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CHINESE CENTRAL ASIA.

Chinese Central Asia: a Ride to Little Tibet. By Henry Lansdell, D.D., M.R.A.S., F.R.G.S., Author of "Through Siberia," "Russian Central Asia," "Through Central Asia," &c. Two Vols. (London: Sampson Low, 1893.)

THERE are few, if any, men who have travelled so extensively throughout the length and breadth of Asia as Dr. Lansdell, and in the work before us he has given an interesting account of his last great journey of 50,000 miles, which occupied "two years and seven months, of which 525 were travelling, and 425 were stationary days. The regions visited comprised five of the kingdoms of Europe, four of Africa, and every kingdom of Asia. The methods of travel were 18,000 miles by railway, 25,000 by water, and 7,000 by driving and riding on the backs of horses, camels, donkeys, yaks, elephants, mules, and men."

Dr. Lansdell is a privileged person, high in favour with influential men in Russia, as well as in England, and has always been permitted to travel freely in all parts of Russia, without let or hindrance, to an extent which would probably hardly be allowed to anyone else. He speaks with high praise of the civility and courtesy with which he was everywhere received, by officials and others; but apart from this, we are glad to find that now that the Russians have consolidated their power in Central Asia, they are gradually giving up their old exclusiveness, as witness the recent experiences of Lieut. Coningham.

Dr. Lansdell's primary objects, as before, were chiefly missionary. He distributed copies of the Scriptures in the various languages of the countries through which he passed; visited mission stations, and prisons, and noted everything likely to be useful for directing future efforts in the same direction. But he has avoided making this feature too prominent a part of his book; and we are glad to see that there is scarcely a word in reference to other religions which could give offence to the most fastidious, except, perhaps, in his sometimes speaking of Mohammed as "the false prophet."

One object which Dr. Lansdell set before him was to penetrate to Lassa; but, unfortunately, the difficulties which have baffled every recent traveller happened to be increased at the time by a war on the Indian frontier; and it is needless to say that he did not succeed. It is to be inferred from his historical notes that Tibet was originally closed against foreigners by the Chinese, and that the custom has since been maintained by the Tibetans.

The greater portion of the book is taken up with the personal narrative of the author's journey. He started from London to St. Petersburg, and thence to Baku, and *via* the Transcaspian Railway to ninety-one miles beyond Bokhara, where the line then terminated, though it was being pushed forward at the rate of three miles per day. Thence he proceeded to Issik-Kul, Vierny, Kuldja, Aksu, Yarkand, and over the Karakorum to India, China, Japan, &c., and then back to London *via* the Suez Canal, visiting many more countries on the way. It is, however, only the early part of the journey, as far as India, which is described in detail.

The Transcaspian Railway was not in existence at the time of Dr. Lansdell's previous journey in Russian Central Asia in 1882; but as far as Kuldja the journey of 1888 frequently intersected and sometimes coincided with that of 1882, and the author observed and notes many changes which had taken place in Bokhara, Samarcand, Tashkend, &c., since his former visit. At Issik-Kul, and still more beyond Kuldja, he began to break entirely new ground, and it is here that the most interesting part of his narrative begins. We may note incidentally that he obtained a new fish (*Diptychus Lansdelli*, Günther) at Lake Issik-Kul.

It was not to be expected that during so long and difficult a journey the author should have been able to give attention to every possible subject of interest, but he succeeded in obtaining a large series of photographs of views and natives. Many of these photographs were used to illustrate magazine articles, and have been reproduced in this book. The author, therefore, apologises for the unfinished state of some of his illustrations, on the score of their having been originally prepared for the exigencies of rapid newspaper printing. The numerous types of races figured should make the book very useful to anthropologists; and the natural history appendices and lists of birds, insects, fish, &c., in which the author had the assistance of various eminent naturalists, will appeal to zoologists. Other matters worth noticing, from a literary and scientific point of view, are the maps, the bibliography and chronology (compiled by Mrs. Lansdell), and the geographical and historical information scattered through the book. To travellers about to set out for the same countries, the account of the author's personal experiences cannot but be of much value, though others can hardly expect to be so exceptionally fortunate as Dr. Lansdell.

Things are greatly changed for the better in Central Asia since the Russian occupation, and Dr. Lansdell was everywhere received as a guest, and treated with the utmost hospitality during the greater part of his journey. It was only between the Russian and British frontiers that he appears to have encountered any very serious hardships, and even these were in large measure due to the difficult nature of the country to be traversed.

Among the Kirghese tribes, near Issik-Kul, the idea of sympathetic cures is firmly fixed.

"Thus for an obstinate attack of yellow jaundice, they wear on the forehead a piece of gold, or better, cause the patient to look at it for a whole day, or if a piece of gold be lacking, which is generally the case, they substitute a glass basin."

At Vierny, Dr. Lansdell found many traces of the great earthquake which had devastated the town in the year previous to his visit. We believe that it is somewhat unusual for countries so far inland to be liable to earthquakes, and that Central Asia is exceptional in this particular.

At Kuldja, the author put up at "the best inn in the town; above the average of Chinese inns elsewhere."

"This was my first experience of a Chinese inn, and it made my flesh creep. Passing through a wide doorway, we entered a square courtyard, with rooms on two sides, and occupied in the centre and on a third side by horses, carts, and drivers. The removal of such trifles as foul straw and manure was deemed superfluous, and through this I had to wade towards the door of a room, and there wait till the coal in it was swept into a corner, and what looked like a brewing apparatus removed.

"There was no flooring, not even of bricks, and no furniture, but at the end of the room was a *kang*, or platform of loose boards, over what appeared to be an ash-pit, though the cinders, no doubt, represented the remains of fires for winter heating. Over this receptacle for rubbish of various kinds I was to sleep and eat."

Besides this, there was an intrusive crowd at the door and window, a flour-mill at work, and the jingling of horse and mule bells in the yard. "This went on all day; and what with the stench of manure, distracting noises, windows unglazed, and inquisitive visitors, my lodging proved to be the worst I had ever had." One man defended his intrusion on the traveller's privacy by asking, "Cannot I come into a room in my own country?"

Here the author was invited to breakfast with Kab-i-chang, the Commissary of Russo-Chinese affairs, where he found a variety of dishes, including black putrid eggs, a special delicacy in China.

After leaving China, Dr. Lansdell crossed the Tian Shan into Chinese Turkestan by the Muzart Pass, at a height of 11,000 or 12,000 feet. Here the Chinese picket did their best to smooth the way by laying boughs of trees across crevasses, and covering them with blocks of ice, for the men and horses to cross to the crest of the pass, a nearly perpendicular ice cliff with steps cut in it, down which horses are sometimes lowered by ropes; but in this case, one man took a horse's head, and another hung on by the tail, and thus, wonderful to relate, they contrived to descend in safety.

This formidable pass has, it appears, never been crossed before by any European; and from this point Dr. Lansdell proceeded to Aksu, the most important place on the way to Kashgar and Yarkand, where he found much to interest him, including criminals wearing the *cangue*, or wooden frame round the neck, a familiar punishment in China. Thence he travelled to Kashgar, passing, on the way, through a place called Maralbashi, where the chief mandarin has a drum before his door, and if this is struck, he is bound to attend at once to the appeal of any suppliant. But, to avoid any trouble, if the drum is struck, the mandarin orders the disturber of his peace one hundred lashes, and then asks his business.

From Kashgar Dr. Lansdell proceeded to Yarkand and Khotan, and at the latter place he witnessed a dance of dervishes, of which he gives an illustration. He was anxious, at Khotan, as well as elsewhere, to take photographs of some of the native beauties, but having no opportunity of seeing them unveiled, he was advised to tell his landlord that he wanted a pretty wife, and to ask him to bring him half a dozen on approval.

Here and there we meet with occasional natural history notes on collecting butterflies, or on birds, &c. observed. For example, we read (vol. ii. p. 270):—"Of aquatic birds I obtained specimens of the white-bellied dipper (*Cinclus leucogaster*) at Ak-Shor, and afterwards at Tribhun. We often noticed this little fisher boldly plunging into the swiftest torrents, seeking insects in a stream the half of which was congealed to solid ice." On the Kilian Pass, about the height of Mont Blanc, Dr. Lansdell had his first experience of mountain sickness. He slid off his yak, and attempted to run up a hill to shoot partridges, but was seized with palpitation of the heart, and was forced to sit down to rest immediately. He appears to have suffered more here than even on the great Karakorum Pass further south (18,800 feet instead of 16,000).

Thus our author gradually made his way to India, where we will now leave him. There are so many detached points of interest mentioned in his work, that our limited space has only permitted us to select a few, here and there, to show its interesting and varied character.

The book is dedicated "To his August and Imperial Majesty, the Emperor of China, &c., &c., &c."

W. F. KIRBY.

HUXLEY'S COLLECTED ESSAYS.

Collected Essays. By T. H. Huxley. Vol. I. "Methods and Results." (London: Macmillan and Co., 1893.)

THERE is probably no lover of apt discourse, of keen criticism, or of scientific doctrine who will not welcome the issue of Prof. Huxley's essays in the present convenient shape. For my own part I know of no writing which by its mere form, even apart from the supreme interest of the matters with which it mostly deals, gives me so much pleasure as that of the author of these essays. In his case more than in that of his contemporaries it is strictly true that the style is the man. Some authors we may admire for the consummate skill with which they transfer to the reader their thought without allowing him, even for a moment, to be conscious of their personality. In Prof. Huxley's work, on the other hand, we never miss his fascinating presence: now he is gravely shaking his head, now compressing the lips with emphasis, and from time to time with a quiet twinkle of the eye making unexpected apologies or protesting that he is of a modest and peace-loving nature. At the same time one becomes accustomed to a rare and delightful phenomenon. Everything which has entered the author's brain by eye or ear, whether of recondite philosophy, biological fact or political programme, comes out again to us—clarified, sifted, arranged, and vivified by its passage through the logical machine of his strong individuality.

These essays were, he says in preface, "written for the most part in the scant leisure of pressing occupations, or in the intervals of ill-health." Though the oldest bears the date of 1866, he finds, so far as their substance goes, nothing to alter in them. "Whether," he concludes, "that is evidence of the soundness of my opinions or of my having made no progress in wisdom for the last quarter of a century, must be left to the courteous reader to decide."

The first volume of the nine, which are to be issued monthly, owes its title to the inclusion therein of the famous essay "On Descartes' Discourse touching the method of using one's reason rightly," and of samples of the application of that method in various fields. Amongst the latter are the essays on the physical basis of life, on the hypothesis that animals are automata, on administrative nihilism, and on the natural inequality of men.

The essay on animal automatism was delivered as an evening address at the meeting of the British Association at Belfast, when Tyndall was president. It was a truly marvellous performance, for it occupied nearly an hour and a half, and was delivered with an appearance of complete spontaneity and ease in the very words which are here printed, without a note or reference of any kind, by a man who, when he first attempted it, "disliked public speaking" and, as he tells us, had a firm conviction that he should break down every time he opened his mouth. To some readers, as to myself, the short "autobiography," with which the volume commences, will be new, and owing to its charming frankness and graceful reticence the most delightful chapter in it. Prof. Huxley, doubtless for good reasons, does not tell us where and under what circumstances each of these essays first saw the light, but the autobiography was apparently published with a photograph not many years ago. It is full of good things. The author confesses to having inherited from his father, as well as an inborn faculty for drawing, "a hot temper, and that amount of tenacity of purpose which unfriendly observers sometimes call obstinacy." He remembers preaching to his mother's maids in the kitchen, with his pinafore turned wrong side forwards in order to represent a surplice—"the earliest indication I can call to mind of the strong clerical affinities which my friend Mr. Herbert Spencer has always ascribed to me!" Of his schoolmasters he has nothing good to say—they "cared about as much for our intellectual and moral welfare as if they were baby-farmers." His great desire on leaving school was to be a mechanical engineer; but the fates were against this, and he commenced the study of medicine.

It is very interesting to those who know the value and range of his original researches in comparative anatomy to read the statement—

"I am afraid there is very little of the genuine naturalist about me. I never collected anything, and species work was always a burden to me; what I cared for was the architectural and engineering part of the business, the working out the wonderful unity of plan in the thousands and thousands of diverse living constructions and the modifications of similar apparatuses to serve diverse ends."

I venture to think that it is not only as a mechanical engineer *in partibus infidelium*, as he says of himself, that Prof. Huxley has dealt with organic form, but also as an artist, a born lover of form, a character which others recognise in him though he does not himself set it down in his analysis.

Some day, it is to be hoped, Prof. Huxley will fill in the outlines of this autobiography, and especially give us an account of those long years of arduous work, of discoveries, struggles, triumphs, and friendships from the time when he succeeded his friend Edward Forbes in 1854 to the present day.

No better introduction can be given to Prof. Huxley's collected essays than his own statement of the objects which he has had in view during the years in which, whilst producing also educational books and many larger and strictly scientific works addressed to the limited circle of biological experts, he has by these occasional addresses and articles taught a vast number of his fellow-countrymen the value of scientific ways of thinking, and freed them from the fetters of orthodox superstition. These objects have been, he says—

"To promote the increase of natural knowledge and to forward the application of scientific methods of investigation to all the problems of life to the best of my ability, in the conviction which has grown with my growth and strengthened with my strength that there is no alleviation for the sufferings of mankind except veracity of thought and of action, and the resolute facing of the world as it is when the garment of make-believe by which pious hands have hidden its uglier features is stripped off. It is with this intent that I have subordinated any reasonable, or unreasonable, ambition for scientific fame, which I may have permitted myself to entertain, to other ends; to the popularisation of science; to the development and organisation of scientific education; to the endless series of battles and skirmishes over evolution; and to untiring opposition to that ecclesiastical spirit, that clericalism, which in England, as everywhere else, and to whatever denomination it may belong, is the deadly enemy of science. In striving for the attainment of these objects, I have been but one among many, and I shall be well content to be remembered, or even not remembered, as such."

E. RAY LANKESTER.

THE PSYCHOLOGY OF TO-DAY.

Grundzüge der Physiologischen Psychologie. Von Wilhelm Wundt. 4te Auflage. (Leipzig: Wm. Engelmann, 1893.)

A NEW edition of this well-known work will be welcomed by all interested in this developing branch of science, and the author is to be congratulated on the fact that a work of this magnitude should reach its fourth edition in nineteen years.

The general plan of the work and the general opinions are unaltered, but there has been much revision and addition of detail throughout. The most extensive alteration consists in the much more detailed description of experimental methods, especially in the chapters on the intensity of sensation, and on Time problems. The descriptions are admirably clear, and their value is greatly increased by the addition of numerous woodcuts illustrating the apparatus employed.

In the first half of the book, which deals with the anatomy and physiology of the nervous system, one turns with interest to learn what the author has to say on the subject of cerebral localisation. Wundt opposes the notion that the physiological substrata of complex mental processes can be localised in a limited area of the brain, though he appears later to disregard this when he suggests that his process of apperception is localised in the præfrontal lobes. While accepting, however, the localisation of motor and sensory processes in a more or less general way, he hesitates to accept that definite localisation which the facts now at our disposal seem to justify, at any rate so far as concerns the so-called motor area. His attitude on this question is influenced by the fact that he regards the prevailing view as an outgrowth from the doctrine of specific nerve energy, of which he is a determined opponent. One of his chief arguments is derived from the phenomena of compensation when a part of the brain has been destroyed. Wundt's view of this process is that the functions of the destroyed part are taken on by another part which had previously had a different function; thus he speaks of an element, which under normal conditions gives rise to a visual sensation, becoming the seat of a tactile or muscular sensation. It seems much more likely that the new function in such a case is taken on by elements of the cortex previously undeveloped, and the fact that compensation occurs so much more readily in the young is in favour of the latter view. On the question which is at present so much debated among English neurologists, viz. whether the Rolandic area of the cortex is to be regarded as motor or sensory (kinæsthetic), Wundt does not express a very definite opinion; he speaks of this area generally as centro-motor, but does not exclude the presence of sensory elements, though of a tactile rather than kinæsthetic nature.

In the second half of this volume, dealing with sensation, the section on what is usually called the muscular sense has been considerably modified. The importance of the part taken by impressions arising in the joints is fully recognised, and in the case of passive movement, Wundt agrees with Goldscheider in ascribing to them a very preponderant *rôle*, but insists on the addition of elements from the muscles and tendons in the case of active movements. Sensations of innervation are also called in to explain active movement, though Wundt now recommends that this name should be given up, and that this component of the sensation-complex should be called central as distinguished from the peripheral components arising in the joints, muscles, tendons, and skin. The author, however, states, as indeed he did in the last edition, that such central components probably have their source in memory-images of movements previously carried out.

The theory of colour vision in another section of this part does not differ materially from that brought forward in the last edition, and in the fourth volume of "Philosophische Studien," though several matters, and especially the phenomena of contrast, which are referred to central conditions, are more fully considered.

A new section has been added on the physical accompaniments of pleasurable and painful feeling, in which recent work on the subject, and especially that of Lehmann, has been embodied. Wundt supposes that the circulatory and respiratory changes which accompany pleasure and pain are the results of central innervations concomitant with the feelings; pleasurable feelings being associated with increased rapidity, and painful with inhibition, of the central processes.

In the first part of the second volume, in which perception is dealt with, there is little new; the most noticeable addition is on the subject of geometric optical illusions. Such illusions are regarded as mainly dependent on sensations arising from movements of the eyes. The author does not altogether exclude the influence of association to which some psychologists would refer them, but he objects strongly to the way in which Lipps has explained them by "introducing indefinite æsthetic notions into psychology, instead of referring æsthetic effects to definite psychological factors."

We have already mentioned the improvements made in the chapter on Time by the description of apparatus and methods. In considering the estimation of time-intervals, the work and theories of Münsterberg and Schumann are adversely criticised, and Wundt takes this opportunity to make a hit at the former psychologist for the large amount of work which he imposes on the muscle sensations in making them responsible for estimation of time and space, as well as for attention and the intensity of sensations.

A section is devoted to Hypnotism, in which the views recently advanced by the author are shortly expressed. The hypnotic condition is regarded as dependent on inhibition of active apperception, *i.e.* of will and voluntary attention. The explanation of the hallucinations and analogous phenomena of hypnotism is referred to a general law that when the greater part of the brain is out of action, the sensitiveness of the active remainder is increased; a law which also applies to the explanation of dreams.

The doctrine of Apperception, which is the most characteristic feature of Wundt's system, does not appear to have suffered any material change. Apperception, as used by the author, corresponds very closely to the attention of many English psychologists, and Wundt himself occasionally seems to use the terms "apperception" and "aufmerksamkeit" indifferently. The book combines the qualities of a text-book and of a philosophical treatise. It may be used with the greatest advantage as a means of learning the way in which the methods of experimental psychology are employed, and as an account of what we have learnt thereby; but it is also an able attempt to treat the whole subject of the connection between Mind and Body philosophically.

RAILWAY WORKS.

Round the Works of our Great Railways. By various Authors. (London: Edward Arnold, 1893.)

THIS volume consists of a reprint of a very interesting series of articles which appeared some few months ago in the *English Illustrated Magazine*, the authors in most cases being intimately connected with the railway companies' works they describe. Taken as a whole, this book is very readable, and contains much useful information.

