYAN.

Bessel's Functions.

THE phrases quoted by Prof. Gray furnish additional examples of the laxity of style amongst scientific men, to which "C. G. K." has called attention.

The English language does not readily afford a means of converting the name of a person into the corresponding adjective; and the result is that a slovenly practice has grown up of using the name itself as an adjective. In certain instances, this practice has become sanctioned by usage; and whenever this is the case, the *same* word must be regarded as doing duty for the proper noun and the corresponding adjective. But the practice is not to be commended, and ought always to be avoided if possible.

In my former letter, the word *conception* is a misprint for *corruption*. A. B. BASSET.

Fledborough Hall, Holyport, Berks, June 16.

Limnology.

AS introduced by Prof. Forel, and widely accepted by scientific men in all countries, the term *Limnology* is applied to the science of lakes exactly as *Oceanography* is applied to the science of oceans. It is consequently with some surprise, and even a little shock, that I find a review in the current issue of NATURE headed "Limnology," and dealing with the small organisms of drinking-water. These have been termed *Limnoplankton* by some writers; but treated from the practical point of view their study is surely not Limnology, and from any point of view only a very small part of it. When a scientific term is new and tender, it runs some risk of unintentional abuse which may impair its future usefulness; and I would appeal to scientific writers not to allow *Limnology* to fall into the confusion which now attends *Physiography*. HUGH ROBERT MILL.

THERE is, no doubt, some measure of justice in the remarks of your correspondent. More stress might have been laid on the fact that the book in question, in spite of its title, is much concerned, not only with the numbers, distribution, and seasonal abundance of the organisms in lakes—as stated on p. 147 of the review—but also with statistics regarding the temperature of the water at various depths and seasons, the penetration of light, and other physical phenomena coming under the head of Limnology in the sense required. THE REVIEWER.

June 17.

"Index Animalium."

WILL you allow me to appeal through your columns for the loan of any of the books in the following list? I wish to see them in order to complete my manuscript from 1758–1800, now rapidly preparing for the press. Parcels may be addressed to me, care of Dr. Henry Woodward, F.R.S., British Museum (Nat. Hist.), London, S.W., and any books lent will be carefully returned in the course of a few days. No other editions are wanted.

Bourguet, L. "Traité de Petrif." 8vo, Paris, 1778.

Catesby, M. "Hist. Nat. Carolina," fo., Nurnberg, 1770.

Doeveren, G. "Abb. Würmer Mensch. Korpers.," 8vo., Leipzig, 1776.

Edwards and Catesby. "Receuil des Oiseaux," 8vo, Nurnberg, 1768–76.

Grossinger, J. B. "Hist. Nat. Hongrie," 8vo, Buda, 1794.

Guidetti, G. "Vermi umani," 4, Firenze, 1783.

Happe, A. F. "Abb. Schmetterling Afrikas," fo., Berlin, 1783–4.

Hiller, J. F. "De Papiliones ferali," 4, Witemb., 1761.

Houttuyn. "Museum," 8vo, Amsterdam, 1786.

Humphrey, G. "Mus. Humfredianum," 8vo, London, 1779.

Lancklavel. "Zerbst Kunst u. Nat. Kabinet," 8vo, Leipzig, 1777.

"Leipziger Magazin f. Naturkunde," for 1785–6–7 and 8.

Le Vaillant, F. "Naturges. Afrik. Vogel." (Bechstein's ed.), 4, Nurnberg, 1797–1802.

Le Vaillant, F. "Naturges. Afrik. Vogel." (Forster's ed.), 8vo, Halle, 1798.

Le Vaillant, F. "Reise innere Afrikas," 8vo, Frankfurt, 1790–97.

Linnæus. "Systema Naturae" (Müller's ed.), 2 parts, 8vo, Nurnberg, 1796 and 1809.

Linnæus. "Systema Naturae" (Vanderstegn van Putte's ed.), 4 v. 8vo, Bruxelles, 1793 and 1796.

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"Magazin d. ausland Insekten," 1 No., 8vo, Erlangen, 1794.

Meyer, F. A. A. "Versuch 4 füssiger Thiere," 8vo, Leipzig. 1796.

Nau, B. S. "Oek. Nat. Fische Mainz," 8vo, Frankfurt, 1788.

Nau, B. S. "Beitr. Nat. Mainzelandes," 8vo, Mainz, 1787–8.

Pezold, C. P. "Lepidopt. anfangsgrunde," 8vo, Coburg, 1796.

Quensel, C. "Diss. Hist. Nat. ignotis Insect," 4, Lund, 1790.

Schneider, J. G. "Amphib. Physiol." (Spec. iii.), 4, Trajecti, 1797.

Schaffer, J. C. "Element Entom." (ed. 3), 4 Regensburg, 1780-87.

Theil, M. "Abb. würm. mensch. Leiber," 8, Berlin, 1766.

Turk, C. W. C. "Verz. meiner Insect. Sammlung," 4, N. Strelitz, 1799.

Wartel, C. P. "Mém. Limaçons Artois," 12, Arras, 1758; and ed. 2, 1768.

Wolff, E. J. "De Verm. intest.," 4, Giessen, 1763.

Wolff and Frauenberg. "Abb. Beschr. Franken Vogel.," fo., Nurnberg, 1799. C. DAVIES SHERBORN.

Habits of the Cuckoo.

ONE day last week I was in my garden—a not particularly private country one—when I heard a cuckoo close by, and, standing quite still, I saw the bird alight upon an apple tree not more than four yards from me. The bird did not appear to object to my close proximity, for it uttered its call "cuckoo" twice. Its mate then came and sat in a plum tree only five yards from me, on the opposite side of me; one of them had a caterpillar in its mouth. Then a blackbird came into another tree in a state of great excitement uttering its "pink pink," as I supposed, at the cuckoos; and the question arose in my mind, "Does the cuckoo feed its own young, and was that in the blackbird's nest?" Can any of your readers help me?

WM. H. WILSON.

Gloucester House, Sudbury, Harrow, June 19.

Economic Entomology.

CAN you tell me where I can get information as to the present condition of economic entomology in this country, more especially as to methods of research usually adopted?

Z.

MAGNETIC PERTURBATIONS OF THE SPECTRAL LINES.[1]

THE subject which we are about to consider this evening forms a connecting link between two of the most interesting branches of human knowledge—namely, that which treats of magnetism and that which treats of light. Almost as soon as the properties of magnets became known, mere curiosity alone must have prompted philosophers to ascertain if any relation existed between magnetism and "the other forces of nature," as they were generally termed. We are consequently led to expect amongst the records of early experimental investigations some accounts which treat of the action of magnetism on light.

Early Experiments.

When we seek for such accounts, however, we find that they are almost wholly absent from the literature of science, and this arises, I believe, from the great difficulty of the investigation and from the circumstance that only negative results were obtained, rather than that no such inquiry suggested itself or was undertaken. Even in quite recent times this inquiry has been prosecuted, but without success, by physicists who have published no account of their experiments. We may take it, therefore, that the inquiry is in itself an old one, although it is only now that it has been carried to a successful issue.

The earliest recorded attempt to solve this problem with which we are acquainted, is that of a celebrated British physicist whose name must for ever shed lustre on the annals of the Royal Institution—I speak of Michael Faraday. In order to understand the nature of the investigation which Faraday took in hand, and which has led up to the discourse of this evening, it is best to consider briefly some elementary facts concerning magnetism and light.

Magnetic Field of Force.

In the first place, I shall assume that we know in a general way what the peculiarities of a body are which lead us to say that it is magnetised, or a magnet. These are that, when freely suspended, it sets itself in a definite direction over the earth's surface, as illustrated by the compass needle, and that in the space around it there is "magnetic" force exerted on pieces of iron, and, in a smaller degree, on other substances. For this reason, we say that a magnet is surrounded by a magnetic field of force. The field of force is simply the space surrounding the magnet, and it extends to infinity in all directions from the magnet. Near the magnet the force is strong, and far away from it the force is almost insensible; and so we say that the field is strong at certain places near the magnet, and that it is weak at places far away from the magnet. The direction of the force at any point is the direction in which the north pole of another magnet would be urged if placed at that point, and the push which this pole experiences may be taken to represent the intensity or strength of the magnetic field at the point in question. This is represented diagrammatically by these drawings [referring to figures suspended before the audience], which show roughly the nature of the field of force surrounding an ordinary bar magnet, a horse-shoe magnet, and the much more powerful form—the electromagnet. It will be seen that the space outside the iron is filled with a system of curved lines running from the north pole to the south pole of the iron core. Where the lines are closest together there the magnetic force is strongest, and the direction of a line at any point is the direction of the resultant magnetic force at that point—that is, the direction in which a north pole would be urged if placed at that point.

Faraday always pictured the magnetic field as filled with lines of force in this way, and the importance of the conception can scarcely be over-rated, for it leads us to view the magnetic action as being transmitted continuously through the intervention of some medium filling all space, rather than by the unintelligible process of direct action at a distance. This medium is called the ether; but as to what it is that is actually going on in the ether around a magnet, we cannot definitely say. It may be that there is a flow of ether along the lines of magnetic force, so that there is an outflow at one end of the magnet and an in-flow at the other, or it may be that the ether is spinning round the lines of force in the magnetic field. For our present purpose, it is not a matter of very much importance what the exact condition of the ether may be in a magnetic field, for if the ether in a magnetic field is either in some peculiar condition of strain or of motion, and if light consists of an undulatory motion propagated through this same ether, then it may be naturally expected that some action should take place when light is propagated through, or radiated in, a magnetic field of force. This is what Faraday suspected, and in order that we may appreciate the problem with which he had to deal, let us place ourselves in his position and ask ourselves the question: "In what manner can we test experimentally if there is any magnetic action on light?"

Tests for Magnetic Action on Light.

In answer to this question, the first thing that occurs to us is to pass a beam of ordinary light through the magnetic field, in some chosen directions, and examine by all the means at our disposal if any action has taken place. When this is done we find that no observable effect is produced. But the scientific investigator does not rest satisfied with one negative result. He varies the conditions of the experiment, and returns to the attack with renewed vigour and hopes. In our first trial we passed a beam of light through the air-filled space around the magnet, and we may vary this experiment either by removing the air altogether, and so causing the beam to traverse a vacuum, or we may replace the air by some dense transparent substance such as glass or water. Under these new conditions, we still fail to detect any influence of the magnetic field on a beam of ordinary light. This negative result might arise from the field of force being too weak to produce an observable effect, or it might be that the effect, if any effect really does exist, may be of such a character that it is impossible to detect it with ordinary light. In common light, the vibrations take place indifferently in all directions around the ray, and follow no law or order as to their type. They

[1] Friday evening discourse delivered at the Royal Institution, May 12, by Thomas Preston, M.A., D.Sc., F.R.S.

possess no permanent relation to any direction around the ray, so that if the magnetic action should happen to be a twisting of the vibrations round the ray, it will be impossible to detect this twist in the case of ordinary light.

The Faraday Effect.

As a matter of fact it is a twist of this kind that actually happens, and this is probably what Faraday anticipated. In order to detect it, therefore, it is necessary to employ a beam of light in which the vibrations are restricted to a single plane passing through the ray. Such light is said to be plane polarised, and may be obtained by transmitting common light through a doubly refracting crystal. Faraday found that when a beam of this plane polarised light is passed through the magnetic field, in the direction of the lines of force, a distinct effect takes place, and that the effect is a twisting of the plane of polarisation of the light vibrations as they pass through the magnetic field, or, to be more precise, as the light passes through the matter occupying the field.

This is the Faraday effect. Its magnitude depends on the strength of the field, and upon the nature of the matter through which the light passes in that field. This latter is an important fact that should not be lost sight of in reasoning upon the nature of this effect. The presence of matter in the field appears to be necessary. The effect is not observed in a vacuum, but becomes greater as the field becomes filled with matter of greater density. It is therefore not a direct action of the magnetic field on the light vibrations, but rather an indirect action exerted through the intervention of the matter which occupies the magnetic field.

This action, as we have said, is a rotation of the plane of polarisation of the beam of light, and it arises from the circumstance that in passing through the magnetic field vibrations which take place from right to left do not travel forward with the same velocity as those which take place from left to right. There is no change in the periods of the vibrations, it is essentially a change of velocity of propagation that occurs. If we examine the transmitted light with a spectroscope, we find that the wave-lengths are unaltered, but that the amount of rotation of the plane of polarisation is different for waves of different lengths. The law which governs the effect is that the rotation of the plane of polarisation varies inversely as the square of the wave-length of the light employed.

Second Form of Experiment (Faraday and Fievez).

You will have noticed that in the foregoing experiment the source of light was placed quite outside the field of magnetic force, while the beam of light was transmitted through the field for examination. Now we might place the source of light itself in the magnetic field, and then examine if the light emitted by it is in any way affected by the magnetic force. This variation of the experiment suggests itself at once, and was indeed also tried by Faraday—in fact, it formed his last experimental research of 1862, but without success. The same experiment has been tried, no doubt, by many other physicists with the same negative result.

The first recorded success, or at least partial success, was by M. Fievez in 1885. He placed the source of light—a gas flame impregnated with sodium vapour—between the pole-pieces of a powerful electro-magnet. This being done, the light radiated by the flame was passed through the slit of a highly dispersive spectroscope and examined. What M. Fievez observed was that the bright spectral lines became broadened by the action of the magnetic field on the radiating source. His account is, perhaps, somewhat confused, owing to his imperfect apprehension of the true nature of the phenomenon which he observed, but, without doubt, he observed a true magnetic effect on the radiated light—namely, this broadening of the spectral lines—but he did not convince the scientific world that he had made any new discovery, and so the matter fell into neglect until it was revived again in 1897 by the now celebrated work of Dr. P. Zeeman.

Work of Zeeman, Lorentz, and Larmor.

The credit which attaches to Dr. Zeeman's work is that he not only, after prolonged effort, succeeded in obtaining this new magnetic effect, but he also convinced the world that the effect was a true one, arising from the action of the magnetic field on the source of light. That Dr. Zeeman was able to do this was due, perhaps, as much to the present advanced state of our theoretical knowledge of this subject as to his own skill and perseverance as an observer; and this is a striking example of the great assistance which well-founded theory affords to experimental investigation. The theory connects the facts already known in reasonable and harmonious sequence, predicts new results, and points out the channels through which they must be sought. Without such scientific theory, this general systematic advance would be impossible, and new results would be stumbled on only by accident.