The London and North-Western Works at Crewe are first described by Mr. C. J. Bowen Cooke, of the locomotive department. The Crewe Works have been so often described by many people, that the present author ran the risk of being unfavourably compared with the others; there is, however, no need to fear the comparison, for the article is well done. It is a pity that anything was written on the subject of building an engine in twenty-five hours; and the author of the article on the Great Eastern Works at Stratford does the same thing on p. 128, although in this case the time is reduced to ten hours. No doubt the statements are wonderful to the general public, but to locomotive builders they merely go to show how railway shareholders' money is sometimes wasted.

Chapter ii. (written by Mr. C. H. Jones, of the locomotive department) describes the Derby Works of the Midland Railway Company. In order to show the size of the staff on this railway in the locomotive department only, the following figures are of interest:—There are 13,150 men, 2328 locomotives, 302 stationary engines, 267 stationary boilers, 1023 hydraulic machines, and 416 cranes of every kind, besides many other mechanical appliances, the supervision of which come under the locomotive department.

Mr. A. J. Brickwell, of the surveyors' department of the Great Northern Railway, is the author of Chapter iii. describing the locomotive work of that company at Doncaster. High speed has always been associated with the Great Northern, and very properly so, for this company has always held the palm in this respect, thanks to the magnificent engines designed by Mr. Stirling, the locomotive engineer. A passable illustration of No. 776 engine, built in 1887, gives some idea of the bold outline of the "flyers" that daily tackle the "Scotchman" express, and seldom drop a minute on the road. What locomotive engineer, besides Mr. Stirling, of Doncaster, can point to engines like these, designed twenty-three years ago, and can still claim that the engines are able to hold their own with their present-day rivals, be they compound or otherwise?

Chapter iv., by Mr. Wilson Worsdell, the locomotive superintendent of the North-Eastern Railway, deals with the works of that company, and we naturally read a good deal about the virtues of the two-cylinder compound locomotive, besides the excellent description of the works. As this company is building some very powerful non-compound express engines, it would appear that compounding is not the source of economy hitherto claimed for this system.

The Great Eastern Railway Works at Stratford are described by the secretary to the locomotive superintendent, Mr. Alex. P. Parker. The article is well written and interesting, notwithstanding the absurdity of claiming credit for throwing an engine together in ten hours. Everything at Stratford is certainly on the most modern system of management and manufacture, and those responsible may well take credit for being "up to date."

Chapter vi. is of much interest, because it deals with the Great Western Railway Company's works at Swindon, and particularly so because of the now defunct broad-gauge system with Sir Daniel Gooch's noble engines. These are well illustrated in the text, and some exciting runs on the engine of the "Dutchman" are described. The following chapter deals with the new narrow-gauge engines built to take the place of the veterans when the line was converted to the narrow gauge.

The last chapter in the book is on the Cowlairs Works of the North British Railway, the only Scotch railway described, the author being Mr. A. E. Lockyer, of the locomotive department. This article is interesting, but it appears to be unduly curtailed, and has fewer illustrations than the other chapters; the illustrations that are included, however, are certainly the clearest in the book. The unique part of this chapter is the description of the working of the trains up the incline at Cowlairs from the Glasgow terminus at Queen Street, by means of a stationary engine and endless wire rope. The description of the works is good.

Altogether the volume is most interesting, and should be read by all connected with, or travelling by, the railways of this country, containing, as it does, much unique information on a subject little thought of outside the railway circle. N. J. LOCKYER.

ESSENTIALS OF CHEMICAL PHYSIOLOGY.

The Essentials of Chemical Physiology. By Prof. W. D. Halliburton. (London: Longmans, Green, and Co., 1893.)

THERE is no doubt that this elementary text-book by Prof. Halliburton will be welcomed by students of chemical physiology. The teaching of physiology has come to be so much a matter of laboratory instruction that the demand for carefully written text-books dealing with the practical parts of the science, has become a very pressing one. This book is a companion volume to Prof. Schäfer's "Essentials of Histology." It is constructed on the plan originally adopted in the syllabus of lectures by Prof. Burdon Sanderson. At the beginning of each chapter there is a series of exercises which form practical illustrations of the subject with which the chapter deals. The exposition which follows the list of exercises is manifestly the work of one who is a master in the modern methods of teaching, and the frequent references to recent research give to these chapters an interest which is unfortunately sometimes absent from text-books. The elementary is followed by an advanced course, in which are given the more elaborate exercises on the subjects of the earlier chapters. In this course perhaps too little attention is paid to experiments on the living organism. The exercises given are concerned chiefly with those substances which can be extracted from the organism by some means or other. We have, for example, a chapter on hæmoglobin, in which we get instruction in regard to substances such as alkaline hæmatin, hæmochromogen, hæmatoporphyrin. There are no exercises on oxygen or carbonic acid, and yet the relation of these gases to the organism is surely of vastly greater importance in physiology than hæmochromogen. Similarly we have the analysis of urine considered even so far as to include the estimation of creatinine, while there are no exercises showing how the constituents are related to physiological conditions.

The function of such instruction as we find in this book is not only to bring physiology to practical expression, but to show its relation to the questions of practical medicine; and exercises, with this in view, are more to be desired than the estimation of creatinine. The difficulties in the way are not such as to prevent the introduction of experiments of the kind suggested.

In the appendix the author describes one or two examples of complicated apparatus, and gives some chemical tests. Apparatus in the complicated forms is always a burden to the physiologist, and any allusion to it should appear in an appendix, if at all. It is difficult to see why the author has placed Kjeldahl's method for estimating nitrogen in the appendix. The method is an easy one and is in universal use, and should be familiar to advanced students. It would also be well to present it to beginners in some simpler form than that which is given here.

Apart from its relation to experimental work the book is of interest in so far as it gives indication of a new departure in physiology. We are told that "the chemist cannot, at present, state anything positive about living matter." So far as we know apparently, we cannot say that there are any chemical changes in living cells.

The author also discards any physical or chemical account of absorption. The cells absorb in virtue of their "vital activity." Finally, in describing the process of respiration, he states his position generally in the following sentence:—"Much recent physiological research has shown that we must largely abandon physical theories for what are called vitalistic theories; in other words, the vital processes of selection possessed by the cell may counteract or supplement physical processes."

It is probably significant, as it is new for vitalism, as a theory of life, to put forward a claim to recognition in the name of "recent research" We are accustomed to the theory being classed among things which are not only characterised by the flavour of antiquity, but are familiar to those only who shun all kinds of experimental investigation. If vitalism be adopted as the true point of view in biology, it will clearly be necessary to reconsider the position of physiological chemistry as a science.

OUR BOOK SHELF.

The Sacred City of the Ethiopians. By J. T. Bent. (London: Longmans, 1893.)

IN the interesting volume before us, Mr. Bent gives us a very readable account of the journey to Ethiopia which he and his wife undertook in the year 1893. The work contains twelve chapters by Mr. Bent, a chapter of rather more than fifty pages by Prof. David Heinrich Müller, of Vienna, upon the inscriptions at Yeha and Aksum, an appendix on the morphological characteristics of the Abyssinians, by Dr. J. G. Garson; and a map of the country, showing Mr. Bent's route. Mr. Bent's purpose in visiting Ethiopia was archæological, and he took considerable pains to visit all the sites of ancient cities, sometimes even seeming to carry his life in his hands in so doing. The principal sites examined by him were Asmara, Keren, Adoua, Yeha, and Aksum, and he made pilgrimages to the famous monasteries of Bizen and Debra Sina, into which last religious house Mrs. Bent succeeded in gaining admittance by assuming male attire. Throughout his travels Mr. Bent was shown the greatest courtesy by the Italians, and although many parts of the country were convulsed by civil war, yet under their direction Mr. Bent made his way in comparative security. Mr. Bent has noted many particulars of interest, and the illustrations made from photographs taken by Mrs. Bent give additional interest to his narrative; but the most important part of the book for the Orientalist are the translations of the Himyaritic and Ethiopic texts which Prof. D. H. Müller has made from Mr. Bent's excellent squeezes. These show that the Sabeans migrated into Ethiopia at a much earlier date than is usually supposed, and they are full of historical and archæological interest. It is true that some of the texts have been copied and published before, but the new critical investigation by such a competent scholar as Prof. Müller has resulted in the elucidation of many important details. If Mr. Bent's book runs into a second edition, he will do well in revising his account of the Mohammedan conquest of Ethiopia to note several facts given in the account of the invasion, written in Ethiopic by a monk, the text of which has recently been published in Berlin by Dr. A. W. Schleicher, entitled "Geschichte der Galla." Meanwhile we thank Mr. Bent for the squeezes and the labour which he undertook to obtain them.

Fra i Batacchi indipendenti. Viaggio di Elio Modigliani, publicato a cura della Societa Geografica Italiana. (Rome, 1892.)

SIGNOR MODIGLIANI communicated an account of his journey through Sumatra in 1890–91, to the Genoa Geographical Congress of 1892, and it is now published in book form, enriched with many excellent illustrations. He describes in some detail the Battak people of Central Sumatra, one of the most remarkable remnants of primitive culture in all Asia, as they retain their own forms of architecture, industry, and writing, together with their primitive religion and their political independence, although surrounded on every side by Mohammedan tribes and Dutch supremacy. The headquarters of the shrunken remnants of the Battaks is round the great lake of Toba, of the western side of which Signor Modigliani has made a large scale map, published in the book. The scenery of this lake is very fine, and a long panoramic view goes far to justify the enthusiasm of the author's description. The main object of the journey was to make ethnographical collections, and some excellent photographs of the Battak physical type are reproduced, together with examples of native art, architecture, and industry. Incidentally a good many adventures befel the author, and these he does not minimise. While there is little in these pages of real importance that has escaped the careful observation of the Dutch and German observers, who have made an almost exhaustive study of the Battaks, the narrative is interesting, and the collections should be very useful to students in Europe. A short meterological appendix gives observations of temperature, pressure (aneroid), humidity, and rainfall from October, 1890, to April, 1891.

Romance of the Insect World. By L. N. Badenoch. (London: Macmillan and Co., 1893.)

THIS is a pleasantly written little book, which contains much interesting information on insect life and habit. The metamorphoses of insects, their food, hermit homes, social homes, defences and protection through adaptation are successively considered. Although there is not much evidence of individual observation, the author has been careful in his selection of authorities. The book is intentionally descriptive rather than explanatory, and, since the descriptions are picturesque without inaccuracy, may be safely recommended to those who seek for information in one of the most fascinating departments of natural history.

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 Postal Transmission of Natural History Specimens.

IN NATURE for November 30, 1893, p. 100, appeared a circular, issued by the Academy of Natural Sciences of Philadelphia, concerning the transmission of specimens of natural history by mail between different countries. This circular asked scientific bodies in certain countries therein named to request their respective Governments to favourably reconsider a proposition, made by the United States Post Office, to admit such specimens to the international mails under the rates for "samples of merchandise," this proposition having been once rejected by those countries.

In commenting upon this circular, Mr. R. McLachlan reproduces (NATURE, December 21, 1893, p. 172) a letter from the Secretary of the British Post Office, dated April 13, 1891, in which the Secretary promised that the British Post Office would not, in the future, stop scientific specimens sent by sample post and addressed to places abroad, but added that the delivery of such specimens abroad could not be guaranteed, for the reason that such specimens "do not come within the definition of sample packets as prescribed by the Postal Union." Mr. McLachlan adds that within the last month he had, "on two occasions, sent specimens abroad by sample post with perfectly satisfactory results." He continues: "But it is to be regretted that the United States Postal Department should, in another way, continue to maintain a barrier against cheap transmission and interchange of specimens. The sample post can, in any case, only be used for small packets, but larger packages can now be sent to nearly all foreign countries by parcel post, the introduction of which was an inestimable boon. The United States Government stands almost alone in persistently refusing to cooperate in this respect."

As chairman of the committee appointed by this Academy to prepare the circular, I have obtained from Mr. N. M. Brooks, Superintendent of Foreign Mails, U.S.P.O., certain official information which, it is believed, will throw a new light on Mr. McLachlan's comments, and make the desirability of sending specimens by sample post still more evident.

Mr. McLachlan's quotation from the letter of the British Postal Secretary mentions the fact that specimens of natural history do not come within the Postal Union's definition of sample packets. Mr. Brooks, in a letter of July 14, 1893, writes: "Said proposition [to admit such specimens as 'samples'] having been formally submitted to a vote of the countries of the Postal Union, and having failed to receive the support of the number of countries necessary to secure its adoption, no country of the Postal Union is at liberty to transmit by mail to another country of the Union, natural history specimens as 'samples of merchandise.'"

On the subject of the parcels post, Mr. Brooks states (letter of January 12, 1894): "It may be well to say that so far as *small packages* of natural history specimens are concerned, the parcels post would afford but few additional facilities over those offered in the regular mails if the rates were assimilated to those in force in Great Britain and Canada; for instance, the lowest charge in Great Britain on a package weighing 3 pounds *or less* addressed for delivery in Belgium is 1 shilling 3 pence (= 30 cents), and to France 1 shilling 4 pence (= 32 cents), while in Canada the charges for a pound *or less* would be to Belgium 46 cents, and to France 48 cents. While the sums above named may be low for the transmission of three-pound or one-pound packages, it must be remembered that these sums are the minimum charges, and must be paid also on smaller packages, even on packages weighing only one or two ounces. If the proposition of this department to admit natural history specimens to the mails as 'samples' had been adopted, small packages of such specimens would have been transmissible throughout the extent of the Postal Union at the rate of one cent for each two ounces, while the facilities offered by the parcels post for the transmission of larger packages would not have been curtailed. For example, under present conditions a package weighing 4½ ounces may be sent from Canada to Belgium or France as *a letter* upon the prepayment of 45 cents; as a parcels-post package the charge would be 46 and 48 cents respectively; as a 'sample' the charge would be 3 cents."

Such a large proportion of the packages contain specimens weighing less than a pound, that the establishment of a "samples" rate of postage for them is in the highest degree desirable.

In the present condition of affairs it would appear that the "hyper-protection," at which Mr. McLachlan hints in his concluding sentence, is not on *this* side of the Atlantic.

Philadelphia, January 18. PHILIP P. CALVERT.

The Origin of Lake Basins.

THE present, while the origin of lake basins is under discussion in your pages, seems a favourable opportunity for collecting all that can be said for and against the glacier theory. Not being a geologist myself, I do not know whether the few remarks I have to make may be new or not. They are therefore submitted with great diffidence for the consideration of experts.

If lake basins have been excavated by boulder-shod glaciers, then it follows, that as these boulders do not act by cutting, but by grinding, the boulders will be worn away as much as the rock beneath them; that is, for every square yard excavated, there will be an equal amount of boulder material ground down. This will be so, as we are hardly entitled to assume that the boulders are on the average harder than the under rock, and as they are in smaller pieces, they will be liable to a greater amount of fracture. Are the glacialists, then, prepared to supply an amount of boulder material equal to the amount excavated? and if not, how do they explain the greater cutting power of the moving blocks? Further, after the glacier has dug a basin, the flow of water under the ice will be very slow, owing to the widening of the glacier, and the water spreading across the whole breadth of the basin. How, under these conditions, is the abraded material got quit of? It will no longer be water-borne, but will probably be pushed upwards and forwards out of the basin by the ice and boulders, and should therefore form a deposit of a breadth nearly equal to that of the basin. Is there any evidence of this?

Another point to which I wish to refer is in explanation of the constant association of lakes with evidences of previous glacial conditions. It is possible, as has been pointed out by Mr. Oldham, that this relation may only be apparent, and that there may be rock basins that are not lakes, and that the only part the ice played was to keep these basins from being filled up by deposits. There, however, seems to be another way in which the ice may have acted and at least helped to make the lake basins. When we examine the position of the principal lakes in Switzerland and Italy, we find that many of them lie where the plains merge into the mountains, that is, close to the foot of the mountains. In many of them the lower part of the lake extends into the plains, while the upper part penetrates the mountain range. Now, the foot of the principal slope is where the greatest accumulation of ice will occur. The quick upper slopes supplying more ice than the lower slopes can take away, the consequence is that the ice accumulates until its greater depth compensates for its slower movement. If, then, the surface of the land was in equilibrium in the shape it was in before the ice made its appearance, then, owing to the unequal distribution of the load, it would evidently not be in equilibrium after the arrival of the ice, and the consequence would be that wherever the ice was deepest there would be the greatest tendency for a depression to form on the surface of the earth. In this way basins would tend to form under the places where the ice was deepest; this would naturally be in, and in front of, the main valleys in the line of the greatest flow of ice, at the point where the quick slope of the valley gives place to the slow slope of the plain, just where we find the principal Alpine lakes. The formation of lake basins in this way will of course be greatly modified by the nature of the under rock. We could easily imagine basins such as those of the Lake of Zurich and the Lake of Varese to be formed in this way, as the shores slope easily in all directions; but it is much more difficult to imagine the upper ends of the greater Alpine lakes, where the shores are precipitous, to be produced by sinking due to the load of ice. It might be objected that if these lake basins were produced in the way suggested, the earth's crust ought to have recovered its form after the Ice Age had passed. This, however, is by no means a necessary conclusion, because when sinking, the rocks being already fractured, deformation can take place comparatively easily; but when rising, the rocks, being in arch-form, are in a much better position to resist an upward thrust than they were to resist a downward one. The result of the snow and ice melting would probably be to cause a general elevation of the mountains as well as of the lakes. JOHN AITKEN.

Darroch, Falkirk, January 20.

I HAVE been following with some interest the recent discussion in these columns concerning the power of ice to erode rock basins, since I have prepared for publication (presented at the December, 1893, meeting of the Geological Society of America) a paper describing some recent studies of my own upon this subject. After several years of study in the glacial belt of New England, having never found definite evidence of rock basins in lakes of large size, I came to the conclusion that the theory of rock basins had little value, particularly since, after having been before us for more than thirty years, so few instances have been proven. In my own case, and I believe also in others, the attempt had always been to trace a continuous rock line, and this I now believe to have been an entirely wrong method; for how many large lakes are there in which *possible* outlets may not be buried beneath drift areas?

By following an entirely different method I have been able to prove that Lake Cayuga in central New York, and probably also Lake Ontario, is in a rock basin. Lake Cayuga has a length of nearly forty miles, and a width varying from one to nearly four miles, while its depth is in one place four hundred and thirty-five feet, the bottom being considerably below sea-level.

The method followed was to find the distinctly preglacial valleys tributary in the preglacial stream valley, now deepened by glacial erosion, and occupied by Lake Cayuga. There are several of these with the broad valley and gently sloping sides so characteristic of old valleys, and so different from the steep side post-glacial gorges. Their directions are at all angles with that of the ice motion. If the main valley (the present lake valley) has not been sensibly deepened by the ice, these tributaries should not be rock bottomed. In the present instance the entire valley is found to be underlain by the Devonian shale in place (nearly horizontal); and the bottom of the preglacial valleys are there, at the lake margin, found to be over 400 feet above the deepest point of the lake.