To see how this applies to our case, we revert to the fact determined by Dr. Zeeman—namely, that when the source of light is placed in a strong magnetic field the spectral lines become broadened (see Fig. 1). As soon as

FIG. 1.—Shows the broadening of the spectral lines by the magnetic field. The upper row shows the lines when the magnet is not excited. The lower row shows the same lines when the magnet is excited. (Reproduced from a photograph, natural size.)

this was announced, Prof. Lorentz, and subsequently Dr. Larmor, examined the question from the theoretical point of view. They analysed the subject mathematically, and came to the conclusion that each spectral line should be not merely broadened, but should be actually split up into three—that is, each line should become three lines, or, as we shall say in future, a triplet. They also arrived at the further most important and interesting conclusion, viz., that the constituent lines of this triplet must be each plane polarised—the central line of the triplet being polarised in one plane, while the side lines are polarised in a perpendicular plane. In fact, the vibrations of the light forming the central line are parallel to the lines of magnetic force, while the vibrations in the side lines are perpendicular to the lines of force. This prediction of tripling and polarisation from theoretical considerations may be regarded as the key to the subsequent advance that has been made in the investigation of this region of physics. In order to understand it, let us place ourselves in Dr. Zeeman's position when he found that the spectral lines became broadened by the magnetic field, and let us be informed that this broadening is in all probability a tripling of the lines accompanied by plane polarisation. The question now is, "How are we to determine if this is the case?"

It is clear that if the broadened line is really a triplet, then the components of this triplet must be so close together that they overlap each other, and so appear to the eye merely as one broad line, as illustrated by the model which is here before you. [Model illustrating the overlapping shown here.] We know that the spectral lines are not infinitely narrow lines, but are really narrow bands of light of finite width, and consequently we are quite prepared to regard the magnetically broadened line as an overlapping triplet, but we cannot remain satisfied until we have proved beyond all doubt that it really is a triplet, and not merely a single broad line. To do this, Dr. Zeeman made use of the second prediction of the theory—namely, that the constituents of the triplet must be plane polarised. If this is so, then the outer edges of the broadened line must be plane polarised, and therefore by introducing a Nicol's prism into the path of the light it must be possible to turn the Nicol so that the plane polarised edges shall be cut off, and the breadth of the line shall be reduced to its normal amount. In fact in this position of the Nicol the outside lines of the triplet are extinguished, and the central component alone remains. This component is, of course, the same in width as the original line, and consequently when the outer members of the triplet are extinguished all the magnetic broadening of the line is removed. When the Nicol is turned through a right angle the central component of the triplet is extinguished, while

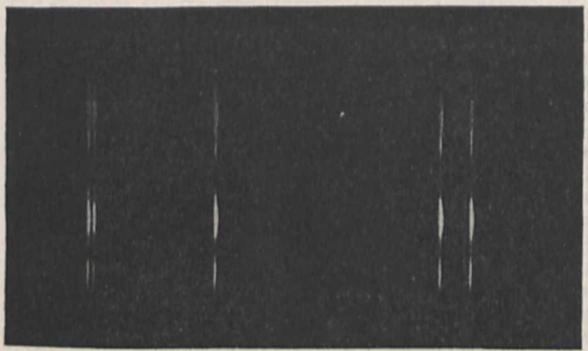

FIG. 2.—The lower row shows the lines uninfluenced by the magnetic field. The row next above shows the same lines broadened by the magnetic field. The top double row shows the analysation by a Nicol's prism. (Reproduced natural size.)

the side lines remain, and, if these side lines are sufficiently separated, so that they do not overlap, then, when the central line is removed, a narrow dark space will exist between the side components, which represents the space intervening between the outer members of the triplet, as illustrated by Fig. 2.

But even though we may be able to so increase the strength of the magnetic field that when the central component of the triplet is removed by a Nicol the side lines stand apart with a clearly defined interval between them, yet this in itself does not absolutely satisfy us that the broadened line is a triplet. It might be contended that the broadened line is not really a triplet, but is merely a band of light polarised in one plane along its edges, and in the perpendicular plane along its centre, and that increase of the magnetic field might never separate it into distinct constituents, but merely continue to broaden it. This contention, however, might be disposed of by a careful study of the facts, even though we might not be able to produce a magnetic field strong enough to completely separate the constituent lines of the triplet.

Actual Triplets Obtained.

But clearly the thing to be arrived at is to so arrange matters, in fact to so design our electro-magnet and to plan the conditions of our experiment, that the magnetic field acting on the source of light shall be strong enough to completely separate the members of the triplet if such exist. You will understand that this is no easy thing to do when you remember that it was only after repeated efforts and many failures that even a slight broadening of the spectral lines was obtained. Nevertheless, in spite of the great difficulty which besets this investigation, and which arises from our inability to obtain a magnetic field of unlimited strength, yet, with a properly designed magnet and other properly arranged conditions, it is possible to obtain a magnetic field strong enough to completely separate the constituents of the magnetic triplet, and thus to prove that the prediction of theory is verified by the actual facts.

Other Perturbations, Complex Types.

But with a magnetic field of great strength the facts as shown by these slides [photographs shown here] turn out to be more complicated and more interesting than the simple theory led us to expect. For while some of the spectral lines are split up into triplets as indicated by

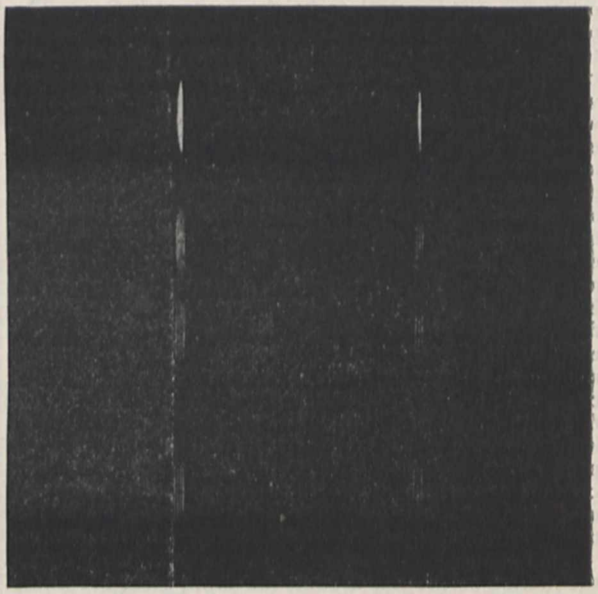

FIG. 3.—The top lines are not subject to the influence of the magnetic field. Underneath the same lines are shown affected by a magnetic field of increasing strength. The line on the right is resolved into a pure triplet, while that on the right appears at first as a quartet, and finally in a very strong field as a sextet (easily seen on the negative). (Reproduced natural size.)

theory, some, on the other hand, become resolved into sextets, or octets, or other complex types (see Fig. 3). Thus when the magnetic field becomes sufficiently intense, we realise to the full all the theoretical predictions and more. The reason of this surplus of realisation over expectation lies in the fact that the theory in its simplest form deals only with the simplest types of motion under the simplest conditions, and the conclusions arrived at are of course of corresponding simplicity. When more complicated types of motion are contemplated, the theory furnishes us with the dynamical explanation of the more complicated types of effect produced by the magnetic field. That tripling pure and simple should occur in the case of every spectral line (as predicted by the simplest form of theory) is not a result which we should expect from a broader consideration of the problem. In fact, if we reflect on the subject, we are forced to the conclusion that deviations from the pure triplet type should be expected, and, as we have seen, such deviations actually do occur. In this respect, therefore, the experimental investigation which yields more than the simple theory expected is not to be taken as in any way discordant with that theory, but on the contrary to be in harmony with it.

Theoretical Considerations.

In order that you may form some idea as to what it is that the theory supposes to be in operation in the production of these phenomena, I have had this elliptic frame constructed [model shown], which I ask you for the present to consider as the orbit described by one of those elements of matter which by their motions set up waves in the ether, and thereby emit what we call light. This white ball, which slides on the elliptic frame, is supposed to represent the element of matter. It is sometimes called an ion, which name is used to imply that the element of matter carries an electric charge inherently associated with it.

Now, under ordinary circumstances this ion revolving in its orbit with very great rapidity will continue to do so peacefully unless external forces come into play to disturb it. When external forces come into action, the orbit ceases in general to be the same as before. The orbit becomes perturbed, and the external forces are termed perturbing forces. But you now ask what is the character of the forces introduced by the magnetic field when the ion is moving through it. In answering this, we are to remember that the ion is supposed to be an element of matter charged with an electric charge—or, if you like, an electric charge possessing inertia. Now, if a charged body moves through a magnetic field, it is an experimental fact that it experiences a force arising from the action of the magnetic field on the moving electric charge. The direction of this force is at right angles both to the direction of motion of the charged body and to the direction of the magnetic force in the field. The effect of this force in our case is to cause the elliptic orbits of the ions to rotate round the lines of magnetic force; or to cause them to have a precessional motion [illustrated by model] instead of staying fixed in space, just as the perturbing forces of the planets in the solar system cause the earth's orbit to have a precessional motion. The angular velocity of this precessional motion is proportional to the strength of the magnetic field, and depends also, as you would expect, on the electric charge and the inertia associated with the ion.

This precessional motion of the orbit, combined with the motion of the ion around the orbit, gives the whole motion of the ion in space, and the result of this combined movement, of these two superposed frequencies—viz. the frequency of revolution of the ion in its orbit, and the frequency of rotation of the orbit around the lines of force—is that, in the case of the light radiated across the lines of force, each period becomes associated with two new periods, or, in other words, each spectral line becomes a triplet. A partial analogue to this, which may to some extent help you to understand the introduction of the two new periods, occurs in the case of sound, although the two phenomena at basis are quite different. The analogue (or quasi-analogue) is this. When two notes of given pitch, that is, of given frequency of vibration, are sounded together, their superposition produces two other notes of frequencies which are respectively the sum and the difference of the frequencies of the two given notes. These are known as the summation and the difference tones of the two given notes. Corresponding to these are the two side lines of the magnetic triplet. The frequency of the vibration in one of these lines is the sum, and the frequency of the other is the difference, of the two frequencies mentioned before—namely, the frequency of the revolution of the ion around its orbit and the frequency of the precessional revolution of the orbit round the lines of force. The centre line of the triplet has the frequency of the original vibration, and this frequency disappears completely when the light is viewed along the lines of force—that is, through axial holes pierced in the pole-pieces. In this direction, too, a further peculiarity arises, for not only does the triplet drop its central member and become a doublet, but each member of this doublet is not plane polarised, as the members of the triplet are. They are each, on the contrary, circularly polarised—that is, the vibration is circular instead of being rectilinear.

This all follows as the expectation of the simple theory which supposes that the ions are free to describe their elliptic orbits undisturbed by any forces other than the magnetic field. But it is only to be expected that other perturbing forces must come into play in the assemblage of ions which build up incandescent matter of the source of light. We know, for example, that the other members of the solar system perturb the earth's motion, so that it deviates from the simple elliptic motion predicted by the simple theory which did not take these perturbing forces into account. Hence, if any such perturbing forces exist, and we should be surprised if they did not exist, the tripling pure and simple of the spectral lines will be departed from, and other types will arise. From the character of these new types we may infer the nature of the perturbations which give rise to them, and hence by the study of these types we obtain a view of what is going on in matter when it is emitting light, which we should not possess if such perturbations did not occur. These deviations from pure tripling are consequently of more importance almost, in regard to our future progress, than the discovery of the tripling itself. To give you some idea of the influence of such perturbations in modifying the triplet form, I may mention that it follows, from simple theoretical considerations, that if the perturbing forces cause the orbit to revolve in its own plane, or cause it to change its ellipticity periodically, then each line of the triplet produced by the magnetic field will be doubled and a sextet will result, and other oscillations of the orbit will give rise to other modifications of the normal triplet type. It is not quite easy to see at once, however, what the perturbing forces are exactly, for we do not know the way in which the ions are associated in matter; but if we regard an ion as a charged element of matter describing an orbit, it will be analogous to a closed circuit, or to a magnetic shell, and will be urged to set in some definite way in the magnetic field. In coming into this position, it may oscillate about the position of equilibrium, and thus introduce an oscillation into the precessional motion of the orbit, which may have the effect of doubling or tripling the constituents of the pure precessional triplet.

Now, experimental investigation shows us that all the spectral lines do not become triplets when viewed across the lines of force in a magnetic field, for some lines show as quartets, or sextets, or octets, or in general as complex triplets derived from the normal triplet by replacing each component by a doublet or a triplet. We conclude, therefore, that the ions which give rise to these complex forms are not perfectly free in their motions through the magnetic field, but are constrained in some way by association with each other in groups, or otherwise, while they move in the magnetic field.

Law of the Magnetic Effect.

And now we come to a very important point in this inquiry. According to the simple theory, every spectral line, when viewed across the lines of force, should become a triplet in the magnetic field, and the difference of the vibration frequency between the side lines of the triplet should be the same for all the spectral lines of a given substance. In other words, the precessional frequency should be the same for all the ionic orbits, or the difference of wave-length $\delta\lambda$ between the lateral components of the magnetic triplet should vary inversely as the square of the wave-length of the spectral line under consideration. Now, when we examine this point by experiment, we find that this simple law is very far from being fulfilled. In fact, a very casual survey of the spectrum of any substance shows that the law does not hold even as a rough approximation; for, while some spectral lines show a considerable resolution in the magnetic field, other lines of nearly the same wave-length, in the same substance, are scarcely affected at all. This deviation is most interesting to those who concern themselves with the ultimate structure of matter, for it shows that the mechanism which produces the spectral lines of any given substance is not of the simplicity postulated in the elementary theory of this magnetic effect.

Grouping of Spectral Lines.

Our previous knowledge of the line spectra of different substances might indeed have led us to suspect some such deviation as this from the results predicted by the simple theory. For if we view the line spectrum of a given substance we find that some of the lines are sharp while others are nebulous or diffuse, and that some are long while others are short—in fact, the lines exhibit characteristic differences which lead us to suspect that they are not all produced by the motion of a single unconstrained ion. On closer scrutiny, they are seen to throw themselves into natural groups. For example, in the case of the monad metals sodium, potassium, &c., the spectral lines of each metal form three series of natural pairs, and again, in the case of the diad group, cadmium, zinc, &c., the spectrum of each shows two series of natural triplets, and so on.

Thus, speaking generally, the lines which form the spectrum of a given substance may be arranged in groups which possess similar characteristics as groups. Calling the lines of these groups A_1, B_1, C_1 . . . A_2, B_2, C_2 . . ., A_3, B_3, C_3 . . . we may regard the successive groups as repetitions of the first, so that the A's—that is A_1, A_2, A_3, &c.—are corresponding lines produced probably by the same ion; while the B's—namely, B_1, B_2, B_3, &c.—correspond to one another and are produced by another ion, and so on. This grouping of the spectral lines has been noticed in the case of several substances, and it has been a subject of earnest inquiry amongst spectroscopists for some time past. All such grouping, however, up to the present, has had to depend on the judgment of the observer as to certain similarities in the general character and arrangement of the lines, and similarities which indeed may or may not have any specific relation to the mechanism by which the lines are produced. In fact, such grouping has been effected by guess-work, or by empirical formulæ, and we need not be surprised if it is found that the groups so far obtained are more or less imperfect.

I introduce this grouping of the spectral lines to your notice in order that we may attack the problem of reducing to order the so far apparently lawless magnetic effect. As I have already mentioned, the lines in the spectrum of any given substance are not all resolved into triplets by the magnetic field, but some are resolved into triplets while others become sextets, &c.; and further, the magnitude of this resolution, that is, the interval $\delta\lambda$ between the lateral components, does not appear at first sight to obey any simple law.

Complex Atoms.

According to the prediction of the simple theory, the separation $\delta\lambda$ should be proportional to λ^2, and although this law is not at all obeyed, if we take all the lines of the spectrum as a single group, yet we find that it is obeyed for the different groups if we divide the lines into a series of groups. In other words, the corresponding lines A_1, A_2, A_3, &c., have the same value for the quantity e/m,* or, as we may say, they are produced by the motion of the same ion. The other corresponding lines, B_1, B_2, B_3, &c., have another common value for e/m, and are produced therefore by a different ion, and so on. We are thus led by this magnetic effect to arrange the lines of a given spectrum into natural groups, and from the nature of the effect we are led to suspect that the corresponding lines of these groups are produced by the same ion, and therefore that the atom of any given substance is really a complex consisting of several different ions, each of which gives rise to certain spectral lines, and these ions are associated to form an atom in some peculiar way which stamps the substance with its own peculiar properties.

In order to illustrate the meaning of this, let us consider the spectrum of some such metal as zinc. The bright lines forming the spectrum of this metal arrange themselves to a large extent in sets of three—that is, they group themselves naturally in triplets. Denoting these triplets in ascending order of refrangibility by A_1, B_1, C_1, A_2, B_2, C_2, &c., we find that the lines A_1, A_2, &c., show the same magnetic effect in character, and have the same value of e/m, so that they form a series obeying the theoretical law deduced by Lorentz and Larmor. In the same way, the lines B_1, B_2, B_3, &c., form another series, which also obeys the theoretical law, and possess a common value for the quantity e/m, similarly for the lines C_1, C_2, C_3, &c. The value of e/m for the A series differs from that possessed by the B series, or the C series, and this leads us to infer that the atom of zinc is built up of ions which differ from each other in the value of the quantity e/m, that each of these different ions is effective in producing a certain series of lines in the spectrum of the metal. When we examine the spectrum of cadmium, or of magnesium—that is, when we examine the spectra of other metals of the same chemical group—we find that not only are the spectra homologous, not only do the lines group themselves in similar groups, but we find in addition that the corresponding lines of the different spectra are *similarly* affected by the magnetic field. And further, not only is the character of the magnetic effect the same for the corresponding lines of the different metals of the same chemical group, but the actual magnitude of the resolution as measured by the quantity e/m is the same for the corresponding series of lines in the different spectra. This is illustrated in the following table, and leads us to

Magnetic effect	Nonets or complex triplets	Sextets	Triplets
Cadmium... ... $\lambda=$	5086	4800	4678
Zinc... ... ... $\lambda=$	4811	4722	4680
Magnesium ... $\lambda=$	5184	5173	5167
Precessional spin ...	$\frac{e}{m}=55$	$\frac{e}{m}=87$	$\frac{e}{m}=100$

[This table shows the effect for the three lines which form the first natural triplet in the spectrum of cadmium compared with the corresponding lines in the spectra of zinc and magnesium. It will be seen that the corresponding lines in the different spectra suffer the same magnetic effect both in character and magnitude. Thus the corresponding lines 4800, 4722, 5173 are each resolved into sextets, and the rate at which the ionic orbit is caused to precess is the same for each (denoted by $e/m = 87$ in the table). Similarly for the other corresponding lines.]

believe, or at least to suspect, that the ion which produces the lines A_1, A_2, A_3, &c., in the spectrum of zinc is

* The quantity e is the electric charge of the ion, and m is its inertia, and the ratio e/m determines the precessional frequency, or spin, of the ionic orbit round the lines of magnetic force in a given field.

the same as that which produces the corresponding series A_1, A_2, A_3, &c., in cadmium, and the same for the corresponding sets in the other metals of this chemical group. In other words, we are led to suspect that, not only is the atom a complex composed of an association of different ions, but that the atoms of those substances which lie in the same chemical group are perhaps built up from the same kind of ions, or at least from ions which possess the same e/m, and that the differences which exist in the materials thus constituted arises more from the manner of association of the ions in the atom than from differences in the fundamental character of the ions which build up the atoms; or it may be, indeed, that all ions are fundamentally the same, and that differences in the value of e/m, or in the character of the vibrations emitted by them, or in the spectral lines produced by them, may really arise from the manner in which they are associated together in building up the atom.

This may be an unjustified speculation, but there can be no doubt as to the fascination which inquiry of this kind has always exerted, and must continue to exert, over the human mind. It is the speculation of the ignorant as well as of the philosophic and trained scientific mind, and even though it should never be proved to rest on any substantial basis of fact, it will continue to cast its charm over every investigator of nature.

It is ever the desire of the human mind to see all the phenomena of nature bound by one connecting chain, and the forging of this chain can be realised only gradually and after great labour in the laboratories of science. From time to time, the hope has been entertained that metals may be transmuted, and that one form may be converted into another; and although this hope has been more generally nurtured by avarice and by ignorance rather than by knowledge, yet it is true that we never have had any sufficient reason for totally abandoning that hope, and even though it may never be realised that in practice we shall be able to convert one substance into another, even though the philosopher's stone be for ever beyond our grasp, yet when the recent developments of science, especially in the region of spectrum analysis, are carefully considered, we have, I think, reasonable hope that the time is fast approaching when intimate relations, if not identities, will be seen to exist between forms of matter which have heretofore been considered as quite distinct. Important spectroscopic information pointing in this same direction has been gleaned through a long series of observations by Sir Norman Lockyer on the spectra of the fixed stars, and on the different spectra yielded by the same substance at different temperatures. These observations lend some support to the idea, so long entertained merely as a speculation, that all the various kinds of matter, all the various so-called chemical elements, may be built up in some way of the same fundamental substance; and it is probable that this protyle theory will, in one form or another, continue to haunt the domains of scientific thought, and remain a useful and important factor in our progress, for all time to come.

Even though it may be that a knowledge of the ultimate constitution of matter must for ever remain a sealed book to our inquiries, yet, framed as we are, we must for ever prosecute the extension of our knowledge in every direction; and in pursuing knowledge it frequently happens that vast acquisitions are made through channels which at first seem most unlikely to lead us any further. It has frequently happened that small and obscure effects, obtained after much labour and difficulty, have led to results of the highest importance, while very pronounced and striking effects which have forced themselves on the attention of the observer have proved comparatively barren. It was by a determined effort of this kind, founded on a correct appreciation of the importance of small outstanding differences—so small as to be despised or passed over by all other observers—that Lord Rayleigh discovered a new gas in our atmosphere, added argon to our list of elements, and initiated the attack which led to the brilliant capture by Prof. Ramsay of several new terrestrial substances.

Viewed from this standpoint, I hope I am to some extent justified in occupying your attention this evening with the consideration of the action of magnetism on light, for although the effect produced is small and not easy to observe, yet it is likely to prove an important instrument of research in the study of matter, and it is not inappropriate that a public account of what has been already achieved should be given in this Institution, in which the inquiry was first begun by Faraday, and in which his spirit still lives.

THE DOVER MEETING OF THE BRITISH ASSOCIATION.

THE meeting of the British Association in Dover on September 13 this year promises, on account of its international character, to be a memorable one in the history of the Association. Dover was selected, though it is a smaller town than is usually chosen for these meetings, on account of its nearness to the French coast, in order that an interchange of visits should take place between the British Association and its French counterpart, which meets this year at Boulogne. The French Government has taken a great interest in the arrangements for the meeting, rightly judging that the meeting cannot but promote friendship and good will between the two nations. A good illustration of the truth that science has no nationality will be found in the fact that one of the evening lectures in Dover will be delivered in French by Prof. Chas. Richet, of Paris, on "La vibration Nerveuse." This will take place on Friday, September 15, at 8.30 p.m. It is extremely probable that Prof. Fleming will find some way of imparting an international character to his lecture on the "Centenary of the Electric Current," to be delivered on Monday, September 18.

The preliminary arrangements for the meeting are well in hand. The usual handbook is being prepared under the editorship of Dr. Sebastian Evans, brother of the ex-President of the Association, and will deal with Dover both in its ancient and modern aspect. The historical part of the subject has been undertaken by the Rev. S. P. H. Statham, Chaplain to the Forces, who has recently written a history of the castle, town, and port of Dover. The geology of the district is in the able hands of Prof. Boyd Dawkins; the botany in those of Mr. Sydney Webb. Dr. Parsons undertakes the climate, health and meteorology of Dover; whilst the harbour and cross-Channel traffic is described by Mr. A. T. Walmisley, C.E., the Harbour Board Engineer. This portion of the handbook should be extremely interesting in view of the national harbour which has been undertaken by the Government after more than fifty years' delay, and which will turn Dover into one of our most important naval ports.

For a town of its size Dover possesses an unusually large number of rooms suitable for public meetings, so little difficulty has been experienced in providing for the Sections. The Town Hall, with its annexe, the ancient Maison Dieu, will serve for the President's address and the soirées. The School of Art, in which five of the Sections assemble, adjoins and communicates with the Town Hall. The reception rooms and offices have an ideal *locale* in the buildings and grounds of the Dover College. This institution was founded some thirty years ago in what remains of the Dover Priory, established about 1130. The magnificent Norman refectory will serve as the reception room and ticket office. The College is only about three minutes' walk from the Priory Station (L.C.D. Railway), and about as far from the Town Hall. Two of the Sections (anthropology and geography) will meet in a part of the town somewhat more remote from the reception room.

There will be no lack of entertainment of a public character. The General Commanding the South Eastern District (Sir Leslie Rundle) will give a garden party at the Castle; the Council, head-master and assistant-masters of Dover College will give another in the College grounds. The Mayor (Sir William Crundall) will give a conversazione, and will also give a reception one afternoon at the Dover Athletic Grounds, when there will be an exhibition and contest of motor cars from all parts of Europe and America.

The smoking concert, which was so successful a feature of the Bristol meeting last year, will be repeated. There will also be a military tattoo by torchlight on the sea front one evening, with music by the massed bands of the garrison.

The visit of the French Association is to take place on Saturday, September 16. The members will arrive early, and, after a light repast at the Lord Warden Hotel, will assemble at the Town Hall, when addresses of welcome will be given. An adjournment will then be made to the various Sections, which will meet on Saturday this year, though that day is generally an "off-day." In many Sections the presidents will reserve their presidential addresses for this occasion, so as to give the French guests a chance of being present. There will be a luncheon afterwards in a marquee in the College grounds. In the afternoon, parties will visit the Castle and other objects of interest in Dover. There may be opportunity for a visit to Canterbury.

On Sunday there will be special services in most of the churches and chapels of Dover, whilst those who care to go further afield can take advantage of the arrangements made by Dean Farrar, of Canterbury, one of the vice-presidents of the Association this year, for there will be special services in the Cathedral, with well-known preachers, and an organ recital in the afternoon. The Canterbury Museum, which owes much to the munificence of its Hon. Curator, Mr. Bennett Goldney, a most useful member of the Dover Local Committee, will be open to members of the Association on Sunday afternoon.

The return visit of the British Association to the French will take place on Thursday, September 21. The details are not finally settled, but there will be a *réunion* with addresses, a luncheon, the unveiling of a plaque to the poet Campbell, who lived at Boulogne for some time. A statue to the French man of science, Duchesne, will also be unveiled. It is intended to start from Boulogne on the five days' excursion through the most interesting towns of Northern France and Belgium. The civic authorities in each town have very cordially responded to the efforts of the French and the Belgian consuls in Dover, and have promised to do all in their power to make the five days' excursion a great success.

Amongst the scientific men from the Continent, the United States and Canada, who have already accepted the invitation of the Local Committee, may be mentioned Profs. Dwelshauvers-Dery, Fittig, Gobert, Julin, Kronecker, Calmette, Chappuis, Barker, Carl Barus, Surgeon-General Billings, Profs. Bovey, Campbell, Scott, Thurston, and Van Rijckevorsel.

From what has been stated, it will be evident that those members of the Association who visit Dover will have no cause to be dissatisfied with the programme before them.

W. H. PENDLEBURY.

THE VOLTA CENTENARY EXHIBITION AT COMO.

IN this age of electricity it is difficult to realise that only a hundred years have elapsed since the first electric current was produced by chemical means. The birthplace of Alessandro Volta has paid a fitting tribute to the pioneer of electrical science by holding an exhibition in commemoration of the discovery of the pile which bears the name of its inventor.

The Como Exhibition, which was opened on May 20, occupies a tract of land bordering on the Lake of Como, its natural surroundings harmonising well with the artistic arrangement of the buildings and exhibits. One section is devoted to electricity, another to the silk industries of Lombardy, while a small collection of pictures, church vestments, &c., forms a minor feature.

International Congresses of electricians and of telegraphists have been organised at Como. At the latter Congress, which was held on May 31, an inaugural address was given by Di San Giuliano, and a competition between professional telegraphists took place.

In the electric exhibits, applied electricity occupies, as might be expected, the most prominent place. All the machines in the exhibition, including the silk-spinning and weaving machinery, a lift to the top of one of the towers, and a high-pressure pump for supplying the fountains, are worked by electricity, each machine having a separate motor.

The principal source of power is a compound "Brünner" horizontal engine worked by steam supplied from two "Babcock and Wilson" boilers. The 150 horse-power thus supplied is transmitted to a steel shaft, where it can be increased up to 300 horse-power by a motor driven by a three-phase alternating current of 3600 volts, the generating plant for which consists of an engine of 100–150 horse-power by Wolf, of Magdeburg, and an alternator by Gadda and Co., of Milan. The main shaft can be connected with ten dynamos by different makers, varying from 24 to 300 horse-power, and as these cannot all be used simultaneously, a comparison of their efficiency is possible. Subsidiary electric power is supplied by three steam and two gas engines operating on dynamos, by Brioschi and other makers, and a fine series of accumulators is available for reinforcing the supply of power which, even without this help, is available up to 500 horse-power.

A large search-light exhibited by the Italian navy has been placed at Brunate, a station 1500 feet above sea-level, whence its rays can be flashed over Como and the surrounding district to a distance of many miles.

Technical instruction in electricity is well represented, while the purely physical side comprises exhibits of Röntgen ray apparatus, wireless telegraphy, electrostatic apparatus by A. Dall' Eco and other makers, and so forth.