There are three possible explanations of this phenomenon: either (1) the rivers had a fall of over 400 feet in less than a mile, while above this the slope was only very slight, or (2) the lake valley has subsided 400 feet, or (3) it has been deepened by ice erosion. Few will, I think, consider the first two to be possible, and there is evidence that they are not. For fuller details reference may be made to my forthcoming paper.

It seems to me that we have here a reasonable and possible method of testing the value of the rock basin theory, and I believe that its application in other regions will show that ice can, where conditions were favourable, excavate lake basins of large size, and has done so. This conviction comes to me in spite of distinct preconception and prejudice against the theory.

R. S. TARR.

Cornell University, Ithaca, New York, January 15.

Glacial Erosion in Alaska.

REFERENCES in your recent correspondence to my estimate of the rate of erosion by the Muir Glacier in Alaska, call for a supplementary statement. The estimate was made in 1886 by determining the amount of sediment per gallon brought down by one of the sub-glacial streams, and calculating as best I could the area of the glacial basin, the amount of annual rainfall, and the probable waste by evaporation and by the formation of icebergs. The result obtained was the removal of one-third of an inch of rock per annum over the glaciated area.

Since my visit to the Muir Glacier, Prof. H. F. Reid has spent two summers on the same ground with more ample preparations for collecting the facts. His report may be found in the *National Geographic Magazine* (Washington), vol. iv. p. 51. According to his calculation, the erosion amounts to three-quarters of an inch, or nearly three times as much as I had estimated. I have little question that Prof. Reid's estimate is more nearly correct than mine, since my calculation was based upon the removal of sediment from the entire drainage area of the glacial amphitheatre. Prof. Reid, however, rightly concludes that this is full twice as large as the actual bed of the glacier to which the glacial erosion was practically limited. Making that correction, our estimates are in close agreement.

It should be observed, however, that these observations do not bear directly upon the question of the erosion of lake basins by glaciers; for the Muir Glacier, whose sediment was estimated as above, is moving down a slope of about 100 feet per mile. The erosion over this slope, therefore, may be quite different from that at the foot of the glacier as it descends below the water-level into the head of the tidal inlet, where, I should presume, the erosive power would be soon reduced to a small quantity. Still, the mechanical problem involved in calculating the distribution of the force of a descending glacier as it reaches the foot of the incline is too complicated for ready solution. That there is some scooping out of a rocky basin in such cases seems amply proved by the facts which I have quoted in my "Ice Age" (pp. 237-239), from Prof. I. C. Russell, concerning the formation of cirques in the Sierra Nevada Mountains.

In my own observations two or three years ago, however, upon Lake Geneva in Switzerland, I was led to believe that whatever might be true of glacial erosion, attention enough had not been given to the theory of a possible buried outlet leading past Mount Sion and Frangy to Seyssel. Certainly the course of the Rhone across the spur of the Jura Mountains at Fort De l'Ecluse is very suggestive of recent occupancy. Among the great lakes of America there can be but little doubt that Lake Erie and some others owe their existence almost wholly to the choking up of preglacial outlets of the valleys by glacial *débris*. The great depth of Lake Geneva, however, would render it improbable that it was wholly due to such a cause, and I do not know that the conditions are such as to permit the supposition made above. I distinctly remember, however, that from the vicinity of Seyssel there was an unobstructed view between the mountains towards Geneva, and that the gravel deposits extend from Geneva far down towards those which appear about the head-waters of the small tributary to the Rhone which joins it at Seyssel. Perhaps this theory has been fully considered and refuted; if so, I have not seen the refutation.

G. FREDERICK WRIGHT.

Oberlin, Ohio, January 17.

On the Equilibrium of Vapour Pressure inside Foam.

IT is known that the vapour pressure near a curved liquid surface is different from that near a flat surface, being less near a concave surface and greater near a convex surface than near a flat one. Now, inside foam bubbles the surfaces are approximately flat, except where three bubbles join to form an edge, and along these edges the surface inside any bubble is concave with a very small curvature. How does it happen that equilibrium can exist with the small pressure in these corners, and a larger pressure required near the flat surfaces? In the first place it may be that equilibrium cannot exist, and that all foam is essentially unstable; and it would be almost impossible to disprove this by a direct experiment. If, however, foam can be stable, it seems as if the only conclusion possible were that the flat surfaces will evaporate and thin down, the liquid condensing in the corners, until the flat parts are so thin that they are in equilibrium with a smaller vapour pressure than a thick liquid surface would require. In other words, that the vapour pressure near a very thin film may be less than it can be near a thick one at the same temperature. It is evident that inside or outside a solid box stability must be possible, so that the second alternative is the only solution.

We see a phenomenon of this latter kind in the hygroscopic films that cover glass. Being due to an attraction of the glass for water there results what I am describing, namely, that in an atmosphere incompletely saturated a film of such a thickness can exist that the vapour pressure near it is such as corresponds to the existing vapour pressure in the surrounding atmosphere.

If we knew the connection between the thickness of a film and the vapour pressure near it, it would be possible to calculate the shape of a bubble near a corner. The pressure at any point being that due to the thickness diminished by an amount proportional to the curvature. So that if $f(y)$ be the pressure due to a film of thickness y and r be the radius of curvature of the surface of the liquid near a corner, we get as the equation of the surface

$$f(y) - \frac{T}{r(\delta - \sigma)} = \text{constant},$$

when T is the superficial tension which may be a function of y and δ the density of the liquid and σ of the vapour of the liquid, which latter will depend on the vapour pressure inside the bubble. To determine this and the constant we should know how much liquid we have at our disposal ($V = \int y dx$) to lie round the bubble and to supply vapour inside, and it would appear that inside a cubical box falling freely, for instance, a bubble would always be spherical unless the quantity of liquid were sufficiently small to require the sides of the bubble to be flattened against the sides of the box; *i.e.* unless the volume of liquid were less than $1 - \pi/6$ times the volume of the box.

In connection with my letter in last week's NATURE, I may suggest that a possible cause of warming of solid powders when mixed with liquids, is that the solids have already got a film of water over their surfaces, which being on the outside in contact with air, is at least on its outer surface in tension, and that this enormous area of air-liquid film disappears when the solid is immersed in liquid, and that the heat is due to the extinction of this great film. It would require very careful measurements of the heat evolved and estimates of the area of the film concerned, to decide whether this would account for the heating observed. In my former letter I assumed that liquids would soak up into *dry* powders, and that these latter warmed liquids when mixed with them. The suggestion I am now making would account for a warming being produced by damp powders, or by spray or cloud falling into a liquid.

G. F. FITZGERALD.

Trinity College, Dublin, January 29.

A Liquid Commutator for Sinusoidal Currents.

MY attention has been drawn to a note in NATURE of January 11 (p. 253) which quotes from the *Electrical World* of New York "a novel method of obtaining sinusoidal alternating currents of very low frequency," described by Lieutenant F. Jarvis Patten. The method is to make a pair of conducting plates revolve in a vessel of liquid which also contains a pair of fixed plates. This liquid commutator, however, is not new. It was the subject of a joint patent taken out by Mr. C. G. Lamb and myself a year and a half ago, and it was used in connection with the magnetic curve-tracer in my British Association lecture at Edinburgh on "Magnetic Induction," and again at the Royal Society soirée last May. It has been, in fact, for some time an item in Messrs. Nalder's catalogue of scientific apparatus. A description of it was published in the *Electrician* of November 18, 1892. J. A. EWING.

Engineering Laboratory, Cambridge, January 26.

A Curiosity in Eggs.

A COMMON "barn-door" hen, belonging to a neighbouring farmer, recently laid an egg measuring 4½ inches in length by 7 inches in circumference; weight 6 ounces. On this egg being carefully broken a second perfect egg, with hard shell of ordinary size (3 inches by 5½ in circumference), was found floating in the contents of the outer one. The contents of both eggs appeared to be normal and healthy. This is surely a very unusual occurrence. E. BROWN.

Further Barton, Cirencester, January 16.

RICHARD SPRUCE, Ph.D., F.R.G.S.

ALTHOUGH little known beyond a limited circle of botanists and South American explorers, the subject of this notice was in many respects a remarkable man, who, under more favourable circumstances, would have acquired a wider reputation. He was the son of a schoolmaster at the village of Ganthorpe, Yorkshire, and at an early age showed a taste for botany, having compiled a "List of the Flora of the Malton District" in 1837, when he was just twenty years old. For some years he was teacher of mathematics at the Collegiate School, York; and during his holidays he explored Eskdale, Teesdale, Killarney, and other districts, paying special attention to the mosses and hepatics, among which he discovered many new species, which he described in the *Phytologist*, the *Transactions* of the Botanical Society of Edinburgh, and in the *London Journal of Botany*. In 1845 he went to the Pyrenees, where he spent ten months, chiefly devoted to his favourite groups of plants, among which he discovered a large number of new or rare species. These were fully described in a paper published in the *Annals and Magazine of Natural History* in 1849.

The delicate state of his health requiring a warmer and more equable climate than that of his native Yorkshire, he decided, by the advice and with the assistance of the late Sir William Hooker, to visit the Amazon valley as a botanical collector, with the object, if possible, of reaching the head waters of the Orinooko and the eastern valleys of the Andes, districts whose riches had been indicated by the explorations of Humboldt and Bonpland at the beginning of the century, but which no experienced botanical collector had since visited. Invaluable assistance was also given by the late Mr. Bentham, who undertook the great labour of dividing and distributing the dried plants as they arrived in England, and sending sets to those who subscribed for them, thus acting as an unpaid but most efficient agent. The same eminent botanist described most of the new species of flowering plants as they arrived, thus making known the value of the collections, and ensuring the sale of the whole of the specimens.

In July, 1849, Mr. Spruce arrived at Para (where the present writer first made his acquaintance), and during the succeeding fifteen years carried out successfully a series of voyages and explorations in equatorial South America, surpassing in extent, probably, those of any other scientific traveller. A mere enumeration of these journeys can alone be given here, in order to show how much was accomplished amidst all the difficulties due to climate, scarcity of food, scanty means, and imperfect means of transportation, aggravated by solitude and ill-health.

After a few months in Para and its vicinity, he moved to Santarem, at the mouth of the Tapajoz River. Here he remained for a year, collecting and studying the remarkable shrubby vegetation which surrounds the town, consisting largely of species then entirely new to botanists. During this time he made an exploration up the river Trombetas and its tributary the Aripecuru to the limit of canoe navigation. The following year was spent at Manaos (Barra do Rio Negro) exploring the surrounding forests and streams. He next ascended the Rio Negro in a large boat of his own, so as to be able to collect and preserve plants during the voyage. Two months were occupied in ascending the river as far as San Gabriel, situated on the cataracts of the Rio Negro, where he rested seven months, making numerous canoe excursions across the river to the various islands and to tributary streams, not without danger amid the roaring waters produced by the granite rocks and reefs which for some miles here fill the broad river-bed.

Spruce next ascended the Uaupes River as far as the first cataract at Panuré or San Jeronymo, which he made his headquarters for another seven months. Here he was delighted by the richness and novelty of the forest vegetation, which was almost wholly new in species, and even in some of the genera. Many of the loftiest trees had flowers of extreme beauty, especially those of the natural orders Vochysiaceæ, Tiliaceæ, Bombaceæ, Lecythideæ, Rhizoboleæ, and Rubiaceæ, and to add to the botanical interest of the district, when the rainy season brought the flowering of the forest trees to a close, the ground beneath them became ornamented with thousands of curious herbaceous plants, mostly leafless but adorned with delicate or brilliantly coloured flowers. These belonged mainly to the genera Voyria, Burmannia, Ptychomeria, and the Triurideæ. Here also fungi were more abundant than in any other locality visited, and about 200 species were collected, many of which were as varied and brilliant in colouring as the flowers themselves.

Leaving the Uaupes the traveller made his next headquarters at San Carlos, the first village in Venezuela situated on the north bank of the Rio Negro, not far from the entrance of the Cassiquiare. From this station excursions were made up the Rio Negro and many of its tributaries, and also through the entire length of the Cassiquiare to Esmeralda on the Upper Orinooko. He was now in the country explored by Humboldt and Bonpland nearly a century before, and collected hosts of plants, which were known only from the specimens sent home by those botanists, together with considerable numbers of new genera and species. In order to procure food in this notoriously hungry region, he made a special journey from San Carlos to the cattle district of the cataracts of Maypures on the Orinooko, travelling over the portage of Pimichin which forms a narrow watershed between the two great river systems. After twenty months in this district he descended again to Manaos, from which he had been absent three years, and prepared for his great journey to the Andes.

Ascending the main stream of the Upper Amazon, and entering its great southern tributary, the Huallaga, he passed beyond its first rapids, and by means of a small western affluent and a day's journey overland, reached Tarapoto. This is a town of about 7000 inhabitants, beautifully situated in a level plain about 1200 feet above the sea, and almost entirely surrounded by forest-clad mountains of moderate height, from which abundant streams descend through narrow ravines, offering in every direction a rich harvest for the enthusiastic botanist. Here Spruce remained for nearly two years, exploring the country for twenty or thirty miles in every direction, occasionally remaining weeks at a time in the more promising mountain localities. Rich collections of all orders of plants were here obtained, especially of ferns and of his favourite groups the mosses and hepatics, while on the mountains—though only 5000 to 6000 feet in elevation, many north-temperate genera, such as Ranunculus, Rubus, Stellaria, and many others, made their first appearance.

In March, 1857, he left Tarapoto for the Andes of Ecuador by way of the Upper Amazon and its tributary, the Pastasa, reaching Canelos by a northern branch, the Bobonasa, and thence through the forest to Baños. On the way he had to cross the river Topo by bamboo bridges, constructed afresh by every traveller from rock to rock across the broad mountain torrent. The stream, however, was in flood, and he had to wait four days before the bridge could be constructed, and then the water was so high and the passage so dangerous that most of his baggage—books, manuscripts, microscope, &c.—had to be left behind under a thatch of leaves till they could be sent for, his party of sixteen persons being in danger of starvation had they waited longer. After reaching Baños, the packages were sent for, and recovered without injury. During his enforced stay on the banks of the Topo, he had found the forest so rich in plants—especially in his favourite hepatics—that after some weeks he returned there in order to obtain a more complete series of its botanical treasures, and again had the greatest difficulty and risk in passing the flooded river, of which he declares that the only pleasant recollection he retains is of the new and strange hepaticæ which he collected on its banks.

After some months at Baños, he devoted more than three years to the continuous exploration of the forests and higher mountains of Ecuador, visiting in turn Tunguragua, El Altar, Guayrapata, Azuay, Pichincha, and Chimborazo, but devoting most time to the first named. In the year 1860 he was commissioned by Mr. Clement Markham, on behalf of the Indian Government, to procure seeds and young plants of the *Cinchona succirubra*, one of the species which produces the best quinine, in order to establish plantations of this precious tree in the Nilghiries. For this purpose he settled himself in the forests on the western slope of Chimborazo, where this species is found between the heights of 3500 and 7000 feet above the sea-level. Assisted by Mr. Robert Cross, a gardener sent for the purpose of taking charge of the plants on the voyage to India, he collected abundance of ripe seeds and raised a quantity of young plants, all of which arrived safely, and helped to form those fine plantations which now supply an abundance of the valuable drug. He also wrote an elaborate report on the Cinchona forests, their vegetation, and the mode of collection and preparation of the bark, which is considered to be one of the best works of its kind that has ever appeared.

This expedition, undertaken and completed under the pressure of almost continual suffering, was the conclusion of Spruce's labours in South America. So long as he had remained in the warm equable climate of the equatorial plains his health had been better than when in England, and appeared to be fairly re-established, notwithstanding much privation and occasional attacks of fever. He suffered, however, from chronic diarrhœa; and the extremes of temperature and of moisture in the forests and mountains, having frequently to wade for hours in ice-cold water, and exposure to the severe and changeable climate of the high Andes, which, as Mr. Whymper assures us, is the most detestable in the world, brought on an attack of some obscure malarial disease which rendered all further exertion impossible, and led to complications which rendered the remainder of his life that of a confirmed invalid. Under medical advice he removed to the hot and dry sea coast, remaining there for two years in the vain expectation of a recovery sufficient to enable him to extend yet further his botanical explorations.

All hope of renewed health being given up, he returned to England in 1864. After a few months in London, he went to live at Hurstpierpoint, Sussex, in order to be near his correspondent, Mr. William Mitten, who had undertaken to describe the whole of his new South American mosses. After remaining there two or three years, in varying conditions of health, he determined to remove to Yorkshire, where a cottage was offered him on the Castle Howard estate, and where his slender means would enable him to command greater comforts than elsewhere. This was rendered necessary by the loss of a large part of the money derived from the sales of his collections, owing to his having placed it at interest in a commercial house in Ecuador, which, unfortunately, became bankrupt. He was granted a small Government pension in recognition of his services in regard to the establishment of the Indian Cinchona plantations and his complete incapacity for any further remunerative work, and on this and the small remnant of his property he was able to live in some comfort, though with the very greatest economy. He resided first at Welburn and afterwards at Coneysthorpe, both small villages situated near Malton and in the immediate vicinity of the noble park of Castle Howard. Here he lived the life of a confirmed invalid, rarely of late years leaving the house, keeping in a room of uniform warmth and subjecting himself to a rigid system of diet. By these precautions he prolonged his life to the ripe age of seventy-six, and then only succumbed to an attack of influenza, from which his much enfeebled system was unable to rally.

During the twenty-five years of his secluded life in Yorkshire he was always occupied with some botanical work, although for much of the time he could only write or use his microscrope while reclining on a couch. His more important works during this period were his "Palmæ Amazonicæ," forming vol. xi. of the botanical series of the Journal of the Linnean Society, and his "Hepaticæ Amazonicæ et Andinæ," in the Transactions of the Botanical Society of Edinburgh, 1885. During the last few years he published many papers on new Hepaticæ, both American and European, and carried on a considerable correspondence with students of that group in all parts of the world, by whom he was looked up to as one of the greatest, if not the greatest, of living authorities in their favourite study.

Having had the pleasure of Dr. Spruce's acquaintance from the time when he reached Para in 1849—an acquaintance which soon ripened into friendship during the many days spent together in various parts of the Amazon and Rio Negro, in London, at Hurstpierpoint, and during several visits to him at Welburn and Coneysthorpe—a few words descriptive of his appearance and character may not be out of place. Richard Spruce was tall and dark, with fine features of a somewhat southern cast, courteous and dignified in manner, but with a fund of quiet humour which made him a most delightful companion. He possessed in a marked degree the faculty of order, which manifested itself in the unvarying neatness of his dress, his beautifully regular handwriting, and the orderly arrangement of all his surroundings. Whether in a native hut on the Rio Negro, or in his little cottage in Yorkshire, his writing materials, his books, his microscope, his herbaria, his stores of food and clothing, all had their appointed places in which they were always to be found. This habit of order made him an admirable collector, and I well remember, on visiting Kew after my return from the Amazon, the late Sir William Hooker took out some bundles of plants collected by Dr. Spruce and pointed out to me how well chosen and beautifully preserved they were, notwithstanding that they had been collected in one of the very moistest climates in the world, in which the care and labour required to produce such a result was very great. He was quick at languages; spoke and wrote French with ease; and in South America rapidly acquired the Portuguese and Spanish languages, for the latter of which he had a great admiration. He had literary tastes, and was fond of the old poets; he was full of anecdote, and even when suffering from illness an hour would rarely pass without some humorous remark or pleasant recollection of old times. He was an advanced Liberal in politics, a true lover of the working classes, and nothing more excited his indignant wrath than to hear of the petty, but cruel, persecutions to which they are often subjected. In all his words and ways he was a perfect gentleman, and to possess his personal friendship was a privilege and a pleasure.