One room in the exhibition buildings is set apart for the "Cimelii di Volta," under which head are comprised Volta's physical apparatus, original manuscripts of his papers, his letters, diplomas, and many of his personal effects. The greater part of these relics are exhibited by the Reale Istituto Lombardo, under whose auspices the collection was formed by public subscription in the years 1861 to 1864; for this collection, one of the rooms belonging to the Society at Milan has been specially set apart. Other relics, chiefly personal, are exhibited by Prof. Alessandro Volta and Prof. Zanino Volta. The University of Pavia exhibits several electroscopes, condensers, and similar electrostatic apparatus; and other exhibits are lent by the Como Museum.

The manuscripts include the following:—

(1) A letter to Volta from the French physicist Nollet, dated September 18, 1767.

(2) A letter from Volta to Prof. Barletti, of Pavia, dated April 18, 1777, containing an anticipation of the electric telegraph. Volta suggests the possibility of connecting Milan and Como with a wire suspended from poles, so that an operator at one end of the line could fire an electric pistol at the other.

(3) A manuscript dated May 14, 1782, dealing with animal electricity.

(4) Volta's paper of March 20, 1800, announcing his discovery of the electric pile to Sir Joseph Banks, President of the Royal Society.

(5) Volta's monograph on the formation of hail, published about 1806.

The apparatus exhibited illustrate Volta's inventions of the electrophorus and the "electric pistol," his application of gas to lamps, combined with an electric gas-lighting apparatus, his invention of the eudiometer, his researches on the capacity of condensers, his condensing electroscope, his investigations on the law of electrostatic force involving the use of the electric balances and the electrometer, his researches on atmospheric electricity, his studies on the expansion of gases, his first forms of voltaic pile, including the columnar pile represented by several examples, also the "crown of cups," and his early experiments on electrolysis. A number of batteries of Leyden jars, electrostatic machines, and other apparatus used by Volta in his experiments, while not referring to any special advancements in science, go far towards giving us an insight into the thoughts and pursuits of a physicist of a century ago, of whom the people of Como feel justly proud. G. H. BRYAN.

UNITED STATES GEOLOGICAL SURVEY.

THE literature of American geology increases at an almost overwhelming rate. We have just received three large volumes containing 2053 pages of letterpress, including Part ii. of the Eighteenth Annual Report of the Survey for 1896-97, being papers chiefly of a theoretical nature; and Part v., the Mineral Resources, in two volumes. We have already called attention in NATURE for May 4 to some of the papers contained in Part ii., of which we received advance copies; these were on "The Triassic Formation of Connecticut," by W. M. Davis, with coloured maps and sections; on the "Geology of the Edwards Plateau and Rio Grande Plain adjacent to Austin and San Antonio, Texas, with reference to the occurrence of underground waters," by R. T. Hill and T. W. Vaughan; and "A Table of the North American Tertiary Horizons, correlated with one another and with those of Western Europe, with annotations," by Mr. William H. Dall.

In addition, this volume contains a report on the "Glaciers of Mount Rainier," by I. C. Russell, with a paper on "The Rocks of Mount Rainier," by G. O. Smith. Associated with the Cascade range in the State of Washington, but of later date and distinct from it both geographically and geologically, are four prominent volcanic mountains, of which one is Mount Rainier, 14,526 feet in height. This mountain is an extinct volcano, but the residual heat of its once molten rocks gives origin to steam-jets, which escape from crevices in the now partially snow-filled craters at the summit. The main mass consists of fragmental andesitic and basaltic materials, with some lava streams; but its outlines have been modified by frost and storms, and deeply sculptured by glaciers. The glaciers are now receding. The scenery around the mountain possesses such great beauty and grandeur that a portion of ground was reserved as a National Park in 1893, and it is now intended to reserve a larger area. Numerous views of the scenery are given.

"The Age of the Franklin White Limestone of Sussex County, New Jersey," is discussed by J. E. Wolff and A. H. Brooks. This limestone occurs in the Pre-Cambrian or Archæan highlands of New Jersey, an area largely occupied by gneisses. These schistose rocks have a nearly constant north-east strike and south-east foliation-dip, with a frequent linear parallel structure which is usually "inclined at a moderate angle to the north-east, lying generally in the plane of dip, and is called 'pitch.'" It is observed that the foliation structure in the limestone is usually parallel to that in the gneiss, and "the pitch structures of the gneiss, white limestone, and associated [magnetite] ore deposits have a general parallelism both in direction and angle." Mr. Wolff regards the pitch-structure as due to primary crystallisation. The authors conclude that the white limestone was deformed, metamorphosed, and partly eroded before the basal member of the Cambrian series was laid down.

"A Geological Sketch of San Clemente Island" is contributed by W. S. T. Smith. This island is the southernmost of a group known as the Channel Islands, which lie off the southern coast of California. It has no permanent human inhabitants except one old man, who has lived there most of the time for the last thirty years. Sheep, cattle and wild goats have been introduced, and there are foxes, lizards and land-shells. The vegetation is limited almost entirely to low shrubbery and herbage. The cactus and "salt-grass" are abundant. The island has a length of nearly twenty-one miles, a maximum width of little over four miles, and an altitude at one point of nearly 2000 feet. It is built up almost entirely of lava flows, with intercalated volcanic breccias and ashes. A detailed account of these is given. Miocene and later sedimentary deposits occupy small areas. The volcanic rocks appear to have been of Miocene age, but older than any of the sedimentary deposits. Attention is drawn to the evidence of faulting which occurred between the close of the Miocene and early Pliocene times, and which has had a marked effect on the physica features of the island. This faulting has continued at intervals ever since.

"The Geology of the Cape Cod District" is described by N. S. Shaler. He discusses the series of geological events which occurred since the beginning of the Cretaceous period in the south-eastern portion of New England. After tilting and the erosion of the Cretaceous and Tertiary beds, various Pleistocene deposits were laid down, and these in turn became somewhat disturbed. The region, in fact, has evidently been one of remarkable instability. A very full and interesting account is given of the structure of the region and of the glacial and post-glacial phenomena, illustrated by numerous views and sections.

"Recent Earth Movement in the Great Lakes Region" is the title of an article by G. K. Gilbert. He points out that although modern movements are of small amount, it is believed that they are of the same kind as the ancient, and that the great changes of the geologic past were effected slowly. His observations now lead to the conclusion that the whole North American lake-region is being lifted on one side or depressed on the other, so that its plane is bodily canted towards the south-south-west, and that the rate of change is such that the two ends of a line 100 miles long and lying in a south-south-west direction are relatively displaced four-tenths of a foot in 100 years. The changes are not directly obvious owing to inequalities of rainfall and evaporation, but the mean height of the lake-surfaces has been affected. With reference to the economic bearings of these changes Mr. Gilbert remarks that the modifications are so slow that they may have small importance in engineering works. He observes, however, that it is a matter of greater moment that cities and towns built on lowlands about Lakes Ontario, Erie, Michigan, and Superior will sooner or later feel the encroachment of the advancing water, and it is peculiarly unfortunate that Chicago, the largest city on the lakes, stands on a sinking plain that is now but little above the high-water level of Lake Michigan.

The two volumes on mineral resources contain a large amount of valuable information, much of it statistical. The products for 1896 showed only a slight increase in value over those for 1895. There are lengthy reports on iron-ores, on the iron and steel industries of all countries, and on the Witwatersrand banket and other gold-bearing conglomerates, most of which appear to be marine. The evidence given in reference to these auriferous deposits shows that in ancient formations the detrital gold is most likely to be found in marine shore deposits. There are shorter reports on copper, lead and zinc, on aluminium with references to bauxite from Georgia and Alabama, on quicksilver, manganese, nickel, cobalt, antimony, and platinum; 163 ounces of platinum were obtained in the United States, and it is mentioned that a nugget weighing 20 ounces was found in Columbia, South America. Coal and coke are treated very fully, so also are petroleum and natural gas. Building-stones, clays, cement, precious stones, phosphates, mineral paints, and a variety of other substences are dealt with. It is noted that black shale is ground for the pigment known as mineral black. Fuller's earth has been reported from a number of localities. Observations have been made on various limestones considered likely to be useful for lithography, and it is reported that South Dakota promises to furnish suitable stone. The final report is devoted to mineral waters.

THE REPORT OF THE INTERNATIONAL AERONAUTICAL SOCIETY.

THE International Meteorological Conference of Paris, 1896 (NATURE, vol. liv. p. 523) appointed various committees to discuss and report on certain scientific questions. One of these committees was entrusted with all questions connected with the science of aeronautics, such as the scientific use of balloons and kites.

Of this committee, Dr. H. Hergesell of Strassburg was the chairman, and Dr. W. de Fonvielle the secretary.

The committee held a meeting at Strassburg, March 31–April 4, 1898, and the report of this meeting, in two languages—German and French—has just appeared.

The meeting was attended by some twenty-five gentlemen, for the most part original or co-opted members of the committee.

During the interval of eighteen months between the meeting in Paris and that at Strassburg, several concerted balloon ascents had been organised and carried out. The area over which balloons, either manned or simply fitted with registering apparatus, had been sent up, extended from St. Petersburg to Paris, and a fair number of balloons took part on each occasion.

The chief business of the Strassburg meeting was to receive and consider the reports of these concerted experiments, and from the experience gained to arrive, if possible, at improvements in apparatus and arrangements for future work.

Among other matters, the preparation of sufficiently sensitive thermographs, to register sudden alternations of temperature, was especially recommended, and also the use of liquid air for the purpose of testing thermometers liable to exposure to extreme temperatures in unmanned balloons.

An interesting paper by Mr. Rotch on his kite work at Blue Hill Observatory, Massachusetts, was also handed in and included in the report.

Various special reports will be found in the appendices.

NOTES.

A DEPUTATION will wait upon Mr. Balfour to-day to place before him reasons why national support should be given to an Antarctic expedition. It is understood that the Government is favourably inclined to the views of the deputation, and that the intention to make a grant towards the cost of the proposed expedition will be announced.

PROF. E. A. SCHÄFER, F.R.S., has been elected successor to the late Prof. Rutherford in the chair of physiology in the University of Edinburgh. Prof. Schäfer is forty-three years of age, and he has been Jodrell professor of physiology in University College, London, since 1863, when he succeeded Sir J. S. Burdon Sanderson.

THE annual conversazione of the Royal Society took place yesterday evening as we went to press.

SIR W. H. WHITE, K.C.B., F.R.S., will receive the freedom of the borough of Devonport on July 20, and will unveil, at the Technical School, a window descriptive of naval architecture.

DR. W. F. HUME, who during the last eight months has been carrying out a geological and topographical survey of the peninsula of Sinai, under the auspices of the Egyptian Government, has returned to Cairo with his survey party.

DR. CYRUS ADLER contributes to *Science* of June 2 and 9 a detailed account of the proceedings of the second conference on the International Catalogue of Scientific Literature, held at the Royal Society last October. The official Acta of the conference appeared in NATURE of October 27, 1898 (vol. lviii. p. 623).

M. PH. VAN TIEGHEM, Professor at the Museum of Natural History and President of the French Academy of Sciences, has been appointed to the chair of Biology of plants cultivated in France and the Colonies at the National Agronomic Institute, Paris; and M. G. Poirault succeeds the late M. Naudin as Director of the Laboratory for Higher Instruction at the Villa Thuret, Antibes.

PROF. ALFRED GIARD, the president of the section o. zoology, anatomy, and physiology of the French Association for the Advancement of Science, has issued a circular in which he points out that as zoological members of the British Association will visit Boulogne, and attend some of the meetings of the French Association, the meeting will afford a good opportunity of discussing questions referring to pisciculture and marine fisheries. Papers dealing with the special zoology of the Channel or of the North Sea are therefore especially invited.

THE International Hydrographic and Biological Congress, which is to discuss the arrangement of periodical researches into the conditions of the North Sea and North Atlantic, was opened at Stockholm on Thursday last. M. Krusenstjerna, Minister of the Interior, delivered a speech, in which he welcomed the delegates in the name of the King of Sweden and Norway. Director-General Akermann (Sweden) was chosen president of the congress.

THE Liverpool School of Tropical Diseases is sending out to the West African coast a special expedition to investigate the causes of malaria and other diseases. The expedition will be headed by Major Ross, the recently-appointed lecturer, and will include Dr. Sunnett, the demonstrator to the Liverpool School. The party will start for Sierra Leone early in August, when the malarial season is at its height, and the conditions are most favourable for research. The expedition hopes to determine, by the methods which Major Ross employed in India, which are the malaria-bearing species of mosquito in the locality chosen, and then inquire whether it is possible, by filling up the particular puddles in which they breed, to exterminate malaria in a given district.

ON Saturday last, the French naval authorities, acting in conjunction with Mr. Marconi, conducted some successful experiments with wireless telegraphy, between a ship and the shore in the English Channel. The French storeship *Vienne* was used for the purpose. Up to Saturday the distance between the South Foreland and Boulogne, about twenty-eight miles, was the greatest space through which these messages have been transmitted. On Saturday messages were sent between the vessel and the English coast from off Boulogne, and afterwards at intervals, until the vessel was twelve or fourteen miles away from that port. The greatest distance through which the messages were transmitted was forty-two miles. It is stated that Mr. Marconi's method of limiting the area of influence of the waves used was successfully applied. The messages were sent at will either to Wimereux or to the South Foreland, without the other station being able to intercept them.

A MARINE exploring expedition to the mid-Pacific, under the direction of Prof. A. Agassiz, is being arranged by the U.S. Commission of Fish and Fisheries. The expedition will leave San Francisco about the middle of August, and proceed directly to Tahiti, in the Society Islands, which will be made the headquarters while the Paumotu Islands are being explored. In this archipelago, which is about 600 miles long, the *Albatross* will pass six or eight weeks. After returning to the Society Islands, the vessel will go to the Tonga, or Friendly Islands, where a week or ten days will be spent. Thence the vessel will sail for the Fiji Islands, where a short stay will be made, and thence to the Marshall Islands, visiting a number of the Ellice Islands and Gilbert Islands on the way. Six or seven weeks will be devoted to the exploration of the Marshall Islands. Between the Marshall Islands and the Hawaiian Islands, and between the latter and San Francisco, a distance of over 4000 miles, a line of deep-sea dredgings will be run, deep-sea townets being used while the dredging is going on. The *Albatross* is expected to return to the United States in April next year. Every effort is being made to thoroughly equip the vessel for deep-sea dredging, trawling and sounding; surface and intermediate towing; shore seining; fishing trials with lines and nets; land collecting, and other branches of the work. The newest apparatus for deep-sea and plankton investigations will be supplied. Special appliances are being constructed for use in the very deep water to be found about some of the islands.

A PARAGRAPH on the thermal conductivity of cast iron, as determined by Messrs. E. H. Hall and C. H. Ayres, appeared in NATURE of April 13 (p. 563). The thermal conductivity of the cast iron used was found to be about 0·1490 at 30° C. Mr. I. Thornton Osmond, Dean of the Pennsylvania State College, calls our attention to the fact that this result differs from values obtained under his direction in 1894, and described in the *Physical Review* of that year (vol. ii. No. 3, Nov.-Dec.). For the cast iron used in this investigation, the thermal conductivity from 60° C. to 90° C. or 100° C. was found to be a little over 0·09; and from 150° C. to 200° C. a little over 0·11. Mr. Osmond adds: "Though believing, from theoretical considerations, the conductivity to be a direct function of temperature, these figures were somewhat surprising; and I made preparation to have the work repeated through a greater temperature range and with great care; but this was never carried into effect. The method used was that of Principal Forbes, substituting thermopile and galvanometer for mercury thermometers, thus greatly reducing the cavities in the bar."

WE regret to learn that among other steps taken in reducing the expenditure of the Colony of Jamaica, it has been decided to withdraw the annual contribution towards the Weather Service, which has for the last eighteen years been under the control of Mr. Maxwell Hall, and to substitute a vote of 50*l*. for the collection and tabulation of statistics of rainfall and temperature. The letter from the Colonial Secretary seems to suggest that one reason for the step taken was that the full co-operation on the part of other Colonies and countries, which was necessary to make the scheme a complete one, was not forthcoming. The Service consisted of one first-class station, six stations of the second and third classes, and about two hundred rainfall stations. The vote was a very small one, and the director appears to have done good work, and to have been successful in issuing storm warnings and rainfall forecasts, although the latter could not reach those principally interested. Various useful investigations have been undertaken and published in the Jamaica Weather Reports, or elsewhere.

THE volume of hourly means of the readings obtained from the self-recording instruments at the five observatories under the Meteorological Council, just published for the year 1895, completes the lustrum 1891–1895; an appendix has therefore been added to the usual tables for the year in question, showing the mean values for that period. In addition to these values, hourly and other means of pressure, temperature and rainfall are given for four observatories, for a period of twenty-five years, and of sunshine for fifteen years. These averages afford valuable data for climatological or other more minute investigations. Further, in deference to a recommendation of the international meteorological conference at Paris in 1896, the hourly readings for some elements are given for two stations—Valencia Observatory as a typical Atlantic Coast station, and Kew Observatory as a typical inland station, and it is intended to continue this departure in future volumes.

PROF. ARRHENIUS contributes to the *Revue Générale des Sciences* an interesting account of his investigations into the causes of secular variations of temperature at the earth's surface. It is shown that widespread changes of mean temperature are more likely to be due to variations in the proportion of terrestrial rays absorbed by the atmosphere than to any variation connected with the solar rays, and that the absorption of terrestrial rays is most likely to be affected by changes in the amount of carbonic acid present in the atmosphere. Using Langley's data, it is calculated that if the amount of carbonic acid were diminished by a little more than half, the temperature would be lowered by about 4°·5 C., while an increase to two and a half or three times the present amount would raise the temperature about 8°·5 C., corresponding to the conditions of Glacial and Eocene times respectively. This calculation gives rise to some interesting speculation as to the possibility of such changes having taken place as the result of volcanic or erosive action, and the effect of the artificial consumption of carbon in raising the temperature of the air.

THE *National Geographic Magazine* for May contains a paper by Mr. J. B. Leiberg, entitled "Is climatic aridity impending on the Pacific slope?" The arid non-forested regions of eastern Oregon, and the semi-arid, sub-humid, and humid forest tracts are examined separately, and in each case evidence is found of adverse climatic change taking place in the direction of aridity.

THE parietal eye, with its adjacent organs, of the New Zealand Tuatera (*Sphenodon*) receives attention at the hands of Dr. A. Dendy in the May issue of the *Quart. Journ. Micr. Soc.* This functionless eye, which, although deeply buried in the integument, is better developed in the reptile named than in any other animal, has hitherto been very generally considered as an unpaired organ. Recent investigations, especially those of the author, point, however, to the conclusion that it was originally dual, like the other sense-organs; and that the parietal eyes were once serially homologous with the functional pair now possessed by vertebrates. In the Tuatera, it is believed that the single parietal eye now developed belongs to the left side, its fellow being represented by an organ of essentially similar structure known as the parietal stalk.

IN the June number of *Nature Notes*, Mr. R. Morley calls attention to the great destruction of monkeys on the Gold Coast for the sake of their skins. It is stated that in the five years preceding 1892 the average annual export of their skins reached 175,000, with a value of 30,000*l*. As skins in prime condition are alone purchased, this may be taken to represent a yearly slaughter of 200,000 monkeys, mostly belonging to a species of Guereza (*Colobus vellerosus*). In 1894 the number of skins was 168,405, valued at 41,001*l*.; but in 1896 the number fell to 67,600, with a value of 8,662*l*. This shrinkage tells its own tale; and if effectual steps are not forthwith taken to stop the slaughter, it may be considered as certain that in a few years this very beautiful species will be practically exterminated.

IN one respect at least it appears that the Madras University is in advance of kindred institutions at home, as students of history are required to possess some knowledge of ethnology and comparative philology. Surely it is time that the anthropological basis of history and sociology was fully recognised in British universities and colleges. Even the enlightened Madras University has to confess that there are no facilities for practical instruction at the colleges. Fully realising that information merely derived from books or lectures is insufficient for education, Mr. Edgar Thurston, the superintendent of the Madras Government Museum, has, with characteristic energy and enthusiasm, supplied the deficiency so far as he is able, and last year gave a course of demonstrations on practical anthropology at the museum. Mr. Thurston not only instructed the students in the technical methods employed, but demonstrated the forms of skulls and external characteristics of the living, and showed how the statistics so obtained elucidated the problems of the migrations of peoples. The collections of prehistoric archæology in the museum afforded proof of the antiquity of man, and the ethnographical collections illustrated the present condition of various tribes.

THE "Struggle between Peoples" is the title of a short paper in the *Bulletins de la Soc. d'Anthropologie*, viii. p. 604, by Félix Regnault, in which he opposes the ordinary view that conquered peoples take refuge in the mountains. It is true the last resistance to invaders is made in the mountains, but that is by the mountaineers, and not by the inhabitants of the plains who have been driven into the mountains. M. Regnault also discusses the effect of a nomad people coming into contact with agriculturists: in some instances, the agriculturists win, and the conquered occupy the less fertile or arid lands; in other cases, the pastoral people conquer the tillers of the soil, but though they temporarily overwhelm them, the latter persist and emerge, and the pastors eventually maintain themselves only in those lands which are favourable to keeping flocks.

A HIGHLY interesting and important contribution to the study of immunity is to be found in a paper by Rudolf Emmerich and Oscar Löw, published in a recent number of the *Zeitschrift für Hygiene*. The authors have obtained from cultures of the *B. pyocyaneus* an enzyme which, when inoculated into animals infected with virulent anthrax bacilli, is able to entirely negative the action of the latter. Success has also attended their efforts to immunise animals against anthrax infection. The method of preparing the substance, which they call "pyocyanase-immun-proteïdin," is not yet perfect, and the details are promised in a later communication. This enzyme is also able to act deleteriously upon typhoid, diphtheria, and plague bacilli *in vitro*, and, curiously, is much more pronounced in its action under anaërobic conditions. It possesses a remarkable power of retaining its bactericidal properties under exposure to high temperatures. Thus 1½ hours of a temperature of from 85 to 90° C., and exposure for 1½ hours to a temperature of 98°·5, and being steamed for an hour at 98°·5 C., all fail to remove its beneficial characteristics. A prospect is now held out by these investigations of obtaining antitoxic substances in a far less costly and cumbrous manner than is involved in procuring curative serums through the medium of living animals; and perhaps the hope of the authors is not unjustified that, "by means of further improvements in immunising methods, the human and animal organisms may be ultimately protected from every conceivable kind of natural infection . . . it only depends upon obtaining the enzyme of certain pathogenic bacteria in the purest possible condition, and their harmless introduction into the body."

A CURIOUS instance of a polymorphous bacterium has been recently given by S. Hashimoto, of Sapporo (Japan), who, working in the Halle Hygienic Institute, has found a microbe which assumes at one time the appearance of small motile rods, at another that of thick, plump cocci hanging together in chains of from ten to twenty individuals, whilst yet more interesting is its assumption of the sarcina form, grouped together in packets consisting of from eight to sixteen individual cells. Every precaution was taken to meet the not unwarranted suspicion that these various appearances were simply due to working with an impure cultivation, but even such a master in technique as Prof. Fraenkl could discern no flaw in the manipulations, and moreover was able to confirm in every particular the interesting discovery of his pupil. The microbe in question was originally obtained from an agar-plate which had been mixed with imperfectly sterilised milk, previously kept for some days in an incubator.

IN the June number of the *American Journal of Science* appears a full and detailed memoir of the life and works of the late Prof. O. C. Marsh, with a portrait. Especial interest attaches to the account of his early journeys into Indian territory; and the exposure of the nefarious treatment of the Indians themselves, which he was so largely instrumental in bringing about. The paper concludes with a complete list of Marsh's publications. The writer agrees with the opinion already expressed in this journal, that the time is not yet ripe for forming an adequate estimation of the late Professor's labours.

Bulletin No. 61 of the Massachusetts Agricultural College (Hatch Experiment Station) is devoted to an account of the life-history of the asparagus-rust, *Puccinia asparagi*, and of the best modes of treatment of plants infested with it.

IN a recent number of Bonnier's *Revue générale de botanique*, M. Guignard records some remarkable observations on the mode of impregnation in *Lilium martagon*. He claims for the two generative nuclei of the pollen-tube the term "antherozoids," to indicate their homology with the corresponding bodies in Gymnosperms and in the higher Cryptogams. Although not provided with cilia, they both elongate and assume a vermiform appearance before entering the embryo-sac, the indications of a spiral form being still evident. The two "antherozoids" both take part in the process of impregnation, the one fusing with the ovum-cell or oosphere, the other with the secondary nucleus of the embryo-sac, or with one of its constituent polar nuclei, to form the endosperm. There is, therefore, in *Lilium martagon*, according to M. Guignard, a double process of conjugation; but the union of the "antherozoid" with the secondary nucleus of the embryo-sac he regards as a process of "pseudo-fecundation." Similar results have been obtained by Prof. S. Nawaschin, and they have been confirmed by Miss Ethel Sargant in a paper read before the Royal Society on May 4.

THE third part of the series of memoirs, in course of publication by the Cambridge University Press, on the material collected during Dr. Arthur Willey's expedition to the Pacific in search of the eggs of the Pearly Nautilus, has just been issued. Three papers are contained therein, dealing respectively with orthogenetic variation in the shells of Chelonia, by Dr. Hans Gadow; Enteropneusta from the South Pacific, by Dr. Willey; and a collection of Echiurids, by Mr. A. E. Shipley.

AN account of the communications and discussions at the International Congress of Zoologists, which met at Cambridge in August last, was given in NATURE at the time of the meeting (vol. lviii. p. 424). A fine volume of *Proceedings*, edited by Mr. Adam Sedgwick, F.R.S., has now been published by Messrs. C. J. Clay and Sons. The volume contains the papers and addresses read before the congress, with reports of remarks made upon the subjects of these communications, and also during the discussions of specific points of zoological importance. Fifteen coloured plates are appended to the volume to illustrate some of the papers. The nature of the contents can be judged from our summary of the work of the congress, and the editor is to be congratulated upon being able to see the *Proceedings* published nine months after the meeting. Few official reports of international congresses appear with such commendable promptitude.

A DIAZO-BODY is a substance obtained by the interaction of nitrous acid and an amine (such as aniline) under certain conditions of temperature. Perhaps no other reaction in organic chemistry is so important either theoretically or technically, and it is so fundamental that the term "to diazotise" has been coined to express the operation. Diazo-compounds are of the general type R.N=N.OH, where R may be any benzene group (C_6H_5, and so on), and are distinguished by their great nstability and explosive power, tending to give off nitrogen. By very simple reactions the substance R.N=N.OH may be made to give R.OH, R.Cl, RBr, RI, RH, $R.NH_2$, $R.NH.NH_2$. In many questions of constitution of benzene ring compounds, the exchange of the diazo-group for the sulphonic group is a necessary step in the argument. The methods hitherto proposed for carrying out this reaction give, in general, very bad yields and involve the production of evil-smelling thio-compounds as intermediary products. In a recent number of the *Berichte*, Dr. Ludwig Gattermann describes a very elegant method, the discovery of which, he states, was due to a happy accident which depends upon the formation of a sulphinic acid directly from the diazo-compound. The diazo solution, preferably as sulphate, is mixed with an excess of sulphuric acid and saturated with sulphur dioxide, and then treated at 0° C. with finely-divided metallic copper, when the sulphinic acid is formed in practically theoretical quantity. The method has been found to be of wide applicability, equally good yields being obtained in the naphthalene series.

THE additions to the Zoological Society's Gardens during the past week include a Hoolock Gibbon (*Hylobates hoolock*, ♂) from Upper Burma, presented by Mr. S. B. Bates; two Blue-bearded Jays (*Cyanocorax cyanopogon*) from Brazil, presented by Mr. Arthur Ussher; a Laughing Kingfisher (*Dacelo gigantea*) from Australia, presented by the Hon. A. Littleton; two Black-bellied Sand-Grouse (*Pterocles arenarius*) from Asia, presented by Mr. G. P. Torrens; twelve Sharp-headed Lizards (*Lacerta dugesi*) from Madeira, presented by Mr. R. H. Archer; two Green Lizards (*Lacerta viridis*), a Tessellated Snake (*Tropidonotus tessellatus*), a Common Snake (*Tropidonotus natrix*), European, presented by the Rev. F. W. Haines; a Northern Mocking-Bird (*Mimus polyglottus*) from North America, presented by Mr. C. Gillett; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, two Spiny-tailed Iguanas (*Ctenosura acanthura*) from Central America, deposited; two Derbian Screamers (*Chauna derbiana*) from Colombia, two Palm Squirrels (*Sciurus palmarum*) from India, a Diamond Python (*Python spilotes*) from Australia, purchased; two Burrhel Wild Sheep (*Ovis burrhel*, ♂ ♀), two Jameson's Gulls (*Larus novae-hollandiae*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

TEMPEL'S COMET 1899 *c* (1873 II.)—M. L. Schulhof has calculated new elements and a continued ephemeris for this comet, using the positions supplied from the observations of Messrs. Perrine and Javelle, made at Lick and Nice respectively. *Astr. Nach.* (Bd. 149, No. 3574).

Elements.

T = 1899, September 6·0 Paris Mean Time.

	° ′ ″	
M =	7 21 50·5	
π =	185 36 20·0	1899·0
☊ =	120 57 56·3	1899·0
i =	12 38 52·6	1899·0
φ =	32 49 38·7	
μ =	671″·9166	

Ephemeris for 12h. Paris Mean Time.