Of his merits as a botanist it must be left to experts to speak; but his writings show that he had great powers of observation, and that nothing escaped him that could throw light on the peculiarities of the grand and luxuriant vegetation among which the best years of his life were passed. His papers and letters sufficiently prove that he possessed a clear and picturesque style of writing, and it is to be hoped that the journals kept during his fifteen years' exploration, which he was himself unable to prepare for publication but which must be full of interesting matter, may soon be given to the world. His sole executor is his old friend and neighbour, Mr. Matthew B. Slater, of Malton.

A. R. W.

PRECIOUS STONES.

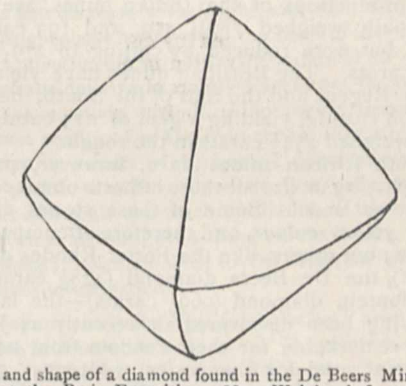
ONLY twenty-five years have elapsed since the existence of diamonds in South Africa was first made known, and during that period the diamond trade of the world has undergone a complete revolution. The working of diamond gravels in Brazil has been almost entirely abandoned, while the search for the gem in India, Borneo, and other districts has been seriously discouraged. The export of rough diamonds from South Africa rose gradually from 200 carats in 1867–68 to 3,841,937 carats in 1888, when it attained a maximum: since that date, however, there has been a slight decline in the output of the mines. The annual value of the diamonds raised in South Africa now exceeds £4,000,000. Strange to say, the discovery of the new and abundant source of diamonds has not had any serious effect in diminishing the market value of the gem. When the diamond was first discovered in South Africa, the estimated value per carat of the rough stones was about £1 10*s.*; in 1890 the price had risen to £1 13*s.* 3*d.*, and last year it declined to £1 5*s.* 8*d.*

The foregoing particulars are taken from a recently published book which gives an admirable account of the origin of the diamond industry in South Africa, and of the successive changes made in the method of mining and washing the "blue-earth" which yields the gems.[1] This work originally appeared as a guide to the Kimberley exhibition of 1892, and contains so much valuable information in a small compass, that the author has been well-advised in issuing it in its present more permanent form.

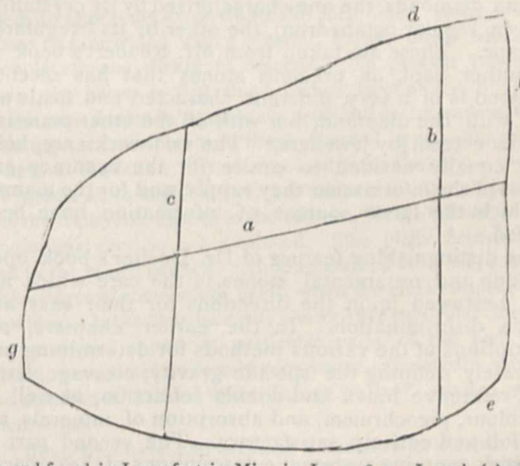
[1] "Diamonds and Gold in South Africa." By Theodore Reunert, M.Inst.M.E., Assoc.M.Inst.C.E., with Maps and Illustrations. (London: E. Stanford; and Capetown, Port Elizabeth, and Johannesburg: J. C. Juta and Co., 1893.)

The working of the celebrated mines about Kimberley was commenced by adventurers working independently in their claims. But as the mining was carried to greater and greater depths, combined action became necessary, and gradually the claims were amalgamated and bought up by large companies.

Up to the year 1872 the working of the claims in the South African mines was carried on by a system of roadways, which were laid out when the concessions were first granted. About the date named, the use of these roads had to be abandoned in favour of a system of haulage by wire ropes—these making a network over the whole of the mines. The appearance of the mines under these two systems of working is admirably illustrated by photographs in the work before us. By the year 1884, the mine at Kimberley having been carried to a depth of 400 feet, and heavy falls of material having produced serious loss and inconvenience, it was felt that the time had come for carrying out a totally different system of mining there. Accordingly, in that year, inclined shafts, starting from the surface, outside the limits of the mine, were put down, and these inclined shafts have been since superseded by vertical ones.



Exact size and shape of a diamond found in the De Beers Mine, and exhibited at the Paris Exposition, 1889. Weight, before cutting, 428½ carats, after cutting, 228½ carats.



Diamond found in Jagersfontein Mine in June 1893. Length (*a*) 2½ in.; greatest width (*b*) 2 in.; smallest width (*c*) 1½ in. Thickness at (*b*) end 1¼ in.; thickness at (*c*) end ⅞ in. Extreme girth in width (taken from *e* to *d*) 5⅜ in. Extreme girth in length (taken from *f* to *g*) 6¾ in. Gross weight 969½ carats.

The changes in the working of the Kimberley Mine have been followed by similar alterations in the nature of the operations carried on in the three other great mines in its immediate neighbourhood—De Beers, Bultfontein, and Dutoitspan. These four mines are in the vicinity of the townships of Kimberley and Beaconsfield in the British colony of Griqualand West. The only other important diamond mine in South Africa is that of Jagersfontein, situated in the Orange Free State, about eighty miles to the south-east of Kimberley.

The diamond mines of South Africa are not less remarkable for the size of the individual stones that they have yielded, than for the vast amount of the precious material with which they have flooded the markets of the world. The "Braganza" diamond, which belonged to the Emperor of Brazil, is said to weigh 1680 carats, but it has never been subjected to the inspection of experts, and there is every reason to believe that it is nothing but a colourless topaz. In the same way the reputed diamond of the Rajah of Matan in Borneo (367 carats) has been recently shown to be only a piece of quartz. The "Great Mogul," the Regent or Pitt diamond, and the Koh-i-nûr, the finest productions of the Indian mines, are said to have originally weighed $787\frac{1}{2}$, 410, and 193 carats respectively, but were reduced by cutting to $279\frac{7}{16}$, $136\frac{7}{8}$, and $102\frac{3}{4}$ carats. The Brazilian mines have yielded the Portuguese Regent and the Star of the South, the former of which, on cutting, yielding a gem of 215 carats, while the latter weighed $254\frac{1}{2}$ carats in the rough.

The South African mines have, however, produced stones surpassing in size all those hitherto obtained either from India or Brazil. Some of these stones are, it is true, of a yellow colour, and therefore of comparatively small value; but others, like the Porter-Rhodes diamond (150 carats), the De Beers diamond ($428\frac{1}{2}$ carats), and the Jagersfontein diamond ($969\frac{1}{2}$ carats)—the last-mentioned having been discovered as recently as June 30, 1893—are remarkable for their freedom from any trace of yellow tint, and for the perfect whiteness or even blue-whiteness of their colour. We are able to give outlines drawn to the true scale of the two largest South African diamonds, the one characterised by its crystalline form (a regular octahedron), the other by its irregularity of shape. These are taken from Mr. Reunert's book.

Another book on precious stones that has recently appeared is of a very different character, and deals not only with the diamond, but with all the other materials held in esteem by jewellers.[1] The two works are, however, equally entitled to praise for the accuracy and fulness of the information they supply, and for the manner in which the latest sources of information have been utilised.

The distinguishing feature of Dr. Doelter's book upon precious and ornamental stones is the care which has been bestowed upon the directions for their easy and certain discrimination. In the earlier chapters, the descriptions of the various methods for determining and accurately defining the specific gravity, cleavage, hardness, refractive index and double refraction, as well as the colour, pleochroism, and absorption of minerals, are very full and entirely satisfactory. The second part of the work contains systematic descriptions of the minerals employed for purposes of ornament; and these, as might be expected from a mineralogist of Dr. Doelter's position, leave nothing to be desired in the way of completeness and accuracy. No less admirable are the accounts given of the artificial production of these minerals, of the materials made to imitate them, and of the value of gems and the modes of cutting them. Details of this kind are of much practical value, and add greatly to the usefulness of the book as a work of reference. The position of certain minerals in the estimation of jewellers is liable to variation as the popular taste changes, and it is certainly not the same in different countries. Dr. Doelter's classification will, however, we think be generally accepted as a judicious one. Of precious stones proper he admits three classes, in the highest of which he places only the diamond, the various forms of corundum, the emerald, and the spinel, though possible exception may be taken to the high position allowed to the last of these. The second-class contains euclase, chrysoberyll, zircon, phenacite, topaz, the noble opal, garnet and tourmaline. To the third class are relegated the turquoise, olivine, cordierite, kyanite, andalusite, staurolite, hiddenite, axinite, vesuvian, and diopside. The "semi-noble stones" fall into two classes, in the higher of which are placed quartz, chalcedony, agate, felspars, lapis lazuli, and rhodonite, while the lower contains amber, fluorspar, nephrite, agalmatolite, malachite, and serpentine. It is doubtful whether some of the forms of quartz, like amethyst and cat's-eye, are not deserving of a place among the noble stones proper.

The third part of the work contains a series of tables for the determination of the minerals which are employed as precious stones. These tables have been drawn up with great care, and cannot fail to prove of very great service to those studying gems and similar materials, either from the scientific or the commercial point of view. The table showing the trade names, and the scientific designations of the several gems, is very complete; and the whole work may be commended for its union of scientific accuracy with practical usefulness.

NOTES.

THE International Sanitary Conference, which was to have opened at Paris on January 24, has been postponed to February 7. We learn that President Cleveland has appointed Dr. Edward S. Shakespeare, of Philadelphia, Dr. Stephen Smith, of New York, and Dr. Preston H. Bailhache, of the United States Marine Hospital Service, delegates to represent the United States at the Congress.

A SLIGHT earthquake visited North Devon about 9 a.m. on Tuesday, January 23. The shock seems to have been felt over the whole of Exmoor as far as South Molton.

WE regret to note the death of Prof. A. Hirsch; he died at Berlin on January 28, at the age of seventy-six. We have also to announce the death of Dr. G. Adler, Professor of Mathematical Physics in Vienna University.

DR. K. VON ZITTEL, Professor of Geology in Munich University, has been made a member of the German Privy Council.

AT a public meeting held at Shrewsbury on Tuesday, it was resolved to raise a memorial to Charles Darwin, who was a native of that town. Another public meeting will be held to consider the best method of carrying out the proposal. The Mayor of Shrewsbury, in commenting upon the proposal, rightly remarked that in doing honour to one who had shed an imperishable lustre on his native town they were doing honour to themselves. In addition to the suggestion that a bronze statue of Darwin should be erected in front of the old Grammar School, now the public library and museum, it was proposed to found a scholarship to his memory in connection with Shrewsbury School. Another suggestion was that the memorial should take the form of a hall of science to be erected in Shrewsbury for the purposes of scientific and technical instruction.

IT is reported that a sum approaching £50,000 has been bequeathed by the late Mr. T. H. Adam, of Newport, for the purposes of technical instruction. The money is to be devoted to teaching practical and theoretical agriculture to men and youths, and a knowledge of dairying, housekeeping, and other subjects to women and girls, either by means of lectures or the establishment of a school or schools of agriculture at Edgmond or Woodseaves, in Shropshire, or Chadwell, in Staffordshire, or elsewhere; or by such other means as the trustees shall think fit.

[1] "Edelsteinkunde; Bestimmung und Unterscheidung der Edelsteine und Schmucksteine. Die Künustliche Darstellung der Edelsteine." Von Dr. C. Doelter, o ö Prof. der Mineralogie an der K.K. Universität Graz. (Leipzig: Veit and Co., 1893.)

THROUGH the liberality of Mr. J. H. Veitch (says the *Kew Bulletin*), the Museum of the Royal Gardens at Kew has recently been enriched by the whole of the fine and extensive collection of vegetable products made by him during his recent travels in Japan. The collection is not only very extensive, but it is also very varied, and contains many things quite new to the Museum.

THE Rev. C. W. Langmore sends us a description of a fine lunar rainbow observed by him at Bracknell, Berks, about nine o'clock on the evening of Wednesday, January 17. At a distance of about four or five times the moon's apparent diameter a circle of brilliant white was seen. This was surrounded by a broad band of brown-orange of several gradations. Next came a narrow band of violet, followed by a broader band of green, and a narrower one of yellow. The whole series was encircled by a broad band of brown-orange.

A MEETING was held at the Society of Arts on Friday last for the purpose of formally constituting an Association of Technical Institutions. Representatives of almost every technical institution in the country attended the meeting. Principal F. G. Ogilvie, Edinburgh, presided, and it was agreed that the objects of the association should be (*a*) to provide a medium for the interchange of ideas amongst its members; (*b*) to influence, by combined action, where desirable, Parliament, County Councils, and other bodies concerned in promoting technical education; and (*c*) to promote the efficient organisation and management of technical institutions, and to facilitate concordant action among governing bodies, and aid the development of technical education throughout the United Kingdom. The council and officers of the association were elected, and a Parliamentary committee was appointed to take such steps as may be necessary to secure due representation for technical schools on the Commission for dealing with secondary education, and to watch the progress of legislation affecting such schools.

THE twenty-first annual dinner of old students of the Royal School of Mines was held on Monday. More than 150 guests were present, among them being Profs. W. C. Roberts Austen, Le Neve Foster, T. E. Thorpe, A. W. Rücker, and G. B. Howes, Sir H. Trueman Wood, Sir Lowthian Bell, Captain Abney, Mr. Bennett H. Brough, Mr. W. Topley, Mr. P. C. Gilchrist, Mr. R. D. Oldham, Dr. E. J. Ball, and Dr. Wynne.

THE weather has recently been very unsettled over the British Islands, owing to the influence of a succession of great atmospheric disturbances passing from the Atlantic to the northward of Scotland; strong gales have occurred in some parts daily for more than a week, accompanied at times with thunderstorms and snow or hail. During the latter part of last week reports from the Azores showed that the barometer there was two inches higher than in Scandinavia, and the steel barometric gradients over this country caused the wind to blow with the force of 10 of the Beaufort scale (0 – 12) in the north and west, both on Saturday and Monday. Although rain has fallen every day, the amount has only been heavy in exceptional cases; an inch and upwards in twenty-four hours was measured both in the north and south towards the close of the week. In the north of Scotland the fall for the week ended January 27 was much above the average.

DR. J. HANN has just communicated to the Academy of Sciences at Vienna a paper entitled "Contribution to the daily range of the meteorological elements in the higher strata of the atmosphere," containing (1) the calculation of the two-hourly observations of all the meterorological elements on the summit of the Ontake in Japan (10,023 feet), from August 1 to September 12, 1891, and at two base stations, with a thorough investigation of the results by harmonic analysis, by which means some interesting differences in the daily range are exhibited between the upper and lower stations; (2) the calculation and discussion of the observations made by self-recording instruments established by M. J. Vallot on Mont Blanc (15,770 feet), from July to September, 1887, together with observations at Grand Mulets (9875 feet) and Chamounix (3396 feet). The maximum temperature on Mont Blanc occurred at 1h. 30m. p.m., and at the other stations at 1h. p.m., but at Geneva it occurred at 2h. 30m. p m. The mean temperature on Mont Blanc from July 18 to August 14 was 20°·5, and at Geneva 69°·8. The average decrease with height was therefore 1°·1 F. for each 100 metres (328 feet); the maximum decrease was 1°·3 at 3h. p.m., and the minimum nearly 1°·0 at 4h. a.m. The daily range of atmospheric pressure shows that notwithstanding the enormous height the double daily period still occurred. The author then discussed, with the aid of the Bavarian stations, the modifications to which the single daily barometric oscillation with increasing altitude is subject. The analysis shows that the amplitudes first decrease with height, and then increase, from about the height above sea at which the times of the phases begin to run in an opposite way to those at the surface of the earth. The influence of the daily variation of temperature in the strata of air below the mountain summit, is thoroughly discussed on the basis of these results. Dr. Hann points out that it is one of the most interesting results of barometric observations on high mountain peaks, that they show us that daily temperature oscillations in free air are much smaller than those shown by thermometers at stations, even those on the peaks. Meteorological science is much indebted to Dr. Hann for this valuable and laborious investigation.

Two ways of producing "artificial glaciers" are described by K. R. Koch in *Wiedmann's Annalen*. The yellow kinds of pitch resembling colophony, which can be commercially obtained, exhibit the plasticity with regard to pressure, and brittleness with regard to tension, that ice possesses, or at least the surface layers do after some exposure to the air. Herr Koch takes a square tray provided with a slanting gutter, down which the pitch is allowed slowly to descend. To prevent its rolling down, the gutter is first lined with a layer of very hot pitch. As the mass descends, fissures are produced in the surface, which show a great resemblance to those observed in ice, though not so deep as the latter. Cracks proceed from the edges towards the middle at an angle of forty-five degrees to the edges, and join the transverse fissures in the centre. Where the bed widens, longitudinal crevices are produced. The black fissures show well in the brown surface. Another method is to coat the pitch with a layer of some white paint, when the cracks appear black on white. It can thus be easily shown that particular forms of cracks always appear at particular parts of the bed. The motion, sometimes uniformly progressive, sometimes pausing, and sometimes directed upwards, can be well studied with a microscope.

THOSE who have had occasion to measure an electric current by the deposition of silver on a platinum bowl as kathode, have probably occasionally noticed the very regular manner in which the silver is deposited in radial lines. This appearance is particularly noticeable on the sides of the bowl, and when a somewhat strong solution of silver nitrate is employed. Herr U. Behn has conducted an elaborate series of experiments with a view to ascertaining the cause of this regular deposition, and has examined the effect on the deposit produced by the concentration of the solution, the current density, and the potential difference between the anode and kathode. He finds that in the electrolysis of silver nitrate, the effect is best obtained with a concentrated solution of the salt, and when the current density at the kathode is small. An increase in the temperature of the voltameter is found to facilitate the formation of the ridges, while, on the other hand, the value of the electromotive force employed seems to exert no influence.

The author has succeeded in obtaining the same effect with solutions of copper sulphate, and finds that the chief condition which must in this case be fulfilled is that the current density should be small. The concentration of the solution affects the deposit in the same manner as with silver nitrate, though to a smaller extent. Much smaller ridges were obtained with solutions of lead acetate and of zinc sulphate. The author considers that the ridges are in all cases caused by the effect of convection currents set up in the electrolyte owing to the changes in concentration which go on in the liquid during the passage of the current. The paper in which these results are given is published in *Wiedemann's Annalen* for January.

IN the January number of *Zeitschrift für praktische Geologie* a brief historical account may be read of the Geological Survey Departments of Bavaria and of Alsace-Lorraine. Bavaria was the first among German States to found a Government Geological Survey. That was more than forty years ago, and ever since its commencement it has been under the able guidance of Oberberg Direktor von Gümbel. To his tireless zeal is largely due the enormous amount of work accomplished by the Survey. The mountains on the borderland of Bohemia and the Austrian Tyrol have been mapped in detail, Franconia was completed in 1891, and there still remain Rhenish Bavaria, the Danube districts, and certain parts in the north-west of Bavaria. The Alsace-Lorraine Survey, instituted in 1873 under the management of Profs. Benecke and Rosenbusch, was handicapped at its commencement by the want of detailed topographical maps. Rapid strides are now being made, and a series of geological sheets of Northern Lorraine have been published since 1887. The long southern strip of Alsace is scarcely begun. National rivalry makes itself felt along the French frontier. The German geologists complain that it is made practically impossible for them to carry their work over the frontier, whereas the French geologists have had the advantage of free access into Alsatian territory.

MODERN geology entered on a new period of progress when it realised some of the results of horizontal rock movement. Heim, Lapworth, Bertrand, and others proved beyond dispute that rock masses could be displaced and carried many miles over the surfaces of underlying rock. A Swiss geologist has just proposed a movement of this kind, but on a gigantic scale, as an explanation of the Chablais mountains which extend on both sides of Lake Geneva. He imagines that the upper part of an immense fold of rock was carried from the districts *south* of Mont Blanc and Mont Rosa, to the *northern* slopes of the Alps, and that this movement was not limited to the Swiss areas, but could be traced eastwards at least into the Engadine. The Chablais mountains and fragmentary portions all along the northern edge of the Swiss and Bavarian highlands are thought to be the remaining traces of the carried rocks, and to be, in short, geologically misplaced mountains. Should this theory prove to be correct, it will be of the highest importance ; at the same time, the evidence in its favour does not yet profess to be entirely conclusive. (*Arch. des Sc. Phys. et natur.*, December, 1893, Geneva, "Sur l'origine des Préalpes Romandes," by Hans Schardt.)

THE statistics of the cases treated for hydrophobia during the month of November at the Pasteur Institute in Paris appear in the December number of the *Annales de l'Institut Pasteur*. No less than 129 persons underwent this treatment, and of these ninety-four were bitten by undoubtedly rabid animals, the remainder having been attacked by animals suspected of suffering from rabies at the time, but in which the actual proof of this being the case, such as a veterinary examination and communication of the disease to other animals, was wanting. Of these persons 109 were bitten by dogs, seventeen by cats, one by a horse, one by a sheep, and one by a pig. In October 127, in September 108, and in August 135 persons were treated for hydrophobia in Paris. The establishment of similar institutes in so many other parts of the world, naturally tends to reduce the number of foreigners attending the Pasteur Institute in Paris ; last year's statistics, however, showed that England still furnished a considerable proportion of the strangers at the Institute, and this state of things is unfortunately likely to continue as long as we are obliged to depend upon other countries for the treatment of this terrible disease.

WE published a few years ago a review of an elaborate work on the chemical and bacteriological examination of potable waters by Salazar and Newman ; these authors have recently communicated a paper on the ice consumed in Valparaiso to the "Actes de la Société Scientifique du Chili," 1893. The inconsistency of people taking elaborate precautions to ensure the purity of their drinking water, whilst ice is used without any consideration of its source, is pointed out. In one of the samples examined, and taken from some of the ice supplied to the city, as many as 15,300 micro-organisms were found in a cubic centimetre of melted ice. Following in the footsteps of other investigators, the authors insist upon all ice used for consumption being prepared from water rendered above suspicion by being either previously distilled or passed through Chamberland filters.

A CATALOGUE of meteorological, magnetic, and physical instruments has been received from E. A. Zschau, Hamburg.

THE December number of Dr. Braithwaite's "British Moss Flora" has been received. It deals with Bryaceæ and Bartramiaceæ.

WE have received several supplements to the Queensland Government Gazette, containing the statistics of meteorological observations made in Queensland during 1893.

THE January number of the *Essex Review* contains an obituary notice of the late Mr. E. Charlesworth, and an article on technical instruction in Essex, by Mr. J. H. Nicholas.

BY far the best description that we have seen of the Manchester Ship Canal, both as regards text and illustration, appears in *Engineering* for January 26. The work is traced from its beginning, eleven and a half years ago, and all the details of construction are dealt with in a very exhaustive manner.

WE have received from Messrs. Williams and Norgate a work entitled "Descriptive Biography Columns," by Mr. Nasarvanji Jivanji Readymoney. The work is designed to receive records of the events that make up one's life, and is therefore similar to Mr. Galton's life-history album, with the addition of a few novel features.

THE second edition of Clowes' and Coleman's "Quantitative Chemical Analysis" (J. and A. Churchill) has just appeared. The original edition was reviewed in these columns in April, 1892. Several important alterations and additions have since been made, thereby increasing the value of a book that has been found useful to both teachers and students.

Bulletin No. 41 of the Experimental Station of the Kansas State Agricultural College, Manhattan, is devoted to a report from the Botanical Department on the effect of fungicides on the germination of corn.

THE *Monatsschrift für Kakteenkunde*, a monthly journal devoted entirely to the cultivation of *Cacti* and other succulent plants, has now entered on the fourth year of its existence. It is edited by Prof. Schumann, of Berlin, and published by Neumann, at Neudamm, in Brandenburg.

WE have received the *Agricultural Gazette of New South Wales* for October, 1893, containing, among other papers, an elaborate one by Mr. N. A. Cobb, on "Plant Diseases and their Remedies." The present instalment is entirely devoted to the very numerous diseases which attack the sugar-cane; copious illustrations are given of its animal and vegetable parasites.

MR. W. TRELEASE reprints, from the fifth annual Report of the Missouri Botanical Garden, an elaborate illustrated paper on sugar maples. He recognises ten species of *Acer* natives of the United States, and classifies them under five groups—the bush maples, vine maples, sycamore maples, soft maples, and hard or sugar maples. The sugar maples are *Acer grandidentatum*, *saccharum*, and *Floridanum*. Linnæus's *Acer saccharinum* is not a sugar maple at all, but is the silver maple belonging to the group of soft maples.

A NEW method of preparing phosphorus is described by Messrs. Rossel and Frank in the current issue of the *Berichte*. By the use of aluminium as reducing agent it is shown that phosphorus may be directly obtained from any mineral phosphate, and the method lends itself admirably to lecture-table demonstration. When ordinary microcosmic salt, hydrogen ammonium sodium phosphate, is fused in a porcelain crucible until it is converted into sodium metaphosphate, and aluminium turnings are dropped into the liquid, the flame of burning phosphorus at once appears. If the experiment is conducted in a glass tube in a slow current of dry hydrogen the phosphorus distils into the cooler part and without the formation of any phosphoretted hydrogen. The residue consists of alumina, sodium aluminate, and a phosphide of aluminium of the composition Al_3P_5. This latter substance may be isolated as a grey crystalline powder by leading phosphorus vapour over aluminium heated in a combustion tube; it is unchanged by further heating, but is decomposed by water with formation of aluminium hydrate, phosphoric acid, and phosphoretted hydrogen. In the preparation of phosphorus by the method above described it is consequently impossible to obtain more than thirty per cent. of the phosphorus contained in the mineral phosphate employed. But it is found that the phosphide is totally decomposed by heating with silica, and hence if the mineral phosphate is previously mixed with some form of silica the whole of the phosphorus is liberated, and the reaction proceeds in a regular and readily controllable manner. Bone meal, powdered phosphorite or fossil phosphate, magnesium pyrophosphate, calcium metaphosphate, or any ordinary available phosphate, may be employed. Care must be taken, however, not to employ superphosphates containing admixed calcium sulphate, such as are commonly obtained for agricultural purposes by treatment with sulphuric acid without separation of the sulphate, for the sulphate is suddenly decomposed by the aluminium when a certain temperature is attained, with explosive force. Superphosphates obtained by treatment with hydrochloric instead of sulphuric acid may be employed with perfect safety, as chlorides are not explosively decomposed by aluminium. The new mode of preparing phosphorus may be conveniently illustrated upon the lecture-table by placing in a combustion tube a yard long, traversed by a slow current of hydrogen, a mixture of two and a half parts of aluminium, six parts of sodium metaphosphate, obtained by heating microcosmic salt, and two parts of finely divided prepared silica, and heating until the reaction commences. This is notified by a sudden brilliant incandescence, and phosphorus is observed to rapidly condense in globules in the cooler portion of the tube, at the end nearest the draught-hole into which the escaping hydrogen is led.

AN interesting paper upon the interaction between oxygen and phosphoretted hydrogen is contributed to the *Zeitschrift für Physikalische Chemie* by Dr. Van de Stadt. It is shown that the two gases instantly combine, with the appearance of flame, when they are allowed to mix under diminished pressure. The combination occurs under these circumstances in the proportions of two volumes of hydrogen phosphide to three volumes of oxygen, the product being phosphorous acid. When, however, the oxygen is admitted very slowly, or the two gases are allowed to mix by diffusion under a pressure not exceeding 50 mm. equal volumes appear to react with production of a greenish flame, liberation of hydrogen, and formation of a crystalline deposit on the walls of the vessel. The crystals melt at about 80°, and appear to consist of the little-known metaphosphorous acid HPO_2; they are deliquescent, but after combination with sufficient water vapour to produce ordinary orthophosphorous acid the substance solidifies again. If the pressure is greater than 50 mm. both the meta and ortho acid are produced together with more or less free hydrogen. When the pressure is gradually reduced the gases combine at a certain low pressure with explosion. It is somewhat remarkable that the influence of moisture is directly opposite to that usually observed, for instead of facilitating the combination it greatly retards it.

NOTES from the Marine Biological Station, Plymouth.—Recent captures include two specimens of a small well-marked species of *Doris*, new to Britain, and probably to science. The tow-nets, on the other hand, have not yielded much of unusual interest lately, the chief contents being Copepods, *Sagitta*, Cirrhipede *Nauplii*, Polychæte larvæ, and Teleostean ova. The breeding season of a large number of both Fishes and Invertebrates has, however, recently commenced, including the Nemertine *Lineus obscurus*, the Polychæte *Phyllodoce*, the Mollusca *Purpura lapillus* and *Acanthodoris pilosa*, the Crustacea *Cravgon vulgaris* and *Eurynome aspera*, and the Ascidian *Botryllus violaceus*. The Anthozoa *Alcyonium digitatum* and *Cereus pedunculatus* are still breeding.

THE additions to the Zoological Society's Gardens during the past week include two Black-eared Marmosets (*Hapale penicillata*) from South-east Brazil, presented by Mrs. G. E. Russell; two Weka Rails (*Ocydromus australis*) from New Zealand, presented by the Hon. Lancelot Lowther; a Crossbi *Loxia curvirostra*) British, presented by Mr. W. S. Berridge; a King Snake (*Coluber getulus*) from Florida, presented by Mr. Lawson Reuss; a Rose-ringed Parrakeet (*Palæornis docilis*) from West Africa, presented by Mr. J. Hickman; a Ring-tailed Coati (*Nasua rufa*) from South America, deposited; two Abyssinian Guinea Fowls (*Numida ptilorhyncha*) from Somaliland, two Burrowing Owls (*Speotyto cunicularia*) from America, eight Undulated Grass Parrakeets (*Melopsittacus undulatus*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

JUPITER'S SATELLITES IN 1664.—In the New York *Nation*, Mr. D. C. Gilman calls attention to an interesting letter of John Winthrop, written in 1664 to Sir Robert Moray. The letter is printed in the *Proceedings* of the Massachusetts Historical Society, June, 1878, and the following is an extract from it:—

"Havinge looked upon Jupiter with a Telescope, upon the 6th of August last, I saw 5 (?) Satellytes very distinctly about that Planet: I observed it with the best curiosity I could, taking very distinct notice of the number of them, by severall aspects with some convenient tyme of intermission; & though I was not without some consideration whether that fifth might not be some fixt star with which Jupiter might at that tyme be in neare conjunction, yet that consideration made me the more carefully to take notice whether I could discerne any such difference of one of them from the other foure, that might by the more twinckling light of it or any other appearance give ground to believe that it might be a fixt starr, but I could discerne nothing of that nature: and I consider that the tube with which I looked upon them, though so good as to shew very clearely the Satellytes, yet was but of 3 foote and halfe with a concave ey-glasse; and I question whether by a farre better tube a fixt star can be discerned so near the body of that planet when in the ever bright activity of its light, for, if so, why are there not often if not alwayes seene with the best tubes the like or more."

The fifth body observed by Winthrop was probably a small star, but though it cannot definitely be said what the body was, every one will agree that it was not the fifth satellite discovered by Prof. Barnard. Even at the present time it is not uncommon for an astronomical tyro to believe he has seen the moons of Mars by means of an opera-glass, being deceived by the appearance of small stars in the vicinity of the planet, and there is little doubt that Winthrop was misled in a similar manner.

THE U.S. NAVAL OBSERVATORY.—The report of Captain F. V. McNair, superintendent of the U.S. Naval Observatory, for the year ending June 30, 1893, has just been issued. We extract from it a few points of interest. On May 15, 1893, the old Naval Observatory was formally abandoned as an observatory, and the new site on Georgetown Heights, Washington, officially occupied. Owing to this change, few observations of the heavenly bodies have been made since the last report. Prof. Eastman has determined the position of the new observatory with reference to the old one. Assuming the adopted latitude and longitude of the old observatory to be correct, the position of the new is lat. 38° 55′ 14″·68, and long. 5h. 8m. 15·71s. west of Greenwich. Prof. Eastman has been relieved of the charge of the transit circle, and is now chief of the department of fundamental observations. The new office is one that many astronomers would consider of doubtful advantage, for we learn that the department consists of one computor to assist in compiling the results of twenty-three years' observations of stars with the transit circle. Prof. Harkness has been chiefly engaged in overlooking the remounting of the equatorials and the prime vertical transit instrument. Into the mountings of the 12 and 26-inch equatorials he has introduced a pair of dials for indicating the right ascension and declination of the point of the heavens to which the telescope is directed. The dials face the observer when his hands are upon the right ascension and declination quick motions, they are brightly illuminated, they give the same degree of accuracy as the old-fashioned coarse circles, and as the right-ascension dial is moved by clockwork it shows the apparent right ascension of the telescope, together with its hour angle, and the right ascension of the meridian. Having the right ascension and declination of any visible object, the observer can instantly bring it into the field of the finder by setting these coordinates upon the dials. All the movements of the instrument are controlled, and all the readings of the dials and circles are made, either from the floor of the dome or from the eye end of the main telescope, thus enabling an observer to work alone without the aid of an assistant. For greater convenience in observing the sun and moon, supplementary gearing has been introduced into the driving clock, by means of which the speed of the telescope can be instantly changed from sidereal to mean solar or mean lunar. Prof. Harkness' arrangement is extremely ingenious, and should be adopted in all observatories in which the aim is to minimise inconveniences. Prof. Frisby reports that, with the assistance of Prof. Brown, the catalogue of 17,000 stars observed by the late Captain Gilliss, at Santiago, has been completed, and is now ready for publication. These facts suffice to show that though the observatory was in an unsettled condition during the year covered by the report, a large amount of good work was accomplished.

THE SATELLITE OF NEPTUNE.—Prof. Struve recently communicated to the St. Petersburg Academy of Sciences a discussion of the observations of the satellite of Neptune made with the 30-inch refractor at Pulkova from 1885 to 1893. A comparison of the four orbits calculated for four different epochs has clearly established the existence of the progressive movement of the pole of the orbit suspected by Mr. Marth some years ago. An acceleration of the motion of the satellite has been detected, the cause of which is unknown. The value obtained for the mass of Neptune is 1/19396, the sun's mass being unity.

GEOGRAPHICAL NOTES.

PROF. MARCEL DUBOIS publishes in the last number of the *Annales de Géographie* an epitome of his address on the inauguration of the Chair of Colonial Geography in the *Faculté des Lettres* at Paris. He proposes to treat the subject of colonial geography on widely philosophical lines, and repudiates the suggestion that it is synonymous with the history of French colonisation or the topographical description of French colonies. M. Dubois is one of the leading exponents in France of the modern conception of geography as a science involving the application of the results of many sciences to the central problem of the relation of Man to the earth.

THE new number of *Petermanns Mitteilungen* contains the first instalment of a paper by Count Joachim Pfeil on South-west Africa, illustrated by an excellent map of the region bordering 20° E., showing the routes of all travellers who have crossed it, and a series of valuable sections from Count Pfeil's own determinations of altitude. The number also contains an account of the Adelsberg Grotto, by Herr Kraus, referring specially to the explorations of MM. Martel and Putick, mentioned in NATURE, vol. xlix. p. 256.

PRINCE CONSTANTINE WIAZEMSKI has completed a very extensive journey through Asia, of which he will soon give an account to the Paris Geographical Society. Leaving St. Petersburg in 1892, he travelled to China by Siberia, and continued thence though Tonkin to Annam, Cambodia, Cochin-China, Siam, the Laos country, Burma, Manipur, Kashmir, Tibet, Bokhara, and Persia, arriving at Tiflis in November last. In this great land journey he made extensive scientific collections, which were unfortunately nearly all lost on account of attacks by natives when passing through the Chin country.

THE LARGE FIREBALL OF JANUARY 25.

A LARGE detonating fireball was observed over a large district at ten o'clock on the evening of Thursday, January 25. Mr. W. F. Denning has sent us the following detailed description of the phenomenon:—

"A slow-moving fireball of the most brilliant kind was seen at Bristol on January 25, at 10h. 1m. Clouds covered the sky at the time, but the planet Jupiter and a few of the brighter stars were dimly visible.

"A sudden and vivid illumination of the firmament caused me to look upwards, without, however, seeing anything. A second flash prompted me to turn round, when I immediately saw, in the north-north-east, the expiring splendours of a large double-headed fireball. No stars could be distinguished in the vicinity, but the point of disappearance was afterwards carefully determined as in azimuth 206° west of south, and altitude 20°. It was slightly descending, and the backward prolongation of its track indicates the radiant as near α Cephei.

"The fireball appears to have been seen with startling effect at many places in Worcestershire. At Alvechurch, Redditch, a loud report similar to a clap of thunder was heard after the disruption of the meteor, and there was a perceptible oscillation, supposed to be due to a slight shock of earthquake. At Worcester, Droitwich, and other places in the locality, windows were violently rattled and houses shaken, so that people rushed out of doors in a terrified state.

"The meteor was well seen at Birmingham, and the detonation followed the explosion in three minutes, according to the testimony of two trustworthy observers.

"From a discussion of the various observations, the disappearance of the meteor is well indicated at a height of only sixteen miles above a point of the earth's surface, four miles north of Ashchurch, near Tewkesbury. Its direction was from north-north-west to south-south-east, and the earth point at Swindon, thirty-five miles from the place of disappearance. The descriptions are somewhat conflicting as to the early stages of the meteor's flight, but it probably passed over Chester at an elevation of fifty-eight miles. At the time of its disappearance near Ashchurch it was forty-seven miles from Bristol, and thirty-six from Birmingham."