1899.		R.A. h. m. s.		Decl. ° ′ ″		Br.
June 25	...	20 8 16·8	...	− 7 23 2	...	2·282
26	...	9 36·7	...	7 40 5		
27	...	10 56·1	...	7 57 54		
28	...	12 15·0	...	8 16 30		
29	...	20 13 33·4	...	− 8 35 52	...	2·525

COMET 1899 *a* (SWIFT).—Dr. A. Stichtenoth, of Kiel, contributes a continued ephemeris of this comet to *Astr. Nach.* (Bd. 149, No. 3574).

Ephemeris for 12h. Berlin Mean Time.

1899.		R.A. h. m. s.		Decl. ° ′		Br.
June 22	...	14 38 41	...	+27 37·1	...	0·27
23	...	36 6	...	26 39·4		
24	...	33 43	...	25 44·1	...	0·23
25	...	31 34	...	24 51·3		
26	...	29 34	...	24 0·8		
27	...	27 44	...	23 12·6		
28	...	26 3	...	22 26·4	...	0·17
29	...	14 24 31	...	+21 42·3		

During the week the comet travels almost in a direct line between the stars ε and α Bootis. It can only with difficulty be now detected with telescopes of less than three inches aperture.

SPECTRA OF RED STARS (CLASS III. *b*).—In August last, 1898, results of a photographic study of the stars of Secchi's Type IV. (Vogel's III. *b*), made by Mr. Ellerman and Prof. G. E. Hale at the Yerkes Observatory, were discussed at the Harvard Conference (*Astro-Physical Journal*, vol. viii. p. 237, 1898). The photographs were obtained with a spectrograph having only one prism and a long-focus camera (20·0 inches). Since that time the spectrograph has been remodelled and provided with a train of three prisms and a shorter focus camera (10·8 inches), and with this instrument much better photographs have been obtained with shorter exposures. *Bulletin* No. 7 of the Yerkes Observatory contains a short description of these, with a plate showing the spectra of four stars of this class (*Astrophysical*

Journal, vol. ix. p. 271, 1899). The examination of the photographs has resulted in the possibility of arranging ten of the stars in a series indicating progressive evolution, and the four given are sufficiently representative to show the changes indicated. These are—

I. 280 Schjellerup = DM 59°·2810 (Magn. 7·8).
II. 273 ,, = 19 Piscium (Magn. 5·5±).
III. 132 ,, = U Hydræ (Magn. 5·5±).
IV. 152 ,, = (Magn. 5·5).

The presence of *bright lines* formerly announced is confirmed by these photographs, and some of these are identical with those observed visually by Prof. Duner at Upsala. Any attempt to establish a connection between these stars and those of other types must include these bright lines, but as yet no star is known intermediate in character between these red stars and other groups. In the absence of a suitable instrument for detecting such bodies at the Yerkes Observatory, advantage has been taken of an offer from Prof. Pickering to photograph suspected objects with the objective prism, and in case this indicates a body of new constitution, the 40-inch refractor and stellar spectrograph will be employed for its detailed examination.

The photographs extend from λ 5150 to λ 5850, the carbon fluting with maximum about λ 563 being specially distinct in the spectra of 19 Piscium and U Hydrae.

Bulletin No. 9, in the same number of the *Journal*, p. 273, contains a plate illustrating a later attempt to find some position for these stars of Class III.*b* in the stellar constitutional system. The stars compared are—

I. The Sun (Type II.).
II. μ Geminorum (Type III.).
III. 132 Schjellerup (Type IV.).

In the region extending from b_4 to about λ 5300, the spectra of μ Geminorum (Type III.) and 132 Schjellerup (Type IV.) are almost identical, while in the region slightly less refrangible there are many common lines. Further towards the red the spectra become very dissimilar, the strong flutings of carbon seen in 132 Schjellerup being entirely wanting in μ Geminorum, although there are a few common features sufficient for comparison. Other photographs in the region Hβ to Hγ show similar coincidences. These photographs, it is stated, show a decided connection between the two classes of red stars, and the observation of more of them may bring out other links in their relationship.

REMINISCENCES OF DARWIN—SIR JOSEPH D. HOOKER.

A STATUE of Charles Darwin by Mr. Hope Pinker, presented to the University of Oxford by Prof. Poulton, Hope Professor of Zoology, was unveiled at the University Museum on the 14th inst., and Sir Joseph D. Hooker delivered the following address, which we reprint from the *Times*, upon the occasion :—

The Vice-Chancellor of your University has done me the honour of asking me to address you on the occasion of the installation of the statue of the great naturalist which now adorns your museum, and has expressed his opinion that a few personal reminiscences would be more acceptable to you from me than an *éloge* of Mr. Darwin's researches and discoveries, of which latter indeed an excellent reasoned *résumé* is well known to you as the work of your Hope professor of zoology. In accepting the task of giving personal reminiscences, I am reminded of the fact that narrators of an advanced age are not only proverbially oblivious, but are too often the victims of self-deception in respect of what they think they remember, to which must be added that where a dual personification is attempted the narrator is apt to assume the more prominent position. I have thus many snares to avoid, and must hope for a lenient judgment on what follows.

EARLY FRIENDSHIP WITH DARWIN.

The fact of our having commenced our scientific careers under very similar conditions favoured the rapid growth of a bond of friendship between Mr. Darwin and myself. We both of us, immediately after leaving our respective Universities, commenced active life as naturalists under the flag of the Royal Navy; he as a volunteer eight years before me, who was an official. We both sailed round the world, collecting and observing often in the same regions, many of them at that time seldom visited and since made accessible to science by his researches—the Cape Verde Islands, St. Helena, Rio, the Cape of Good Hope, the Falkland Islands, Tierra del Fuego, Tasmania, and New Zealand. On returning to England we both enjoyed the rare advantage of the counsel and encouragement of one of the greatest leaders in science of the time—Mr., afterwards Sir Charles, Lyell. It was through the father of Sir C. Lyell, the translator of the "Vita Nuova" of Dante, and a friend of my father, that I first heard of Mr. Darwin. The "Journal of Researches into the Natural History and Geology of the Countries visited during the Voyage of the *Beagle*" was then passing through the press, and the proof sheets were being submitted to Sir C. Lyell for his information and criticisms. These were passed on to Sir Charles's father, himself a naturalist, who was permitted to lend them to me for perusal, because I was then preparing to accompany Sir James Ross as a naturalist on the Antarctic expedition (1839–43). At that particular time I was engaged upon engrossing hospital duties, and I slept with the proofs under my pillow that I might at once, on awaking, devour their contents. They impressed me profoundly, I may say despairingly, with the genius of the writer, the variety of his acquirements, the keenness of his powers of observation, and the lucidity of his descriptions. To follow in his footsteps, at however great a distance, seemed to be a hopeless aspiration; nevertheless they quickened my enthusiasm in the desire to travel and observe. A copy of the complete work was a parting gift from Mr. Lyell on the eve of my leaving England, and no more instructive and inspiriting work occupied the bookshelf of my narrow quarters throughout the voyage. In the interval I had been introduced to Mr. Darwin, on a casual meeting in Trafalgar-square by a brother officer who had accompanied him in the *Beagle* to Rio, when I was impressed by his animated expression, heavy beetle brow, mellow voice, and delightfully frank and cordial greeting to his former shipmate. Shortly after the arrival in England of the Antarctic expedition (in 1843) I received from Mr. Darwin a long letter, warmly congratulating me on my return to my family and friends, directing my attention to the importance of correlating the flora of Fuegia with those of the Cordillera and of Europe, and inviting me to study and publish the botanical collections which he had made in the Galapagos Islands, Patagonia, and Fuegia.

VISITS TO DARWIN AT DOWN.

This led to an interchange of views on the subject of geographical distribution, followed by an invitation to visit him at what he used to call his inaccessible home at Down, which was then eight or ten miles distant from the nearest railroad station. This I joyfully accepted; and then commenced that friendship which ripened rapidly into feelings of esteem and reverence for his life, works, and character that were never clouded for one instant during the forty subsequent years of our joint lives. In the admirable biography of his father by my friend, Prof. Frank Darwin, are recorded the subjects, especially botanical and geographical, which were for many years the subjects of conversation and correspondence between us. During the many visits to Down which followed, he laid before me without reserve, not only his vast stores of knowledge, but his mature and immature speculations and theories, describing how they originated, and dwelling on their influence on the progress of his researches. Among these, so long ago as 1844, was his sketch of "The Origin of Species," which I was the first to see of the few friends to whom he ever showed it. At that very early period of my own studies I failed to grasp its full significance, *à propos* of which I may mention that I have been reproached for this by friends who have wondered, not only that I did not assimilate it at once, but that I did not apply it to my earliest essays on the distribution of plants. My friends overlooked the fact that the communication was a confidential one, of a hypothesis which its author hoped to establish as a tenable theory by an accumulation of facts in support of it, which he was engaged in collecting with a view to future publication. On the occasions of many other visits it was Mr. Darwin's practice to ask me, shortly after breakfast, to retire with him to his study for twenty minutes or so, when he brought out a long list of questions to put to me on the botanical subjects then engaging his attention. These questions were sometimes answered offhand, others required consideration, and others a protracted research in the Herbarium or in the gardens at Kew. The answers were written on slips of paper, which were deposited in bags or pockets that hung against the wall within reach of his arm, each of them a receptacle devoted to a special object of inquiry. To me this operation of "pumping," as he called it, was most instructive. I could not but feel that any information that I could give him was comparatively trivial, while what I carried away was often as much as I could stagger under. As his health fluctuated or declined, and especially during his sharper attacks of illness, these interviews became intermittent, and on such occasions he would ask me to bring my own work with me to Down, where I pursued my studies free from the distractions of Kew, and with the advantages of his counsel and aid whenever desired. These morning interviews were followed by his taking a complete rest, for they always exhausted him, often producing a buzzing noise in the head, and sometimes what he called "stars in the eyes," the latter too often the prelude of an attack of violent eczema in the head, during which he was hardly recognisable. These attacks were followed by a period of what with him was the nearest approach to health, and always to activity. Shortly before lunch I used to hear his mellow voice under my window, summoning me to walk with him, first to inspect the experiments in his little plant-houses, and then to take a precise number of rounds of the "sand-walk," which he trudged with quick step, staff in hand, wearing a broad-brimmed straw hat and light shooting coat in summer, and a felt hat and warm cape in winter. This walk was repeated in the afternoon; on both these occasions his conversation was delightful, animated when he was well enough, never depressing however ill he might be. It turned naturally on the scenes we had witnessed in far-away regions and anecdotes of our seafaring lives, and on the discoveries in science, then, as now, hurrying onwards and treading on one another's heels in their haste for recognition. In the evening we had books and music, of which latter Mr. Darwin was, during the first few years of our friendship, almost passionately fond. I well remember now, at the 1847 meeting of the British Association in this city, his asking me to accompany him to hear the organ at New College Chapel, and, on coming away, saying to me, "Hooker, I felt it up and down my back;" and I find in the "Life and Letters" that when a student at Cambridge, after hearing a beautiful anthem, he made use of a similar expression to a friend who had accompanied him. It is a curious fact that music should have had in after life no charm for him—that "it set him thinking too energetically at what he had been at work on instead of giving him pleasure."

AN ESTIMATE OF DARWIN'S CHARACTER.

If I were asked what traits in Mr. Darwin's character appeared to me most remarkable during the many exercises of his intellect that I was privileged to bear witness to, they would be, first, his self-control and indomitable perseverance under bodily suffering, then his ready grasp of difficult problems, and, lastly, the power of turning to account the waste observations, failures, and even the blunders of his predecessors in whatever subject of inquiry. It was this power of utilising the vain efforts of others which in my friend Sir James Paget's opinion afforded the best evidence of Darwin's genius. Like so many men who have been great discoverers, or whose works or writings are proofs of their having intellects indicating great originality, he was wont to attribute his success to industry rather than ability. "It is dogged that does it" was an expression he often made use of. In his autobiography he says of himself, "My industry has been nearly as great as it could have been in the observation and collection of facts"; and, again, "of the complex and diversified mental qualities and conditions which determined my success as a man of science, I regard as the most important the love of science—unbounded patience in long reflecting over many subjects—industry in observing facts, and a fair share of invention, as well as of common sense." In this introspection he has, if my judgment is correct, greatly undervalued "invention"; that is originality or that outcome of the exercise of the imagination which is so conspicuous in every experiment he made or controlled, and in the genesis of every new fact or idea that he first brought to light. Referring to his disregard when possible of his bodily sufferings, I remember his once saying to me that his sleepless nights had their advantages, for they enabled him to forget his hours of misery when recording the movement of his beloved plants from dark to dawn and daybreak. For those other qualities of head and heart that endeared Mr. Darwin to his friends I must refer you to the "Life and Letters." There is only one upon which I would comment, it is that passage of his autobiography where he says, "I have no great quickness of apprehension or wit." Possibly the "of" and "or" are here transposed; whether or no, my impression of his conversation has left the opposite as characteristic of him. It is, at any rate, inconsistent with the fact that in arguing he was ever ready with repartee, as I many times experienced to my discomfiture, though never to my displeasure; it was a physic so thoughtfully and kindly exhibited. And I may conclude these fragmentary records with an anecdote which goes, I think, to support my view, and which I give, if not verbally correctly, as nearly as my memory of so ancient an episode permits. I was describing to him the reception at the Linnean Society, where he was unable to be present, of his now famous account of "The two forms or dimorphic condition of Primula," for which he took the common primrose as an illustration. On that occasion an enthusiastic admirer of its author got up, and in concluding his *éloge* likened British botanists who had overlooked so conspicuous and beautiful a contrivance to effect cross-fertilisation to Wordsworth's "Peter Bell," to whom

> "A primrose on the river's brim
> A yellow primrose was to him,
> And it was nothing more."

When I told Mr. Darwin of this he roared with laughter, and, slapping his side with his hand, a rather common trick with him when excited, he said, "I would rather be the man who thought of that on the spur of the moment than have written the paper that suggested it."

"*AMERIND*"—*A SUGGESTED DESIGNATION FOR AMERICAN ABORIGINES.*

A PART of the *Proceedings* of the Anthropological Society of Washington, at a meeting on May 23, seem destined to produce permanent influence on ethnologic nomenclature; this part of the proceedings taking the form of a symposium on the name of the native American tribes. The discussion was opened by Colonel F. F. Hilder, of the Bureau of American Ethnology, with a critical account of the origin of the misnomer "Indian," applied by Columbus to the American aborigines; he was followed by Major J. W. Powell, who advocated the substitution of the name *Amerind*, recently suggested in a conference with lexicographers. A communication by Dr. O. T. Mason followed, in which the various schemes of ethnologic classification and nomenclature were summarised and discussed. Contributions to the symposium were made also by Dr. Albert S. Gatschet, Dr. Thomas Wilson, and Miss Alice C. Fletcher. At the close of the discussion the contributions were summarised by President McGee as follows:—

(1) There is no satisfactory denotive term in use to designate the native American tribes. Most biologists and many ethnologists employ the term "American"; but this term is inappropriate, in that it connotes, and is commonly used for, the present predominantly Caucasian population. The term "Indian" is used in popular speech and writing, and to a slight extent in ethnologic literature; but it is seriously objectionable in that it perpetuates an error, and for the further reason that it connotes, and so confuses, distinct peoples. Various descriptive or connotive terms are also in use, such as "North American Savages," "Red Men," &c.; but these designations are often misleading, and never adapted to convenient employment in a denotive way.