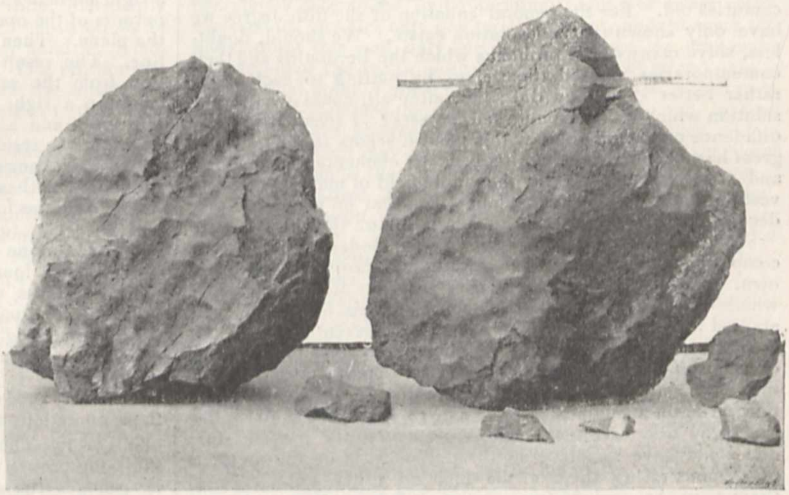
Mr. Lloyd Bozward writes to us as follows:—"At about ten on Thursday night a meteor of enormous size passed over Worcester. The night here was densely overcast. For all that, the brilliance was so intense as to dim the light of the street lamps. Even when first manifest the radiance was exceedingly bright, and as the phenomenon passed onwards the light grew in brightness until it equalled the lustre of the electric arc, and has been compared to the glow of a great electric search-light. The emitted light lasted at least 30 seconds. Apparently the path was from the north-west. Two minutes after disappearance three detonations were heard, the last being of exceptional violence, shaking buildings, and causing the earth to vibrate. Here at Henwick, the head of the meteor, though visible at other places, was invisible, but a magnificent long luminous trail was apparent. At Hallow, hence three miles north, and at Clifton-on-Teme, hence twelve miles north-west, the light was seen, and the effects of the terrific explosion were experienced. At the former place the crockery-ware was jarred off the shelves of cottages. A loud rumbling noise was also heard, some persons describing it as like the prolonged roar of distant thunder. At the Wych Malvern, slates were displaced from house-roofs. A gentleman who observed the meteor at Mold, North Wales, says that, if anything, it appeared to him to be larger than the moon. The colour 'was blue in the centre, and had yellow fire round the edges.' No explosion was heard there. The meteor, it is supposed, broke up near Clifton-on-Teme, but no trace of its débris has hitherto been found. At Droitwich, hence seven miles north-east, it was thought that the Evesham gas works, twelve miles away, had blown up. At Pershore the head of the meteor was seen, and its bursting, which it is said was accompanied by the flashing of a dull red light, was witnessed. At Malvern, eight miles westward, the terrific effects of the occurrence were apparent. Here there is no previous record of a meteor on so grand, prolonged, and terrific a scale."

Several letters describing the meteor have appeared in the *Times*. Mr. W. H. Lloyd observed the phenomenon from the top of the Cotswolds, about half a mile north of Minchin Hampton. He saw a ball of fire pass rapidly from north to south, and disappear in one or two seconds. About a minute or a minute and a half afterwards a series of explosions was heard. A detonating sound was also heard at Cheltenham, but at some other places no peculiar sound was noticed. A loud rumbling noise like an explosion was heard near Ross, Herefordshire, and ascribed to an earthquake shock. Mr. J. G. Wood remarks in yesterday's *Times* that there is possibly a connection between earthquakes and meteoric phenomena. He points out that the North Devon disturbance of January 23 (see p. 320) was followed by the meteor of January 25, and that both an earthquake and a bright light was observed at Ross, though the observer did not actually see a meteor. The light of the meteor is variously stated, but the majority of observers describe it as intensely bright and bluish, similar to the light of the electric arc. Mr. J. D. La Touche, writing from Stokesay Vicarage, Shropshire, says that the phenomenon continued for certainly more than half a minute; but at Brixworth, Northampton, the duration is said to have been about seven or eight seconds. All agree, however, that the meteor was of a brilliancy so great that the whole sky was illuminated, and Venus and Jupiter paled into insignificance before it.

ON A METEORITE FROM GILGOIN STATION.[1]

IT will be remembered that at the June (1889) meeting of the Society I exhibited a meteor weighing 67½ lbs. sent to me by Mr. J. F. Yeomons, of Gilgoin Station, situated forty miles towards east south-east from Brewarrina. (This meteorite is the left-hand one shown in the accompanying figure.) It had been long exposed to the weather, and the chemical action of air and rain had broken up the surface of it to such an extent that pieces fell off each time it was handled.

On February 8, 1893, Mr. Yeomons again wrote to me and said:—"We have in our possession an aerolite, found, a short time since, about two miles south of the one sent you some time ago. I can have it sent to you by train from Byrock." Various delays occurred, and I did not get it until September 5. The meteor had been very carefully packed, and had not suffered much loss on the journey, although, like the previous one from this locality, it is much cracked, and many parts of the surface are ready to crumble away. All the parts together weigh 74½ lbs., and its specific gravity as a whole is 3·757. The No. 1 Gilgoin meteor weighs 67½ lbs. and its specific gravity is 3·857. They are so much alike that it strengthens the probability arising from external similarity and nearness of the localities in which they were found that they are parts of one much larger. It is but right, however, to add that if so, they must have travelled through the atmosphere together a sufficient distance to cause the usual melted surface, which, although in parts lost by subsequent slow effect of oxidation, is yet too extensive to admit the alternative that they divided as they fell.



This recently-found No. 2 Gilgoin meteor is, roughly, double convex, and measures 7 inches through the thickest part, and 14 × 15 inches diameter. The surface has been melted, but is not so smooth and glossy as others I have seen; when a part of it which has not been oxidised is broken, it is dark grey in colour, and shows a great abundance of fine bright, white metallic particles. The rule is laid in a space left by some pieces missing. The meteorite has not yet been analysed, but I hope Prof. Liversidge will undertake that work.

H. C. RUSSELL.

[1] Read at the Royal Society, Sydney, November 1, 1893.

MODERN MATHEMATICAL THOUGHT.[1]

ONE who, like myself, is not a mathematician in the modern sense naturally feels that some apology is due for accepting the invitation with which this society has honoured me, to address it on a mathematical subject. Possibly an adequate apology may be found in the reflection that one who has not gone deeply into any of the contemporaneous problems of mathematics, but who, as a student, has had a sufficient fondness for the subject to keep himself informed of the general course of thought in it, may be able to take such a general review as is appropriate to the present occasion. I shall therefore ask your consideration of some comparisons between the mode of thinking on mathematical subjects at the present time, and those methods which have come down to us from the past, with a view of pointing out in what direction progress lies, and what is the significance of mathematical investigation at the present day.

Among the miscellaneous reading of my youth was a history of modern Europe, which concluded with a general survey and attempted forecast of progress in arts, science, and literature. So far as I can judge, this work was written about the time of

[1] Address delivered before the New York Mathematical Society at the annual meeting, December 28, 1893, by Prof. Simon Newcomb.

Euler or Lagrange. On the subject of mathematics the writer's conclusion was that fruitful investigation seemed at an end, and that there was little prospect of brilliant discoveries in the future. To us, a century later, this judgment might seem to illustrate the danger of prophesying, and lead us to look upon the author as one who must have been too prone to hasty conclusions. I am not sure that careful analysis would not show the author's view to be less rash than it may now appear. May we not say that in the special direction and along the special lines which mathematical research was following a century ago no very brilliant discoveries have been made? Can we really say that Euler's field of work has been greatly widened since his time? Of the great problems which baffled the skill of the ancient geometers, including the quadrature of the circle, the duplication of the cube, and the trisection of the angle, we have not solved one. Our only advance in treating them has been to show that they are insoluble. To the problem of three bodies we have not added one of the integrals necessary to the complete solution. Our elementary integral calculus is two centuries old. For the general equation of the fifth degree we have only shown that no solution exists. We should, doubtless, solve many of the problems which the Bernoullis and their contemporaries amused themselves by putting to each other, rather better than they did; but, after all, could we get any solution which was beyond their powers? I speak with some diffidence on such a point as this; but it seems to me that progress has been made by going back to elementary principles, and starting out to survey the whole field of mathematical investigation from a higher plane than that on which our predecessors stood, rather than by continuing on their lines.

We may illustrate this passage to new modes of thought by comparing Euclid's doctrine of ratio and proportion with our own. No one questions the beauty or rigour of the process by which Euclid developed this doctrine in his fifth book, and applied it to the theory of numbers in his seventh book. But can we help pitying our forefathers who had to learn the complex propositions and ponderous demonstrations of the fifth book, all the processes and results of which we could now write on a single sheet of paper? As a mental discipline the study was excellent; but it seems hardly possible that one could have remembered the propositions or the methods of demonstrating them if he had no other knowledge of them than that derived from the work itself. When we carefully examine these propositions, we find that while Euclid recognised the fact that one of two ratios might be greater than, equal to, or less than another, yet he never regarded them as mere quantities which could be treated as such. From his standpoint a ratio was always a relation, and a relation cannot exist without two terms.

In pointing out this complexity of Euclid's doctrine, I must not be taken to endorse the very loose way in which the doctrine in question is usually treated in our modern textbooks. What we should aim at is to replace Euclid's methods by those which pertain to modern mathematics. At the present time we conceive that a relation between any two concepts of the same kind may always be reduced to a single term by substituting for it an operator whose function it is to change one of these concepts into the other. In the case of the relation between two lines, considered simply as one dimensional quantities, which relation is called a ratio, we regard the ratio as a numerical factor or multiple, which, operating on one line, changes it into the other. For example, that relation which Euclid would have expressed by saying that two lines were to each other as 5 to 2, or that twice one line was equal to five times the other, we should now express by saying that if we multiplied one of the lines by two and one half, we should produce the other. This might seem to be simple difference of words, but it is much more. It is a simplification of ideas; a substitution of one conception for two. Euclid needed two terms to express a relation; we need but one.

But this is not the only simplification. A peculiarity of our modern mathematics is that operators themselves are regarded as independent objects of reasoning; susceptible of becoming operands, without specification of their particular qualities as operators. Thus, instead of considering the ratio which I have just mentioned as an operation of multiplying a line by two and one half, we finally reduce it to the simple quantity two and one half, which we may conceive to remain inert until we bring it into activity as a multiplier. It thus assumes a concrete form, capable of being carried about in thought, and operated upon as if it were a single thing.

This example may afford us a starting-point for a farther illustration of the way in which we have broadened the conceptions which lie at the basis of mathematical thought. Let us reflect upon the relation between a straight line going out from a certain point, and another line of equal length going out from the same point at right angles to the first. Had this relation been presented to Euclid as a subject for study, he would probably have replied that though much simpler than those he was studying, he could see nothing fruitful in it, and would have drawn no conclusions from it. But if we trace up the thought we shall find a wide field before us, embracing the first conception of groups, and with it an important part of our modern mathematics. In accordance with the principle already set forth, we replace the relation between these two lines by an operator which will change the first into the second. We define this operator by saying that its function is to turn a line through a right angle in a fixed plane containing the line. This definition permits of the operator in question being applied to any line in the plane. Then let us apply it twice in succession to the same line. The result will be a line pointing in the opposite direction from the original one. A third operation will bring it again to a right angle on the opposite side from the second position; and a fourth will restore the line to its original position, the result being to carry it through a complete circle. If we now consider the operations which would have been equivalent to these one, two, three, and four revolutions through a right angle as four separate operators, we see that their results will be either to leave the line in its original position, or to move it into one of three definite positions. If we then repeat one of these four operations as often as we please, or in any order we please, we shall only bring the line to one of the four positions in question. We thus have a group of the fourth order, possessing the property that the repetition of any two operations of the group is equivalent to some single operation of it.

I scarcely need call attention to the familiar homology between these operations and successive multiplications by the imaginary unit $\sqrt{-1}$. This last concept, considered as a multiplier, has the same properties as our rotating operator. Repeated twice, it changes the sign or direction of the quantity on which it operates; repeated four times, it restores it to its original value. Let us extend this idea a little. Instead of taking two lines at right angles to each other, let us consider two which form an angle of 40°. As already remarked, this relation is homologous with an operator which will turn a single line through that angle. If we continually repeat this operation, we shall bring the line into thirty-five different positions, the thirty-sixth position being identical with the original one. Thus we should have thirty-six positions in all, expressed by that number of lines radiating from a single centre, and making angles of 10° with each other. Now let us imagine thirty-six operators whose function it is to turn a line, no matter what, successively through an arc of 10°, 20°, 30°, &c. up to 360°, the last being equivalent to an operator which simply does nothing. These thirty-six operators will form a group which we know to be strictly homologous with multiplication by the thirty-six expressions

$$e^{i\phi}, e^{2i\phi}, e^{3i\phi}, \ldots e^{36i\phi} = e^{\circ} = 1,$$

where ϕ is the arc of 10° in circular measure.

So far we have only considered operations formed by the continual repetition of a single one; in the language of the subject, all our groups are constructed from powers of a single operator. Now let us extend our process by substituting a cube for our straight line. Through this cube we have an axis parallel to four of its plane sides. By rotating the cube through any multiples of 90° around this axis we effect an interchange of position between four of its sides. This process of interchanging is homologous with rotation through 90°, being in fact equivalent to it, and therefore it is also homologous with multiplication by the imaginary unit. But there is also another homology. Let us designate the four sides of the cube parallel to the axis of rotation as A, B, C, D. Then our group of rotations will be homologous with the powers of a cyclic substitution between the four letters A, B, C, D.

Let us next introduce a new operator, namely, rotation around an axis at right angles to the first one, but always through an arc of 90°. This introduces a new element into the problem, and enables us to change the cube from any one position to any other position, that is, to effect any interchange among the sides which would be consistent with their remaining sides of the same cube. Here we have a series of rotations which, in the case of the cube, are homologous with certain linear transformations which have been developed by Klein in his very beautiful book on the Icosahedron.

But it is also obvious that in introducing these rotations we are practically operating with quaternions, the operator being a unit vector. Thus we have a homology between certain forms of quaternion multiplication and linear transformations involving the imaginary unit. Moreover, since these rotations are also homologous with substitutions, performed on six symbols representing the six sides of the cube, it follows that there is also a homology between certain groups of substitutions and certain linear transformations involving two quantities, a numerator and a denominator, and quaternion multiplication by unit vectors.

I have taken a cube as the simplest illustration. Evidently we can construct a great number of groups of substitutions of the same sort between the sides of any regular solid, as Klein has done in the work I have already cited. The relation between the linear substitutions thus found and the solution of corresponding algebraic equations forms one of the most beautiful branches of our modern mathematics.

We have in all these cases a very simple illustration of a law of thought, the application of which forms the basis of an important part of modern mathematical research. We may call it the law of homology. I am not sure of my ability to define it rigorously, but I think we may express it in some such form as this: If we have two sets of concepts, say A and B, such that to every concept of the one set shall correspond a concept of the other, and to every relation between any two of one set a corresponding relation between the corresponding two of the other, then all language, reasoning, and conclusions as to the one set may be applied to the other set. We may, of course, extend the law to a correspondence between things or concepts, and symbols, or other forms of language.

This law is, I think, more universal than might at first sight appear. Not only the progress, but the very existence of our race depends upon that coordination between our mental processes and the processes of the external universe, which has gradually been brought about by the attrition between man and nature through unnumbered generations. A man is perfect, powerful, and effective in proportion as his thoughts of nature coincide with the processes of nature herself; each process of nature having its image in his thought, and *vice versa*. Now, language consists in coordination between words and conceptions. Thus we pass from nature to what corresponds to it in thought, and from thought to what corresponds to it in language, and thus bring about a correspondence between language and nature.

Modern scientific research affords many examples of the application of this law, which would be very marvellous if they were not so familiar. We are so accustomed to the prediction of an eclipse that we see no philosophy in it. And yet might not a very intellectual being from another sphere see something wonderful in the fact that by a process of making symbols with pen and ink upon sheets of paper, and combining them according to certain simple rules, it is possible to predict with unerring certainty that the shadow of the moon, on a given day and at a given hour and minute, will pass over a certain place on the earth's surface? Surely the being might ask with surprise how such a result could be attained. Our reply would be simply this: There is a one-to-one correspondence between the symbols which the mathematician makes on his paper, and the laws of motion of the heavenly bodies. His symbols embody the methods of nature itself.

The introduction and application of homologies such as I have pointed out have, perhaps, their greatest value as thought-savers. In the field of mathematical thought they bear some resemblance to labour-saving machines in the field of economics. They enable the results of ratiocination to be reached without going through the process of reasoning in the particular case. Much that I have said illustrates this use of the method, but there is yet another case which has been so fruitful as to be worthy of special mention: I mean the general theory of functions of an imaginary variable. We may regard such functions as being in reality representative of a pair of functions of a certain class involving a pair of real variables; but the difficulty of conceiving the various ways in which the two variables might be related, and the results of the changes which they might go through, in such a way as to clearly follow out all possible results, would have rendered their direct study impossible.

But when Gauss and Cauchy conceived the happy idea of representing two such variables, the real and the imaginary one, by the rectangular coordinates of a point in a plane, those relations which before taxed the powers of conception became comparatively simple. Considered as a magnitude, the complex variable, or the sum of a real quantity and a purely imaginary one, the latter being considered as one measured in imaginary units, was represented by the length and position of a straight line drawn from an origin of coordinates to the point whose coordinates were represented by the values of the variable. Such a line, when both length and direction are considered, is now familiarly known as a vector. The conception of the vector would, however, in many cases be laborious. But the vector is completely determined by its terminal point; to every vector corresponds one and only one terminal point, and to every terminal point one and only one vector. Hence we may make abstraction of the vector entirely, and in thought attend only to the terminal point. Since for every pair of values we assign to our original variables there is one point, and only one, we may in thought make abstraction of both of these variables, and of the vectors which they represent, and consider only the point whose coordinates they are. Thus the continuous variation of the two quantities, how complex soever it may be, is represented by a motion of the point. Now such a motion is very easy to conceive. We may consider it as performing a number of revolutions around some fixed position without the slightest difficulty, whereas to conceive the corresponding variations in the algebraic variables themselves would need considerable mental effort. Thus, and thus alone, has the beautiful theory, first largely developed by Cauchy, and afterward continued by Riemann, been brought to its present state of perfection.

Another example of the principle in question, where the two objections of reasoning are so nearly of a kind that no thought is saved, is afforded by the principle of duality in projective geometry. Here a one-to-one correspondence is established between the mutual relations of points and lines, with the result that in demonstrating any proposition relating to these concepts we at the same time demonstrate a correlative proposition formed from the original one by simply interchanging the words "point" and "line."

The subjects of which I have heretofore spoken belong conjointly to algebra and geometry. Indeed, one of the great results of bringing homologous interpretation into modern mathematics has been to unify the treatment of algebra and geometry, and almost fuse them into a single science. To a large class of theorems of algebra belong corresponding theorems of geometry, each of one class proving one of the other class. Thus the two sciences become mutually helpful. In geometry we have a visible representation of algebraic theorems; by algebraic operations we reach geometrical conclusions which it might be much more difficult to reach by direct reasoning. A remarkable example is afforded by the geometrical application of the theory of invariants. These are perhaps the last kind of algebraic conclusion which the student, when they are first presented to his attention, would conceive to have a geometrical application, yet a very little study suffices to establish a complete homology between them and the distribution of points upon a straight line.

This use of homologies does not mark the only line by which we have advanced beyond our predecessors. Progress has been possible only by emancipating ourselves from certain of the conceptions of ancient geometry which are still uppermost in all our elementary teaching. The illustration I have already given is here much to the point. The expression of a relation between two straight lines by the multiplier which would change one into the other is now familiar to every schoolboy, and the relation itself was familiar to Euclid. But the yet simpler relation of a line to another of equal length standing at right angles to it, and the corresponding operator which will change one into the other, was never thought of by Euclid, and is unfamiliar in our schools. Why is this? It seems to me that it grows out of the ancestral idea that mathematics concerns itself with measurement and that the object of measurement is to express all magnitudes in one-dimensional measure. So completely has this idea directed language, that we still extend the use of the word "equal" to all cases of this particular kind of linear equality: we say that a circle is equal to the rectangle contained by its radius and half its circumference. We have therefore been obliged to invent the word "congruent" for absolute equality in all points, or to qualify the adjective "equal" by "identical," saying "identically equal." There is of course no objection to the comparison of magnitudes in this way by reference to one dimensional measures, or by presupposing that the change which one magnitude must undergo in order to be transformed into the other is to be expressed by a single parameter, but changes involving two or any number of parameters, are just as important as those involving one, and the attempt to express all metric relations by referring them to a single parameter has placed such restrictions on thought that it seems to me appropriate to apply the term emancipation to our act in freeing ourselves from them. With us mathematics is no longer the science of quantity. But even if we consider that the ultimate object of mathematics is relations between quantities, we have reaped a rich reward by the emancipation, for we are enabled by the use of our broader ideas to reach new conclusions as to metric relations.

The idea of groups of operations, as I have tried to develop it, has in recent years been so extended as to cover a large part of the fields of algebra and geometry. Among the leaders in this extension has been Sophus Lie. Considered from the algebraic point of view, his idea in its simplest form may be expressed thus: We have a certain quantity, say x. We have also an operation of any sort which we may perform upon this quantity. Let this operation depend on a certain quantity, a, which necessarily enters into it. As one of the simplest possible examples, we may consider the operation to be that of adding a to x. As the quantity a may take an infinity of values, it follows that there will be an infinity of operations all belonging to one class, which operations will be distinguished by the particular value of a in each case. We thus operate on x with one of these operators, and get a certain result, say x'. We operate on x' with a second operator, of the same class, and get a second result, say x''. If whatever operators we choose from the class, the result x'' could have been obtained from the original quantity x by some operation of the class, then these operations are such that the product of any two is equivalent to the performance of some one of them. Thus, by repeating them for ever, we could get no results except such as could be obtained by some one operator. To illustrate by one simple example: if our operation consists in the addition of an arbitrary quantity to x, then we change x into x' by adding a certain quantity a and x' into x'' by adding a second quantity b. The result of these two additions is the same as if we had added in the first place the quantity $a + b$. It need hardly be said that the multiplication by x of any quantity would be another example of the same kind. The performance of any number of successive multiplications on a quantity is always equal to a single multiplication by the product of all the factors of the separate multiplications.

These operations are not confined to single quantities. We may consider the operation to be performed upon a system of quantities, which are thus transformed into an equal number of different quantities, each of these new quantities corresponding to one of the first system. If a repetition of the operation upon the second system of quantities gives rise to a third system, which could have been formed from the first system by an operation of the same class, then all these possible operations form a group.

The idea of such systems of operations is by no means new. It has always been obvious, since the general theory of algebraic operations has been studied, that any combination of the operations of addition, multiplication, and division could always be reduced to a system in which there would be only a single operation of division necessary—just as in arithmetic a complex fraction, no matter what the order of complexity of its terms, can always be reduced to a single simple fraction, that is, to a ratio of two integers, but cannot, in general, be reduced to an integer. Abel made use of this theorem in his celebrated Memoir on the impossibility of solving the general equation of the fifth degree.

Another field of mathematical thought, quite distinct from that at which we have just glanced, may be called the fairyland of geometry. To make a mathematician, we must have a higher development of his special power than falls to the lot of other men. When he enters fairyland he must, to do himself justice, take wings which will carry him far above the flights, and even above the sight, of ordinary mortals. To the most imaginative of the latter, a being enclosed in a sphere, the surface of which was absolutely impenetrable, would be so securely imprisoned that not even a spirit could escape except by being so ethereal that it could pass through the substance of the sphere. But the mathematical spirit, in four-dimensional space, could step out without even touching any part of the globe. Taking his stand at a short distance from the earth, he could with his telescope scan every particle of it, from centre to surface, without any necessity that the light should pass through any part of the substance of the earth. If a practised gymnast, he could turn a somersault and come down right side left, just as he looks to our eyes when seen by reflection in a mirror, and that without suffering any distortion or injury whatever. A straight line, or a line which to all our examination would appear straight, if followed far enough, might return into itself. Space itself may have a boundary, or, rather, there may be only a certain quantity of it; go on for ever, and we would find ourselves always coming back to the starting-point. All these results, too, are reached not merely by facetious forms, but by rigorous geometrical demonstration.

The considerations which lead to the study of these forms of space are so simple that they can be traced without difficulty. When the youth begins the study of plane geometry his attention is devoted entirely to figures lying in a plane. For him space has only two dimensions. To a given point on a straight line only one perpendicular can be drawn. By moving a line of any sort in the plane he can describe a surface, but a solid is wholly without his field. He cannot draw a line from the outside to the inside of a circle without intersecting it. On a given base only two triangles with given sides can be erected, one being on one side of the base, the other on the other. When he reaches solid geometry his conceptions are greatly extended. He can draw any number of perpendiculars to the same point of a straight line. If he has two straight lines perpendicular to each other, he can draw a third straight line which shall be perpendicular to both. A plane surface is not confined to its own plane, but can be moved up and down in such a way as to describe a solid. The characteristic of this motion is that it constantly carries every part of the plane to a position which no part occupied before.

Now, it is a fundamental principle of pure science that the liberty of making hypotheses is unlimited. It is not necessary that we shall prove the hypothesis to be a reality before we are allowed to make it. It is legitimate to anticipate all the possibilities. It is, therefore, a perfectly legitimate exercise of thought to imagine what would result if we should not stop at three dimensions in geometry, but construct one for space having four. As the boy, at a certain stage in his studies, passes from two to three dimensions, so may the mathematician pass from three to four dimensions with equal facility. He does indeed meet with the obstacle that he cannot draw figures in four dimensions, and his faculties are so limited that he cannot construct in his own mind an image of things as they would look in space of four dimensions. But this need not prevent his reasoning on the subject, and one of the most obvious conclusions he would reach is this: As in space of two dimensions one line can be drawn perpendicular to another at a given point, and by adding another dimension to space a third line can be drawn perpendicular to these two; so in a fourth dimension we can draw a line which shall be perpendicular to all three. True, we cannot imagine how the line would look, or where it would be placed, but this is merely because of the limitations of our faculties. As a surface describes a solid by continually leaving the space in which it lies at the moment, so a four-dimensional solid will be generated by a three-dimensional one by a continuous motion which shall constantly be directed outside of this three-dimensional space in which our universe appears to exist. As the man confined in a circle can evade it by stepping over it, so the mathematician, if placed inside a sphere in four-dimensional space, would simply step over it as easily as we should over a circle drawn on the floor. Add a fourth dimension to space, and there is room for an indefinite number of universes, all alongside of each other, as there is for an indefinite number of sheets of paper when we pile them upon each other.

From this point of view of physical science, the question whether the actuality of a fourth dimension can be considered admissible is a very interesting one. All we can say is that, so far as observation goes, all legitimate conclusions seem to be against it. No induction of physical science is more universal or complete than that three conditions fix the position of a point. The phenomena of light shows that no vibrations go outside of three-dimensional space, even in the luminiferous ether. If there is another universe, or a great number of other universes, outside of our own, we can only say that we have no evidence of their exerting any action upon our own. True, those who are fond of explaining anomalous occurrences, by the action of beings that we otherwise know nothing about, have here a very easy field for their imagination. The question of the sufficiency of the laws of nature to account for all phenomena is, however, too wide a one to be discussed at present.

As illustrating the limitation of our faculties in this direction, it is remarkable that we are unable to conceive of a space of two dimensions otherwise than as contained in one of three. A mere plane, with nothing on each side of it, is to us inconceivable. We are thus compelled, so far as our conceptions go, to accept three dimensions and no more. We have in this a legitimate result of the universal experience through all generations being that of a triply extended space.

Intimately associated with this is the concept of what is sometimes called curved space. I confess that I do not like this expression, as I do not see how space itself can be regarded as curved. Geometry is not the science of space, but the science of figures in space, possessing the properties of extension and mobility which we find to be common to all material bodies. The question raised here is a very old one, and in a general way its history is familiar.

Mathematicians have often attempted to construct geometry without the use of what is commonly called the ninth axiom of Euclid, which seems to me best expressed by saying that in a plane only one line can be drawn which shall be parallel to another line in the plane in the sense of never meeting it in either direction. Yet every attempt to construct an elementary geometry without this axiom has been proved to involve a fallacy in some point of the reasoning. This consideration led Lobatchewsky, and independently of him, I believe, Gauss, to inquire whether a geometry might not be constructed in which this axiom did not hold; in which, in fact, it was possible that if we had two parallel lines in a plane, one of them might turn through a very minute angle without thereby meeting the other line in either direction. The possibility of this was soon shown, and a system of geometry was thus constructed in which the sum of the angles of a plane triangle might be less than two right angles.

Afterward the opposite hypothesis was also introduced. It was found that, given two parallel lines in a plane, it might be supposed that they would ultimately meet in both directions. This hypothesis might even be made without there being more than one point of intersection, each straight line returning into itself. The geometry arising from these two hypotheses has been reduced to a rigorous system by Klein.

To guess the future of mathematical science would be a rash attempt. If made it might seem that, in view of what has been accomplished during our time, the safest course would be to predict great discoveries in this and all other branches of science. The question is sometimes asked whether a mathematical method may not yet be invented which shall be as great an advance on the infinitesimal calculus as the latter was on the methods of Euclid and Diaphontus. So far as solving problems which now confront us is concerned, I am not sure that the safest course would not be to answer such questions in the negative. Is it not true in physics as in mathematics that great discoveries have been made on unexpected lines, and that the problems which perplexed our ancestors now baffle our own efforts? We must also remember that the discovery of what could not be done has been an important element in progress. We are met at every step by the iron law of the conservation of energy: in every direction we see the limits of the possible. The mathematics of the twenty-first century may be very different from our own; perhaps the schoolboy will begin algebra with the theory of substitution-groups, as he might now but for inherited habits. But we may well doubt whether our posterity will solve many problems which we cannot, or invent an algorithm more powerful than the calculus. The first principles of all our mathemaical methods are as old as Euclid, and we cannot expect that the future will do more than apply them to new problems.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—At a meeting of the Junior Scientific Club, held on Friday, January 26, Mr. Pycraft exhibited a restoration of the wing of archæopteryx; Mr. F. A. Hillard read a paper on carborundum, and other substances, prepared by means of the electric arc; and Mr. H. M. Vernon read a paper on the activity of the cardiac centre under varying conditions. It was agreed at the meeting that the annual Boyle lecture, which will be given this year by Prof. Macalister, should be held early in May, and that a conversazione should be given on another day in the summer term.

CAMBRIDGE.—Mr. J. W. Capstick, Fellow of Trinity, has been appointed an Assistant Demonstrator in Physics at the Cavendish Laboratory, in the room of Mr. Whetham, who has been elected to the Clerk Maxwell Scholarship.

A course of lectures with demonstrations in elementary physiology for students of agriculture will be given this term by Mr. Eichholz, Fellow of Emmanuel College, on Mondays and Saturdays, at nine.

Baron Anatole von Hügel, Curator of the Museum of Archæology and Ethnology, will this term give two courses of lectures on the collections in the Museum.

A syndicate, consisting of the Vice-Chancellor, the Master of Peterhouse, the Master of Christ's, Prof. Thomson, F.R.S., Prof. Liveing, F.R.S., Mr. Glazebrook, F.R.S., and Mr. Shaw, F.R.S., is about to be appointed to consider the best means of extending the Cavendish Laboratory. A site for the extension is reserved, but the standing difficulty of funds is likely to prove a serious one unless outside help can be obtained.

Dr. P. W. Latham has resigned the Downing Professorship of Medicine, which he has held since 1874. The appointment is made by a special board of electors. Mr. J. R. Green, of Trinity College, Professor of Botany to the Royal Pharmaceutical Society of Great Britain, has been approved by the General Board of Studies for the degree of Doctor of Science.

It is proposed to admit to the privileges of affiliated students, matriculated members of the University of Adelaide who have studied there for two years in arts, law, science, or medicine, and have passed certain specified examinations. Such affiliated students are exempted from the Previous Examination and from one year of residence for the B.A. degree.

SCIENTIFIC SERIALS.

American Meteorological Journal, January.—History of the Weather Map, by M. W. Harrington. Simultaneous observations, which form the basis of weather charts, were made in Virginia from 1772 to 1777; about the same time Lavoisier proposed that such observations should be made in Europe, and referred to an earlier proposal by Borda. In 1842, Kreil, of Prague, proposed the use of an electromagnetic telegraph for the same purpose. The earliest proposal for a weather map was probably made by Brandes, in 1816, but his plan seems never to have been carried out, and it was not until 1856 that current charts of the weather were made by the Smithsonian Institution. In 1857, Le Verrier published an international bulletin, but his synoptic charts were not issued until 1863; and in this country Admiral FitzRoy commenced the publication of telegraphic weather reports in 1860; since this time such reports and charts became general.—The meteorological work of the Medical Department of the United States Army, by Major C. Smart. The earliest meteorological journal in the office of the Surgeon-General is from Cambridge, for July, 1816. The first results were published in the *Meteorological Register* for the years 1822–5.—The meteorological work of the Smithsonian Institution, by S. P. Langley. In December, 1847, Prof. J. Henry proposed a "system of extended meteorological observations for solving the problem of American storms," and shortly afterwards the institution issued directions for meteorological observations; in 1849 elementary telegraphic weather reports were furnished to the institution daily.—Early individual observers in the United States, by A. J. Henry. A daily record of the weather was kept by the Rev. J. Campanius at Fort Christiania, near the present city of Wilmington, Delaware, during 1644–5, and at Boston, by the Hon. P. Dudley, in

1729-30. The instrumental period began with Dr. J. Lining's observations at Charleston, in 1738. The above, and articles on the storms of the Atlantic, and the creation of meteorological observatories upon islands, are abstracts of papers prepared for the Chicago Congress of Meteorology.—The recurrence of hurricanes in the solar magnetic 26·68 day period, by F. H. Bigelow. The author compares the curves of hurricane recurrences with those of the solar magnetic period. An inspection of the curves shows that they have closely synchronous maxima and minima. Mr. Bigelow concludes that the intensifications of the polar magnetic field have much to do with the generation of West Indian tropical storms, but he admits that many points of the subject are as yet only partially understood.

Bulletins de la Société d'Anthropologie de Paris, Tome iv. (4e Serie), December 15, 1893.—M. Ch. Letourneau describes a stone cross, found at Carnac, with inscriptions. The two arms of this cross are *patée*, like those of a Maltese cross, and the four faces of the quadrangular shaft are covered with inscriptions which resemble in their general character those megalithic inscriptions which are so numerous in the neighbourhood of Locmariaker. As these inscriptions must have been cut subsequently to the fashioning of the cross, we have a very different case to that in which a cross is found carved on a menhir. This cross, with two others of a similar character, are figured by Miln as tail-pieces in his work "Fouilles de Carnac" (Paris, 1877), and he considers them to mark the transition period between Paganism and Christianity. There can be no doubt, however, that the men who chiseled the great menhir of Locmariaker and carved the inscriptions of Gavr Inis were capable of cutting a cross out of stone if they were disposed to do so; afterwards these crosses might have been preserved by the Christians, and even, perhaps, restored by them.—Dr. Paul Raymond contributes a paper on the prehistoric period in the departments of Gard and Ardèche; and M. Désiré Charnay describes the remains of the cliff-dwellers exhibited at the World's Fair at Chicago.—The colour of the eyes has long been looked upon as one of the most important race signs, and Dr. Harreaux proposes a systematic method of describing the iris, which, so far as one can judge without the assistance of plates, will enable qualified observers to record and recognise very minute differences; the system, however, appears to be somewhat too complicated for general use and is surpassed in precision by the iridographic method of Bertillon.—Dr. Ledouble contributes a valuable paper on the anomalies of the great dorsal muscle.—M. A. Pokrovsky describes four crania found by Prof. Obolonsky in the grotto of Sundurli-Koba, near the village of Ouzoundja, in the Crimea. Three out of the four are considerably plagiocephalic, the plagiocephaly being left in two cases and right in the third; two of the crania are male, one is female, and the fourth is that of a child of about twelve years of age.—M. Adrien de Mortillet gives an account of the figures cut on the megalithic monuments near Paris; these are three in number, one in the valley of the Seine, at Aubergenville; the two others in the valley of the Epte, at Dampsmesnil and at Boury. The dolmen at Aubergenville is known as the Trou-aux-Anglais, that at Dampsmesnil is called by the country people the Trou-aux-Loups, while the third is the Dolmen de la Bellehaye.

Bulletin of the New York Mathematical Society, vol. iii. No. 3, December, 1893 (New York).—A doubly-infinite system of simple groups (pp. 73-78) is an abstract of a paper presented to the Congress of Mathematics at Chicago, by Prof. E. H. Moore. The paper is to be published in full in the Proceedings, and also in the *Mathematische Annalen*. Two notes follow, on monogenic functions of a single variable (pp. 78, 79), by Dr. Craig, and Lambert's non-Euclidean geometry (pp. 79, 80), by Prof. Halsted. This latter is very interesting, as it narrates the discovery of an old paper of Lambert's (Zur Theorie der Parallellinien, 1766) on what was long after named the non-Euclidean geometry. Pages 80-88 are taken up with remarks on the teaching of mathematics at Göttingen. There are the usual "notes" and "new publications" (pp. 88-94).