(2) In most cases, the classifications on which current nomenclature are based, and many terms depending on them for definition, are obsolete; and the retention of the unsuitable nomenclature of the past tends to perpetuate misleading classifications.

(3) While the name "Indian" is firmly fixed in American literature and speech, and must long retain its current meaning (at least as a synonym), the need of scientific students for a definite designation is such that any suitable term acceptable to ethnologists may be expected to come into use with considerable rapidity. In this, as in other respects, the body of working specialists form the court of last appeal; and it cannot be doubted that their decision will eventually be adopted by thinkers along other lines.

(4) As the most active students of the native American tribes, it would seem to be incumbent on American ethnologists to propose a general designation for these tribes.

(5) In view of these and other considerations, the name *Amerind* is commended to the consideration of American and foreign students of tribes and peoples. The term is an arbitrary compound of the leading syllables of the frequently-used phrase "American Indian"; it thus carries a connotive or associative element which will serve explicative and mnemonic function in early use, yet must tend to disappear as the name becomes denotive through habitual use.

(6) The proposed term carries no implication of classific relation, raises no mooted question concerning the origin or distribution of races, and perpetuates no obsolete idea; so far as the facts and theories of ethnology are concerned, it is purely denotive.

(7) The proposed term is sufficiently brief and euphonious for all practical purposes, not only in the English, but in the prevailing languages of continental Europe; and it may readily be pluralised in these languages, in accordance with their respective rules, without losing its distinctive sematic character. Moreover, it lends itself readily to adjectival termination in two forms (a desideratum in widely-used ethnologic terms, as experience has shown), viz. *Amerindian* and *Amerindic*, and is susceptible, also, of adverbial termination, while it can readily be used in the requisite actional form, *Amerindise*, or in relational form, such as *post-Amerindian*, &c.; the affixes being, of course, modifiable according to the rules of the different languages in which the term may be used.

(8) The term is proposed as a designation for all of the aboriginal tribes of the American continent and adjacent islands, including the Eskimo.

The working ethnologists in the Society were practically unanimous in approving the term for tentative adoption, and for commendation to fellow-students in this and other countries.

MAGNETIC OBSERVATIONS AT MAURITIUS.[1]

DR. MELDRUM'S name is inseparably connected with the fortunes of the Royal Alfred Observatory. The value of his researches in meteorology, especially in cyclonic movements of the atmosphere, has been repeatedly acknowledged. The simple rules that he has enunciated for the handling of ships during hurricanes in the Southern Seas are based upon rigorous scientific grounds, and though it may be true that no completely satisfactory rule is possible for determining more than the approximate position of the central vortex of a cyclone by any observations at a single station, yet in a majority of cases the mariner who trusts strictly to the instructions provided will find himself in a position of safety. The recent publication of the Mauritius magnetic reductions by Mr. Claxton, the present director of the Royal Alfred Observatory, shows that Dr. Meldrum devoted himself not less energetically to the study of the absolute determinations of the magnetic elements of his station. We may never arrive at the happy condition foreshadowed by Gauss, when trustworthy and complete observations from all parts of the earth shall be obtained, but the possession of a continuous record from a distant outlying station has a value peculiarly its own, and may act as a stimulus to the establishment of other observatories in localities where they are most needed to provide material for the discussion of the amount of change in the magnetic potential of the earth, of which the simultaneous magnetic disturbances afford evidence.

Mr. Claxton, with a loyalty which we recognise and appreciate, is content to stand aside and play the part of editor to his predecessor's work. But the arrangement is not very satisfactory, giving rise as it does to two introductions, one by the editor and one by Dr. Meldrum. If the information derivable from these two sources had been carefully welded into one consecutive history, the description of the tables could have been followed more easily, and the processes employed in the reductions have been more readily apprehended.

The general arrangement does not call for any special remark. All who have been engaged in similar work know the amount of labour involved, and the care that has to be exercised. We notice what we think is a very praiseworthy feature, a determined effort to maintain a uniformity of sensitiveness on the photographic record. A difference of one m.m. in the scale reading is intended to represent a scale value of ·0005 millimetre-milligramme. This is a convenient value, sufficiently sensitive to exhibit changes for ordinary magnetic disturbances, but yet not so sensitive as to send the spot of light off the paper even in a violent magnetic storm. But Dr. Meldrum reports that it is impossible in spite of every precaution to keep this value of the coefficient constant. The length of time elapsed between the cleaning of the knife edge and the agate plane, the temperature, the change of level of the magnet due to secular decrease in the value of the vertical force, all operate as disturbing causes, necessitating continual examination and re-adjustment. Tables of the scale coefficient employed are given. The horizontal force magnet shows as usual the larger variation.

Mr. Claxton gives in a tabular form the more trustworthy determinations of declination and dip that have been made on the island of Mauritius since 1750. Lacaille gave 52° 55′ for inclination in 1761, and in 1896 this angle had increased to 54° 32′. The earliest determination of declination gave 16° 30′ W. in 1753, it now reads 9° 49′; but the director points out, which indeed is sufficiently obvious, that there are large discrepancies among the observations arising probably from the use of indifferent instruments and the effect of local magnetic attraction, varying at the different spots at which the several determinations have been made. For these reasons, no attempt has been made to discuss the secular variation of any of the magnetic elements.

1 "Mauritius Magnetical Reductions." Edited by T. F. Claxton, F.R.A.S. Being a discussion of the results obtained from the self-recording magnetometers from 1875 to 1890, under the direction of C. Meldrum, M.A., LL.D., F.R.S.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—In a congregation held on June 13 the Curators of the University Chest were authorised to expend a sum not exceeding 10,000*l*. in the erection of a pathological laboratory on ground adjoining the University Museum, and also to pay the sum of 250*l*. a year for five years for the equipment and maintenance of this laboratory from the date at which it shall be brought into use. An anonymous donor, a member of the University, has already offered the sum of 5000*l*. towards the erection of this laboratory, provided that it be commenced before January 1, 1901.

The above decrees were passed by Convocation on June 20, when also the twenty-fourth annual report of the visitors of the University Observatory was presented. In consequence of this report, the Curators of the University Chest will be asked to expend a sum not exceeding 500*l*. in the reconstruction of the western dome of the observatory.

It is proposed to adapt the upper floor of the Ashmolean Museum for the purposes of instruction in geography.

CAMBRIDGE.—At St. John's College the following awards in Natural Science were made on June 19:—

Foundation Scholarships continued or increased: Rudge, Yapp, Howard, Brown, Harnett, Lewton-Brain, O. May, Adams, Fletcher, Harding, Browning, Gregory, Wakely, Williams, Walker.

Exhibitions: Wyeth, Ticehurst, J. H. Field, King, Paton.

Hutchinson Studentship for research (botany and zoology): G. S. West.

Research Prize (physics): Vincent.

Herschel Prize (astronomy): Eckhardt.

A CORRESPONDENT informs us that Mr. G. Birtwistle, who was bracketed Senior Wrangler this year with Mr. R. P. Paranjpye, has not only had much success in mathematics during his career, but has distinguished himself in other subjects. When at Owens College he devoted himself chiefly to chemistry, and in 1896 graduated B.Sc. with first-class honours in chemistry, obtaining also a Le Blanc medal and University scholarship. With regard to Mr. Paranjpye, the Allahabad correspondent of the *Times* states that he is a Maratha Brahmin, born twenty-three years ago in the village of Murdi, in the Ratnagiri district. First in the first division has been his invariable record since in 1891, at the age of fifteen, he headed the list at the matriculation examination for the whole of the Bombay Presidency. During his three years at Fergusson College he passed first in the first class at every examination. Fergusson College is an institution manned entirely by native professors, and Mr. Paranjpye, before going to England, pledged twenty years of his life to service in the college, where he will draw a salary not exceeding Rs.70 a month.

THE quinquennial meeting and international congress convened by the International Council of Women will be held in London on June 26–July 5. A number of subjects in the progress of which women take active part will be discussed in the various sections of the congress. In the educational section the life and training of the child, primary education, universities, modern educational experiments, technical education, women as educators, co-education, training of teachers, and examinations, will be brought forward. In the professional section, among the subjects of papers and discussions are: professions open to women, and the work of women in physical and biological sciences. Other subjects to be discussed are farming in its various branches as an occupation for women, and the training of women in agriculture, horticulture, and other trades and professions.

IN an address delivered at the Leys School, Cambridge, on Friday last, Mr. A. J. Balfour referred to the educational values of science and literature. In the course of his remarks he said: "I cannot really conceive that any man, however enamoured of scientific method, should for a moment undervalue that insight into human nature and the interests which have always stirred human nature, and the manner in which those interests have been transformed by men of genius from time to time in the imaginative crucible of literature—I cannot imagine that such a training should be undervalued even by the most rigid advocate of scientific method. On the other hand, is it credible that in these days there should any man be found who should undervalue that curiosity about the world in which we live which science cannot indeed satisfy, but towards the satisfaction of which, after all, science is the only minister?" The claims of science are here given fair recognition, and men of science do not usually ask for more than this. Their complaint is that science is too often regarded as the Cinderella among school and university subjects; and it is only of late years that any noteworthy improvements have taken place in her position.

AN interesting account of the "Mosque of the Olive Tree" (Jama-Ez-Zituna) at Tunis, one of the three great centres of Mahomedan learning in North Africa, the others being El Azhar in Cairo and the Great Mosque at Fez, in Morocco, is given in a recent report by Sir Harry Johnston. Over 400 students are usually taught at this University, while there are about 100 professors. The lectures begin at sunrise and continue until sunset, fifteen different lectures usually going on at the same time. Each professor sits cross-legged, with his back against one of the many columns of the mosque, his students grouped about him. Until recently, there was but little method in the instruction; each professor rambled on in his discourse, ranging over any topic on which he cared to impart information, and the students listened or not as they chose. To encourage a more practical education, the State offered the students exemption from military service and from certain taxes if they passed an elementary outside examination; but only four of sixty-six recently succeeded in doing this. In future, it is intended to impress on the management of the mosque that each professor should keep to one subject; that the student should be obliged to take notes, and pass periodical examinations. External lectures on scientific subjects and on matters of present-day interest have also been established, and about 100 students from the mosque now attend these.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 27.—"On the Presence of Oxygen in the Atmospheres of certain Fixed Stars." By David Gill, C.B., F.R.S., &c., Her Majesty's Astronomer at the Cape of Good Hope.

The observations described confirm the conclusions arrived at by Mr. F. McClean and Sir Norman Lockyer as to the existence of oxygen lines in the spectrum of β Crucis. From measures of photographs of the spectrum of this star, it is concluded that the whole of the known helium lines within the measured range of spectrum are unquestionably present, as also are all known oxygen lines stronger than intensity 4.

"There remains not the slightest doubt that all the stronger oxygen lines are present in the spectrum of β Crucis, at least between λ 4250 and 4575, and this fact requires no further aboratory experiments for its establishment. It is almost equally certain that there is no trace of true nitrogen lines in this spectrum. . . . Besides hydrogen, helium and oxygen, the spectrum of β Crucis shows the probable presence of carbon (4267·2) and magnesium (4481·17). . . . The spectra of β Crucis, β and ϵ Canis Majoris, and probably β Centauri are all practically identical."

Linnean Society, June 1.—Dr. A. Günther, F.R.S., President, in the chair.—Mr. W. B. Hemsley, F.R.S., exhibited a selection of high-level plants from the collections formerly made by Sir Joseph Hooker, Dr. Thomson, General Sir R. Strachey, and more recently by Captain Welby, Mr. and Mrs. Littledale, and Mr. Arnold Pike in Northern India, Tibet, and Mongolia, many of them from altitudes of 18,000 to 19,200 feet. A selection was also shown from the collections made in the Andes by Sir Martin Conway, Mr. Fitzgerald, Mr. Gosse, and Mr. Whymper, at various altitudes up to 18,500 feet. The principal points referred to were the small size of many of the plants, the protective woolly covering of others, and the general preponderance of the natural order *Compositae.*—On behalf of Mr. Rupert Vallentin, Mr. J. E. Harting exhibited lantern slides of the so-called "Sea-Elephant" (*Macrorhinus elephantinus*), prepared from photographs taken in February last by Mr. Vallentin in the Falkland Islands. After briefly tracing the distribution of this huge seal on various Antarctic and subtropical islands, Mr. Vallentin's notes on a specimen killed in Stanley Harbour were read. This specimen measured 18 feet 11 inches from the end of the trunk to a straight line between the two hinder extremities; the trunk, produced by the inflation of a loose tubular sac of skin above the nostrils, is present only in the male, and measures, when fully extended, twelve inches from the gape. No fresh facts were made known concerning the nature of the food of this animal, described by some writers as herbivorous like the manatee, by others as feeding on mollusca and crustacea like the walrus. In this case the stomach was empty, with the exception of a large number of Nematode worms, specimens of which were exhibited.—Mr. Harting also exhibited and made remarks on some living specimens of the Bank vole (*Microtus glareolus*), recently obtained by Mr. Robert Drane on Skomer Island, Pembrokeshire.—Mr. A. W. Bennett exhibited and described a remarkable Alga from Scotland (*Lyngbya* sp. ?) possessing a soluble pigment producing a beautiful fluorescent solution.—The President exhibited photographs of four out of eight gigantic tortoises originally brought from Aldabra Island, and now living in the grounds of Government House, Seychelles, and communicated a report on the subject of the present distribution of the species, addressed to the Right Hon. Joseph Chamberlain, M.P., by the Administrator of the Seychelles.—Sir John Lubbock, Bart., M.P., F.R.S., read a paper on some Australasian collembola, figures of which were exhibited.—On behalf of Mr. F. N. Williams, the Secretary read a paper on some *Caryophyllaceae* from Szechuen, with a note on the recent botanical exploration of that province.—A paper was read by Mr. W. T. Calman on the Crustacean genus *Bathynella* (Vejd.), which was shown to be an ally of the important form *Anaspides* (Thom.) originally described in the Society's *Transactions*, vol. vi. p. 285.