The number of the *Journal of Botany* for December, 1893, contains further Notes on the genus *Potamogeton*, by Mr. A. Fryer, with illustrations; Descriptions of three new African grasses, by Mr. A. B. Rendle; the completion of Mr. E. G. Baker's Synopsis of genera and species of *Malveæ*; and Mr. Carruthers' Report of the Department of Botany in the British Museum for 1892.—The most important papers in the No. for January, 1894, are one on the Primary subdivisions in the genus *Silene*, by Mr. F. N. Williams; and the late Prof. Asa Gray's Last words on nomenclature.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, January 17.—Sixty-first Annual Meeting.—Mr. Frederic Merrifield, Vice-President, in the chair.—An abstract of the treasurer's accounts, showing a balance in the Society's favour, having been read by Mr. J. Jenner Weir, one of the auditors, the secretary, Mr. H. Goss, read the report of the council. It was then announced that the following gentlemen had been elected as officers and council for 1894:—President, Mr. Henry J. Elwes; treasurer, Mr. Robert McLachlan, F.R.S.; secretaries, Mr. Herbert Goss and the Rev. Canon Fowler; librarian, Mr. George C. Champion; and as other members of the council, Mr. Walter F. H. Blandford, Mr. Charles J. Gahan, Mr. Frederic Merrifield, Prof. Edward B. Poulton, F.R.S., Colonel Charles Swinhoe, Mr. George H. Verrall, Mr. James J. Walker, R.N., and the Right Hon. Lord Walsingham, F.R.S. Mr. Merrifield then read the President's address, in which, after alluding to the principal events of the past year, and the prosperous condition of the Society, he referred to the additions which had been made in 1893 to the literature of entomology, calling attention to the "Butterflies of China and Japan," by Mr. J. H. Leech; the "Moths of India," by Mr. G. F. Hampson; "Butterflies of North America," by Mr. W. H. Edwards; "Lepidoptera Indica," by Dr. F. Moore; and the continuation of the "Biologia Centrali-Americana," by Messrs. F. D. Godman, F.R.S., and Osbert Salvin, F.R.S. He also commented on the recent publications of the Grand Duke Nicholas Mikhailovitch, M. Charles Oberthür, and Dr. Staudinger, on the continent. The President concluded by referring to the losses by death during the year of several Fellows of the Society and other entomologists, special mention being made of Prof. H. A. Hagen, the Rev. Leonard Blomefield, Mr. A. C. Horner, Prof. J. Wood-Mason, the Rev. Henry Burney, Mr. J. C. Bowring, the Rev. F. O. Morris, Mr. J. Batty, Mr. Francis P. Pascoe, Herr Eduard Honrath, and Dr. Adolph Speyer. A vote of thanks to the President was proposed by Colonel Swinhoe, seconded by Mr. Jenner Weir, and carried. Lord Walsingham proposed a vote of thanks to the officers of the Society; this was seconded by Mr. Waterhouse, and carried. Mr. Merrifield, Mr. McLachlan, and Mr. Goss replied, and the proceedings terminated.

Royal Microscopical Society, January 17.—Annual Meeting.—Mr. A. D. Michael, President, in the chair.—After the report of the council for the past year and the Treasurer's statement of accounts had been read and adopted, the President announced that the following were elected as officers and council for the ensuing year:—President: A. D. Michael; Vice-Presidents: Prof. L. S. Beale, F.R.S., Dr. R. Braithwaite, Frank Crisp, T. H. Powell; Treasurer: W. T. Suffolk; Secretaries: Prof. F. Jeffrey Bell, Rev. Dr. W. H. Dallinger, F.R.S.; Ordinary Members of Council: A. W. Bennett, Rev. E. Carr, E. Dadswell, C. H. Gill, Dr. R. G. Hebb, G. C. Karop, E. M. Nelson, Prof. Urban Pritchard, C. F. Rousselet, Prof. Charles Stewart, J. J. Vezey, and T. C. White.—The President then delivered the annual address. He took for his subject the growth and present state of our knowledge of the Acari. The name "Acarus" was probably first used by Aristotle; it means uncuttable. But Aristotle did not anticipate Cambridge rocking microtomes, and the President exhibited a set of over 120 serial sections cut from a far smaller Acarus than Aristotle could ever have seen. The President then described what an Acarus really is and in what respects it differs from other Arachnida, a distinction which is erroneously stated in almost all text-books of zoology. The classification of the group practically began with Linnæus; it was shown how difficult it is to identify a Linnean species, and the progress of classification was shortly traced from the single Linnean genus to the two hundred and twelve genera admitted by Trouessart, one of the latest writers on the subject. The President then referred to the fact that many of the predatory Acari had not any special organs of vision, and yet that they were most active creatures, and would catch such agile insects as Thysanuridæ without constructing any web or trap, and did not seem to suffer in the least from their eyeless condition; he had seen small and weak Acari quietly waiting until larger ones had finished feeding before they ventured to attack the leavings, although both were blind. The various forms of acarine parasitism and commensualism were then described, including one where a parasite lives in the fur of the rabbit, not feeding on the host, but on other parasites which really do so, and the number of these which it will destroy is amazing. The President then illustrated the principal families of Acari by selecting one or two instances of each, which were specially interesting either from their habits, their anatomy, or otherwise. The Sarcoptidæ, or bird parasites, were represented by a parasite of the cormorant, discovered by the President, in which the male has one leg much larger than the other, and the skeleton of the body is greatly modified to support it; but the enlarged leg and modified skeleton are on the right side of the body in some specimens, and on the left in others. The so-called cheese-mites were referred to in order to describe the hypopus-stage in the life-history of many of them; when the creature, which is originally soft and easily killed by heat or exposure, suddenly becomes hard and able to endure almost all vicissitudes, and also to live for a long period without eating; it is then provided with special organs for adhering to insects, and thus the species are widely distributed under circumstances where they would otherwise perish. The President then spoke of his recent researches into the association between many Acari (Gamasids) and certain ants in whose nests they live, and of a still stranger and hitherto unrecorded case, even more lately observed by him, in which a species of Acarus (*Bdella*) lives habitually in as pider's web in harmony with the otherwise most ferocious occupant. The speaker then shortly described his recent discovery of the extraordinary way in which female Gemasids are fertilised, a spermatic capsule being conveyed to its destination by the mandibles of the male. Finally, the descent of the Acari was discussed. The discourse was illustrated by the lantern.

EDINBURGH.

Royal Society, December 12, 1893.—The Rev. Prof. Duns in the chair.—Dr. George Berry read a note on the focus of concavo-convex lenses, the surfaces of which are of equal curvature. The effect of the thickness of the lens was specially considered.—Dr. W. Peddie read a paper on torsional oscillations of wires. The law of decay of oscillations when the set is large was investigated experimentally, and a very accurate empirical formula was given for the representation of the results. A theory of the phenomenon was then investigated, and was shown to lead to the empirical formula as an approximation when the loss of energy per oscillation was not too large a fraction of the total energy of oscillation. The theory was also shown to lead to a relation between torsion and set, which, on application to Wiedemann's results, was found to be in practically complete accordance with experiment. It was shown also to lead necessarily to Kelvin's well-known "law of compound-interest" for the decay of oscillations when these are very small.—Dr. C. G. Knott communicated a paper, by Mr. S. Kimura, on certain electrical properties of iron occluding gases. The gases used were carbonic acid, carbonic oxide, and hydrogen. The paper dealt with the changes of thermo-electric power and of resistance.—Dr. Knott also read a paper, by Mr S. Tolver Preston, on the ether—an idea of Sir John Herschel modernised.

January 15.—Prof. Sir Douglas Maclagan, President, in the chair.—After the reading of two obituary notices, Prof. Crum Brown communicated a paper by Prof. Alexander Smith, Wabash College, Indiana, U.S.A., on two stereo-isomeric hydrazones of benzoin.—Dr. Knott communicated a paper, by Prof. Tait, on the compression of fluids. In this paper Amagat's recently published results are applied to test the truth of the empirical formula

$$\frac{v_0 - v}{v_0 p} = \frac{e}{\pi + p},$$

where π is the internal pressure and $v_0(1-e)$ is the ultimate volume under infinite pressure. Tests are made, at pressures of 1, 1501, and 3001 atmospheres, for the substances ether, ethylic alcohol, methylic alcohol, propylic alcohol, carbon bisulphide, iodide of ethyl, chloride of phosphorus, acetone, and water. The quantity e is found to be nearly the same for all these substances, and indicates an ultimate reduction of volume of about 30 per cent. It increases as a rule with rise of temperature. In the case of water, π increases steadily with rise of temperature up to about 40° C. In all other substances π decreases steadily with rise of temperature. These facts correspond to the known changes of compressibility with temperature. An attempt is then made to see how far it may be possible to extend the formula to substances such as carbonic acid at ordinary temperatures, considerable pressure being required to keep the substance in the liquid state. Consistent values of e and π are obtained at temperatures and pressures both above and below the critical point. It is found that π is positive, at volumes a little above the critical volume, over a considerable range of temperature. Hence the Laplace effect predominates over the kinetic repulsion In the other regions for which tests were made, π is negative. It vanishes, at a temperature a little over 80° C., throughout the observed range of volumes. This vanishing of π corresponds to the case of the ideally perfect gas.

PARIS.

Academy of Sciences, January 22.—M. Lœwy in the chair.—Integration of the equation for sound in an indefinite fluid in one, two, or three dimensions, when resistances of various types introduce into this equation terms proportional respectively to the characteristic function of the movement or to its first derived partials, by M. J. Boussinesq. A solution of a problem in the propagation of sound-waves suggested by M. Poincaré in a recent communication.—On the calculation of coefficients of self-induction in a particular case, by M. A. Potier.—Experiments on the histological mechanism of the secretion of granular glands, by M. L. Ranvier. An account of methods employed in observing the cell-activities of the submaxillary gland of the rat.—A study of the fauna of the Gulf of Lyons, by M. H. de Lacaze-Duthiers.—Report on the meteorological observatory established by M. Vallot, near the summit of Mont Blanc, and on the first volume of the annals of the work of this observatory, by the commissioners, MM. Mascart and Bouquet de la Grye.—On the solar phenomena observed at the observatory of the Roman College, during the first two quarters of the year 1893. A letter by M. P. Tacchini, giving details concerning protuberances, faculæ, spots, and eruptions observed. All the phenomena were more frequent in the southern zones, the maximum numbers also were found in these zones. In the first quarter, eruptions were not observed. The maxima of faculæ and spots were found in the same zones (± 10°, ± 20°), of protuberances in higher latitudes.—Note on equations and implicit functions, by M. A. Pellet. — On new experimental studies concerning the form, pressures, and temperatures of a jet of vapour, by M. H. Parenty. Diagrams are given showing the distribution of pressures in jets with apertures of different types.—Contribution to the study of the properties of the arc with alternating current, by M. G. Claude.—On the minimum electromotive force necessary for the electrolysis of dissolved alkaline salts, by M. C. Nourrisson. From thermochemical data the E.M.F. necessary is for chlorides 2·02 volts, bromides 1·75, iodides 1·16, sulphates 2·15, nitrates 2·07, and chlorates 2·07 volts. The experimental results for the halogen salts of the alkalies and alkaline earths agree with these numbers, but for the corresponding sulphates, nitrates, and chlorates somewhat higher values are obtained. The minimum E.M.F. necessary for the electrolysis of a dissolved alkaline salt is constant for oxy-salts and is constant for the haloid salts of the same acid.—On an application of sodium silicate, by M. G. Geisenheimer. The application referred to is that of being used to soften waters for laundry purposes.—On some phosphochromates, by M. Maurice Blondel. The formation and properties are described of bodies having the formulæ $3K_2O.P_2O_5.8CrO_3$ and $2K_2O.H_2O.P_2O_5.4CrO_3$, or $2K_3PO_4.8CrO_3$ and $2K_2HPO_4.4CrO_3$.—Action of sulphuric acid on wood charcoal, by M. A. Verneuil Some of the secondary products have been isolated and identified, notably the penta- and hexa-carboxylic acids, $C_6H(CO_2H)_5$ and $C_6(CO_2H)_6$.—Condensation of isovaleraldehyde with acetone, by MM. Ph. Barbier and L. Bouveault.—Studies on the chemical properties of the alcoholic extract of yeast; formation of carbonic acid and absorption of oxygen, by M. J. de Rey-Pailhade.—On the sea bottom of the region of Banyuls and Cape Creux, by M. G. Pruvot.—A certain symptom of death, indicated by the ophthalmotonometer. Laws of ocular tension. A note by M. W. Nicati.—Some observations on snake poisons, by M. S. Jourdain. Remarks supplementary to MM. Bertrand and Phisalix's recent paper.—On the ichthyological fauna of the fresh waters of Borneo, by M. Léon Vaillant.—A method of assuring and promoting the germination of vines, by M. Gustave Chauveaud.—On the structure of the French Alps, by M. Marcel Bertrand.—On the laws of the contortions of the shell of the earth, by M. Zürcher.—The temperature of the upper atmosphere, by M. Gustave Hermite. The author shows from the results of two balloon ascents in 1893 that the decrease of temperature with the height is much more rapid than is indicated by temperatures recorded at mountain observatories.

SYDNEY.

Royal Society of New South Wales, September 6, 1893.—H. C. Russell, F.R.S., Vice-President, in the chair.—The following papers were read by Prof. Liversidge, F.R.S.: (*a*) On the origin of moss gold; (*b*) on the condition of gold in quartz and calcite veins; (*c*) on the origin of gold nuggets; (*d*) on the crystallisation of gold in hexagonal forms; (*e*) gold moiré-métallique. Results of observations of Comet VI. (Brooks), 1892, at Windsor, New South Wales, by John Tebbutt.—Treatment of manufactured iron and steel for constructional purposes, by W. F. How.

October 4.—Prof. T. P. Anderson Stuart, President, in the chair.—On rock paintings by the Aborigines in caves on Bulgar Creek, near Singleton, by R. H. Mathews.—Notes on artesian water in Australia, by Prof. T. W. E. David.

November 1.—Prof. T. P. Anderson Stuart, President, in the chair.—Artesian bores on Bundabunda Station in Queensland, by Hon. W. H. Suttor.—On the probability of extraordinarily high spring tides about the December solstice of 1893, by John Tebbutt—(*a*) On meteorite No. 2 from Gilgoin Station; (*b*) On different pictorial methods of showing rainfall, by H. C. Russell, F.R.S.—On the occurrence of a new mineral "Willyamite" from Broken Hill, by E. F. Pittman.

December 6.—Prof. T. P. Anderson Stuart, President, in the chair.—On the occurrence of Triassic plant remains in a shale bed near Manly, by B. Dunstan.—The orbit of the double star *h* 5014, by R. P. Sellors.—Occurrence of "Evansite" in Tasmania, by H. G. Smith.—On the separation of gold, silver, and iodine from sea-water by Muntz metal sheathing, by Prof. Liversidge, F.R.S.—Notes on the Cremorne bore, by Prof. T. W. E. David and E. F. Pittman.—The progress and position of irrigation in New South Wales, by H. G. McKinney.

NETHERLANDS.

Entomological Society, January 21.—P. C. T. Snellen, President, in the chair.—The President exhibited several specimens of *Vanessa cardui* from different regions, showing that it is a very common species, being distributed over nearly the whole world; he also showed specimens of *Papilio epius* and *Papilio antimachus*, both from Java.—Dr. J. Th. Oudemans announced that he was preparing a revision of Snellen van Vollenhoven's list of indigenous Tenthredinæ; he also stated that on the pupæ of Lepidoptera the sex can be recognised, and showed a remarkable nest of *Vespa media*.—Mr. A. Brants read an interesting paper on the caterpillar of *Notodonta ziczac*.—Mr. P. J. M. Schuyt proposed the preparing of lists for exchange of indigenous Lepidoptera.—Mr. J. de Vries exhibited a variety of *Xanthia gilvago*, Dr. F. W. O. Kallenbach, a specimen of the rare *Cidaria unifasciata*, and Dr. A. J. van Rossum, a peculiar variety of *Deilephila euphorbiæ*.—Mr. J. R. H. Neervoort van de Poll exhibited a rare variety of *Ornithoptera Priamus*, and a very fine and rich collection of the colepterous genus Haplosonyx.—Dr. Ed. Everts called attention to a third supplement of his enumeration of indigenous Coleoptera, and showed several species not yet found in the Netherlands, but collected in Belgium in the neighbourhood of the limits.—Dr. F. A. Jentink asked if any of the members present had observed cats hunting after butterflies, a fact which he had found mentioned in a British periodical, and which he could confirm with his own experience. Dr. H. J. Veth said he had noticed a similar behaviour of cats against Tineidæ in a house where the latter were very abundant.—Dr. A. F. A. Leesberg called attention to *Meloë autumnalis*, of which several specimens were captured at Mount St. Pieter, near Maastricht, though this species is extremely rare elsewhere.—Mr. W. G. Huet showed a peculiar nest of *Vespa vulgaris* and a web of spider, on which hung a long thread with a small stone at its end.—Finally, Mr. F. M. van der Wulp exhibited several indigenous and exotic species of Hippobosca, Olfersia, and Ornithomyia, and described the principal characters to distinguish these genera and their species.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Alembic Club Reprints, No. 5—Extracts from Micrographia: R. Hooke (Edinburgh, Clay).—Einführung in das Studium der Bakteriologie: Dr. Carl Günther (Leipzig, Thieme).—London Matriculation Directory, No. xv. January 1894 (University Correspondence College).—Congrès International d'Archéologie et d'Anthropologie Préhistoriques, 11-ème Session, à Moscou, Tome 2 (Moscou).—Science and Christian Tradition: T. H. Huxley (Macmillan).—Ein Geologischer Querschnitt durch die Ost-Alpen: A. Rothpletz (Stuttgart, Schweizerbart).—Lectures on Mathematics: F. Klein, reported by A. Ziwet (Macmillan).—Botanical Wall Diagrams (various) (S.P.C.K.).—Quantitative Chemical Analysis, Clowes and Coleman, 2nd Edition (Churchill).

PAMPHLETS.—Questions and Answers on Meteorology: R. H. Scott (Williams and Strahan).—Sulla Distribuzione Tipografica dei Terremoti: M. Baratta (Roma).—Carsosaurus Marchesettii, &c.: Dr. A. Kornhuber (Wien).—Ueber Partanosaurus Zitteli Skuphos und Microleptosaurus Schlosseri nov. gen., nov. spec.: Dr. T. G. Skuphos (Wien). Die Mittelliasische Cephalopoden-Fauna des Hinter-Schafberges in Oberösterreich: G. Geyer (Wien).

SERIALS.—The British Moss-Flora, Part xv.: Dr. R. Braithwaite (the Author, Clapham Road).—Journal of the Chemical Society, Supplementary Number, December (Gurney and Jackson).—Ditto, January (Gurney and Jackson).—Nuovo Giornale Botanico Italiano, vol. xxv. No. 4 (Firenze).—Bulletino della Società Botanica Italiana, 1893, Nos 8, 9, 10 (Firenze).—The Essex Review, January (Chelmsford, Durrant).—Annalen des K. K. Naturhistorischen Hofmuseums, Band viii. Nos. 2, 3, 4 Wien).—Studies from the Yale Psychological Laboratory, 1892-93 (New Haven).—Jahrbuch der K. K. Geologischen Reichsanstalt, xliii. Band, 2 Heft (Wien).—The Geographical Journal, February (Stanford).

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