Zoological Society, June 6.—Dr. Henry Woodward, F.R.S., Vice-President, in the chair.—Mr. Sclater exhibited photographs of the female specimen of Grévy's zebra now living in the gardens of the Société d'Acclimatation, Paris; and read a letter from Captain J. L. Harrington, H.B.M. Envoy to Abyssinia, in which he expressed a hope to be able to bring living examples of this animal home with him when he returned to this country.—Mr. A. Blaynay Percival exhibited and made remarks upon some specimens of birds and insects which he had recently brought from the southern districts of British Central Africa.—Mr. G. A. Boulenger, F.R.S., exhibited some living specimens of a Siluroid fish, the "Harmut" (*Clarias lazera*, C. and V.), from Damietta, Egypt, collected by Mr. W. L. S. Loat, which were believed to be the first examples of this curious fish imported alive to this country.—Dr. S. F. Harmer, F.R.S., gave an account of specimens of the remains of a deer in the collection of the University Museum of Zoology at Cambridge, obtained from the Forest-Bed series at Pakefield, near Lowestoft, and belonging to the form usually known as *Cervus verticornis*, Dawk. The cranial portion of the skull was well preserved, and the antlers had a spread of six feet, measured in a straight line. The question of nomenclature was considered, with the result that *C. verticornis* of the Forest-

Bed was shown to be, probably, not identical with *C. carnutorum*, Laug., but a synonym of *C. belgrandi*, Lart.—Dr. A. Günther, F.R.S., gave an account of a collection of freshwater fishes made by Mr. R. B. N. Walker in the rivers of the Gold Coast. The collection, though a small one, was of considerable interest, as it contained specimens of several forms previously unknown from the Gold Coast. It had led the author to prepare a critical revision of the Gaboon species of *Chrysichthys*, which were numerous and difficult of discrimination. Eight new species were described in this paper, viz. *Petersius occidentalis* and seven species of *Chrysichthys*.—A communication was read from Dr. R. O. Cunningham, containing notes on the structure of Laborde's shark (*Euprotomicrus labordii*), an example of which had recently been presented to the museum of Queen's College, Belfast.—A communication was read from Mr. J. Stanley Gardiner, containing an account of the Astræid corals which he had collected in the South Pacific. The collection contained specimens of twelve genera and forty-eight species, six of the latter being new to science.—A communication was read from Dr. W. T. Blanford, F.R.S., containing the characters of several species of shells of the genera *Streptaxis* and *Ennea* from India, Ceylon and Burma. Of the former genus three species were described as new, bringing up the number of species of this genus, described from Southern India, to eleven. Of the genus *Ennea* two new species were described.

Mathematical Society, June 8.—Lord Kelvin, G.C.V.O., President, in the chair.—The President announced that the Council had awarded the De Morgan medal to Prof. W. Burnside, F.R.S., for his researches in mathematics, particularly in the theory of groups of finite order. Prof. Burnside, who was present, briefly returned thanks for the award, which had taken him by surprise.—Prof. Mittag Leffler, of Stockholm, a foreign member, was admitted into the Society, and made an interesting communication (in French) on the convergency of series. Prof. Elliott, F.R.S., Prof. Love, F.R.S., and Dr. Hobson, F.R.S., offered some remarks, to which Prof. Mittag Leffler replied.—The President spoke on "Solitary waves, equivoluminal and irrotational, in an elastic solid." In the course of his address he showed how greatly mathematicians were indebted to Sir George Stokes, F.R.S. Prof. Love said he had been much interested in the diagrams shown by Lord Kelvin. He afterwards gave a sketch of a paper by Prof. J. H. Michell on the transmission of stress across a plane of discontinuity in an isotropic elastic solid, and the potential solutions for a plane boundary.—The following papers were taken as read: On several classes of simple groups, Dr. G. A. Miller; on theta differential equations and expansions, Rev. M. M. U. Wilkinson; finite current sheets, Mr. J. H. Jeans; (1) on a congruence theorem having reference to an extensive class of coefficients; (2) on a set of coefficients analogous to the Eulerian numbers, Dr. Glaisher, F.R.S.; (1) the reduction of a linear substitution to its canonical form; (2) on the integration of systems of total differential equations, Prof. A. C. Dixon.

Entomological Society, June 7.—Mr. G. Verrall, President, in the chair.—Mr. J. J. Walker exhibited on behalf of Mr. G. F. Mathew a number of interesting Lepidoptera, chiefly from the Mediterranean region, and including amongst others the following: examples of *Thais polyxena*, Schiff., var. *ochracea*, Staud., having an unusually deep and rich colour, bred from larvæ found at Platæa, Greece; male and female of *Thestor ballus*, Hb., from Alexandria, the male remarkable in being largely marked with orange on the upper side of the front wings; and a singular aberration, from Corfu, of *Melitaea didyma*, Ochs., with central band of black spots very strongly marked on both wings, the other spots being obsolete and the ground colour pale fulvous.—Mr. E. E. Green exhibited a teratomorphic specimen of a zygænid moth, *Chalcosia venosa*, Walk., which he had found at rest on a leaf in Ceylon. In this specimen four wings were present on the left side, the hindmost being almost as fully developed as the normal hind wing on the right side, while the other three appeared to be attached to the meso-thorax. He also showed larvæ and pupæ of insects in air-tight glass tubes in which a little cotton wool, sprinkled with formalin, had been placed. The specimens, which had been thus preserved for nearly two years, had lost little of their original colour or brilliancy.—Mr. Gahan exhibited pupa-cases of a Longicorn beetle, *Plocederus obesus*, Gah., which were remarkable in being composed almost wholly of carbonate of lime. It was not known how the pupa-cases were fabricated, but presumably the larvæ must possess special lime-secreting glands.—Mr. R. McLachlan read a paper on a second Asiatic species of *Corydalis*, and exhibited the male type of the species described, which he proposed to name *Corydalis orientalis*. He said the first Asiatic species of *Corydalis* was described and figured by Prof. Wood-Mason in 1884, the genus up to that time having been considered to be peculiarly American. Mr. H. J. Elwes communicated a paper on the Lepidoptera of the Altai Mountains, and the Rev. A. E. Eaton a paper entitled "An annotated list of the *Ephemeridae* of New Zealand."

Geological Society, June 7.—W. Whitaker, F.R.S., President, in the chair.—On the geology of Northern Anglesey, by C. A. Matley; with an appendix on the microscopic study of some of the rocks, by Prof. W. W. Watts. The strata which occupy the northern part of Anglesey have been the subject of much controversy, some geologists considering them (with the exception of a few patches in the extreme north) to be pre-Cambrian, while others maintain that they are of Bala age, and that they are an upward continuation of the black slates that everywhere appear to underlie them to the south. The author attacks this problem from its palæontological as well as its stratigraphical side. The contortion, overfolding, cleavage, dislocation, and disruption which the rocks have undergone are described. Disruption is traced from its early stages into "crush-conglomerates." Some of the disrupted rocks are Ordovician, and traces of ancient dykes have been found rent to pieces by the movement, which is stated to be post-Ordovician and pre-Carboniferous. The detached masses of limestone and the isolated "quartz-knobs" of the northern complex are considered to be portions of strata which have suffered disruption in the same way as the thinner hard bands in the crush-zones. The appendix contains notes on some of the rocks from the Green series and the Ordovician system, the quartzites, and the crush-conglomerates.—On an intrusion of granite into diabase at Sorel Point (Northern Jersey), by John Parkinson. In the early pages the general character of this intrusion is described. Following this general introduction, the characters of the granite are described in some detail; then those of the diabase, formerly an ophitic dolerite. Details of structure of the granite in which absorbed basic material is present, and of the diabase into which acid material has permeated, are dealt with: particular attention being directed to the great alteration which the diabase has undergone—this has frequently amounted to a total reconstitution. In conclusion, points of resemblance and of difference are noted between this district and others; and an interesting slide from Alderney is described, showing the probable extension of such rocks in other directions.

EDINBURGH.

Royal Society, May 8.—Prof. Flint in the chair.—By request of the Council, Mr. C. W. Andrews, of the British Museum, gave an account of his expedition to Christmas Island, with special reference to its geology. The island seems to be a raised atoll resting on a basis of volcanic rocks and Miocene limestones, which in places are some hundreds of feet thick. The rocks forming the highest parts of the island are for the most part dolomitised, and the most recent of the deposits found are beds of phosphate of lime, which cap some of the highest hills on the east and north sides. Formerly existing as a group of islets with a central lagoon, Christmas Island has undergone a succession of movements of elevation, evidenced by the existence of a number of inland cliffs and terraces. At present a narrow fringing reef is forming round the greater part of the coast. The fauna and flora are specially remarkable for the large number of species peculiar to the island. Specially interesting are the two forms of rats (the one being fitted for climbing trees, and the other for burrowing), six species of land-crab, two bats (one flying at midday), several forms of pigeon, and numerous sea birds. As regards the flora, there was no difficulty in understanding how the seeds had originally found a lodgment in the island. One important part of the work of the expedition was to make a collection of the fauna and flora before the settlement of the island led to the introduction of foreign species and the modification or destruction of the endemic forms. Sir John Murray, in emphasising the importance of the scientific work carried out by Mr. Andrews, pointed out that Christmas Island was an illustration of how unexpectedly purely scientific inquiry led to a practical issue; for it was in the course of his investigations into oceanic deposits that he discovered Christmas Island to be a storehouse of phosphate of lime.

May 16.—Prof. McKendrick in the chair.—Dr. C. G. Knott gave a short note on magnetic strains in bismuth. A slight indication had been obtained that there was a change of form in bismuth when strongly magnetised, but the indication was so slight that it was more prudent meanwhile to reserve judgment. —A communication by Mr. Omond on fog-bows, &c., seen at Ben Nevis since 1887, and a note on fog-bows by Prof. Tait were presented in continuation of former papers.—Mr. R. Forgan exhibited his practical method of enlarging and deepening the field of a compound microscope. The essence of the method consisted in shortening the distance between the object-glass and eye-piece, thereby obtaining a diminution of magnification with a corresponding increase of field. In short, the microscope was made to act somewhat after the fashion of a telescope. One interesting feature was the remarkable depth of focus obtained, so that the florets of a dandelion head could be seen throughout with great distinctness. The Chairman remarked that the form of microscope exhibited should prove very serviceable in the study of circulatory systems when high magnification was not desired.—The Rev. Prof. Duns, in a paper on some remains of Scottish early Post-Pliocene mammals, drew attention to the very important problems—zoological, climatological, and ethnographical—which were associated with the disappearance of animals in recent times. For example, what causes led to the disappearance of certain species, among whose remains no contemporaneous human remains were found? Did the absence of human remains necessarily imply that man had not appeared on the scene? The problems should be looked at both from the biotic and stratigraphical points of view; and it was most desirable that, in their characterisation of extinct species, experts should include a description of the physical and vital conditions of the localities in which these species occurred. The paper included a history and description of the fine mammoth tusk discovered near Ratho, Midlothian, in 1820, of the magnificent Greater Red Deer antlers discovered near Kingskettle, Fife, and other important relics now in the museum of the Free Church College, Edinburgh.

Paris.

Academy of Sciences, June 12.—M. van Tieghem in the chair.—The jubilee of Sir G. G. Stokes and the centenary of the Royal Institution, by M. A. Cornu.—The angle of inclination of the sides studied with the aid of radioscopy and radiography both in morbid and healthy states, by MM. Ch. Gouchard and H. Guilleminot. The authors have studied more especially the appearances in cases of pleurisy. In recent unilateral pleurisy the diseased side has a smaller amplitude of oscillation than the healthy one, and the side is inclined at a greater angle.—Observations of shooting-stars, made at Athens, by M. D. Eginitis. The observations refer especially to the swarms observed on the nights of October 17, 18, November 3, 8, and 25, and December 6, 7, 11, 12, and 13.—On an extension of a theorem of Mittag-Leffler, by M. E. Phragmén. —Deformation of waves in the course of propagation, by M. P. Vieille.—On the equation of motion of automobiles, by M. A. Blondel.—Trials of instruments destined for experiments on the decimalisation of angles, by M. Caspari.—On the expansion of metallic alloys, by M. H. Le Chatelier. Alloys of copper and antimony, and copper with aluminium were studied, and the results expressed graphically in two curves.—The direct measurement of the osmotic pressure of very dilute solutions of sodium chloride, by M. A. Ponsot. The values found for the coefficient *i* varied between 1·76 and 1·81, agreeing closely with the results obtained by Pickering by the freezing point method.—Rays emitted by an electrified point, by M. S. Leduc. The rays given off from a point connected with an electrostatic machine resemble the violet rays of the spectrum in their effects upon a sensitised plate.—Heat of oxidation of sodium, by M. de Forcrand. From the data given it would appear that the number currently admitted for the heat of oxidisation of sodium is too high by about 10 per cent.—On the estimation of hydrogen phosphide in gaseous mixtures, by M. J. Riban. A criticism of a recent paper by M. Joannis. The author contends that an acid solution of cuprous chloride acts perfectly satisfactorily as an absorbent for phosphoretted hydrogen, provided that care be taken to use an unoxidised product.—Action of iodine on alkalies, by M. E. Péchard.—Action of water upon the double iodides of mercury with potassium and ammonium, by M. Maurice François.—On copper reduced at low temperature, by M. Alb. Colson. Copper oxide reduced at 200° by hydrogen or by carbon monoxide, gives many reactions that do not occur with copper foil. Thus the metal catches fire in dry bromine, even at −21° C. If the copper is raised to above 280° C., or if exposed to moist air, it loses this property.—On mixed anhydrides of formic acid, by M. A. Béhal. By mixing formic acid and acetic anhydride, heat is evolved, and the cause of this is attributed by the author to the formation of a mixed anhydride, $CH_3.CO.O.CHO$, which can be isolated by treatment with petroleum ether and fractional distillation.—Contribution to the study of ivy; preparation of hederine, by M. Houdas. The glucoside hederine, $C_{64}H_{104}O_{19}$, obtained from ivy, gives on hydrolysis by dilute acids, rhamnose, a new sugar hederose, and a new substance $C_{26}H_{40}O_4$, to which the name of hederidine is given.—On the form *Oospora* (*Streptothrix*) of the *Microsporum* of the horse, by M. E. Bodin.—On a layer of magnetite with granite at Quérigut (Ariège), by M. A. Lacroix.—On the presence of iodine in the mineral waters of Royat, by M. A. Duboin. Iodine was not present in solution, but only in traces in organic compounds in suspension, ·04 mgr. iodine in 1 litre of water.—Bathymetric map of the Azores, by M. J. Thoulet.—Nervous oscillations following unipolar excitation; method for measuring their speed of propagation, by M. Aug. Charpentier.—Ivy and hederine; physiological and toxicological study, by M. A. Joanin.—New researches on the diastatic functions of indigo-bearing plants, by M. L. Bréaudat.—On a parasitic fungus in cancer, by M. J. Chevalier. A comparison of the organism isolated by the author, with that isolated previously from cancer growths by Dr. Bra, showed that the two parasites were absolutely identical.

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