THURSDAY, JUNE 18, 1891.

EGYPTIAN IRRIGATION.

THE "Note" on the above subject by Sir Colin Moncrieff, which we publish this week, will prove pleasant reading to all who have the welfare of Egypt at heart. To those who have known that country intimately in the past, the brief record of progress in irrigation since the British occupation will recall the horrors of the *corvée*, and the torturing of the wretched peasantry by tyrannical farmers of the taxes; and to engineers the record will imply, not only that all those atrocities have been abolished, but further that some of the most difficult and important engineering problems of recent times have been successfully solved by Sir Colin Moncrieff and the able staff under his control. Nothing is exaggerated, but we have in the "Note" a plain and modest statement of the quiet and unostentatious execution of works the mere discussion of the difficulties of which had occupied the time of the predecessors of Sir Colin for the previous quarter of a century without anything useful resulting.

It will be only necessary to refer to one or two matters to establish this proposition. In paragraph 10, Sir Colin announces that the Barrage has been completed, and placed in a condition to fulfil its original purpose, for the sum of about £460,000. Contrast this with the published statement of M. Linant, a former engineer-in-chief of the Egyptian Government, who, in 1872, expressed a doubt whether it would not cost more to repair the existing Barrage than to build an entirely new one, and further says: "If, at the time when the Barrage was commenced, steam-engines had been what they are to-day, one would certainly have advised Mehemet Ali to abandon his project of a Barrage for the establishment of pumping-machinery." Even at that time, M. Linant thought it was not too late to consider whether it would not be better to abandon the idea of repairing the Barrage; and to assist in the determination of the question he submitted an estimate of the cost of pumping, amounting to £465,000 per annum, which, he thought, the cultivators could well afford to pay.

We have already stated that Sir Colin Moncrieff has effected the same result by a single expenditure of £460,000 instead of by an annually recurring one of £465,000. By means of the completed Barrage the whole summer supply of the Nile is thrown on to the lands, so obviously there is no work for pumps, and the vast cost of the same is saved to the country. Although national feeling runs high in France, we cannot but think that French engineers will rejoice that the world-renowned Barrage of the Nile, the design of which by M. Mongel was approved of by the Council of the Ponts et Chaussées in 1842, and carried into execution during the ensuing ten years, has at last, after thirty years' practical inutility and failure, been finally completed by their worthy compeers and successors in Egypt—the British engineers—whose experience, gained in the great irrigation works of our Indian Empire, has been as zealously utilized in securing the success of a great French work as it would have been in carrying out a new one of their own design.

One other matter in Sir Colin Moncrieff's "Note" may be referred to—namely, the drainage recently effected No doubt, the fact enforced upon Indian engineers by. numberless experiences—that high-level perennial irrigation must be accompanied by drainage works if soil and people are to remain in a healthy condition—was not well known to the French projectors of summer irrigation works in Egypt; and, as a consequence, whereas magnificent canals carrying 5000 cubic feet and upwards per second were constructed, no corresponding means were provided for draining the superfluous and often saline water off the lands. Sir Colin tells us that the mileage of the drains at present is not less than 1500. When we consider that, in addition to these vast works of improved irrigation and drainage, a steady reclamation of marshland has been going on, we have reason as a nation to be proud of the good work which our countrymen have carried on in Egypt; as, whatever may happen in the future, the fact of the British occupation will, from its successful applications of science, be indelibly stamped upon the face of the country for all time, and its memory will for other reasons live honourably in the traditions of the emancipated and much-enduring fellaheen.

PHYSIOLOGICAL PSYCHOLOGY.

Leitfaden der physiologischen Psychologie. In 14 Vorlesungen. Von Dr. Th. Ziehen, Docent in Jena. (Jena: Gustav Fischer, 1891.)

THIS little volume will be welcome to a good many students of psychology, both in Germany and beyond. Anyone who has had to look up the newer researches in experimental psychology in Germany knows the serious difficulty of gaining easy access to them. They are scattered over a whole heterogeneous mass of serial and other publications. Now we have to look into an avowedly psychological journal or brochure, but more frequently still into physiological works, and not infrequently into journals for psychiatry. The explanation is obvious. Psychology, in passing into the objective and experimental phase, is broadening its base to an almost perplexing extent, and is encroaching more especially on the domain of physiology. Hence the need of a volume like the present work, which aims at giving the beginner a conspectus of the psychological field. We want such a book badly in English, the only available one, that of Prof. Ladd, being at once incomplete on certain sides, and in part too metaphysical. Meantime we can recommend Dr. Ziehen's "Vorlesungen" as exceedingly well adapted to give the student a clear idea of the scope and the methods of the new science of physiological psychology.

Dr. Ziehen marks off physiological from what he calls transcendental psychology by the differentia that it deals with psychical processes as attached to cerebral functions. Psychophysic, the branch of investigation opened up by Weber and Fechner, he includes under physiological psychology as that part which aims at exact measurement. This seems to be a satisfactory way of mapping out the ground. The standpoint of the physiological psychologist is indicated in the assumption that every psychical process must be thought of as having a concomitant physiological process. This, too, though it would exclude such a "physiological psychology" as that of Ladd, seems a reasonable way of viewing the matter. Further, the author proceeds to set forth the typical form of psycho-physical process as reflex, and he considers that every known development of the psychical phase must be capable of being viewed as an incident in such a reflex process. Here Dr. Ziehen meets the real difficulty in psychology, and, as we see, meets it boldly. From the physiological point of view we are bound to take the reflex as our starting-point, and to view the most intricate plexus of cerebral processes as merely an expansion of the intermediate central stage of this reflex. But can the same mode of treatment be applied to the intricate inter-weavings which constitute our mental life? As mere events in time, synchronizing with neural events, they appear to be susceptible of being thus regarded, and this, as the author rightly contends, is precisely the way in which the physiological psychologist has to conceive of psychical phenomena.

Starting, then, with the reflex, of which the writer gives an admirable account by way of introduction, he proceeds to deal with the psychical process in its three successive stages, viz. sensation, answering to the afferent or sensory section of the nervous process; ideation, or, as he puts it, association, answering to the expanded form of the central section; and action, answering to the efferent or motor section. The account of sensation is fairly full, and up to date. Perhaps the treatment of the relation of stimulus to sensation (Weber's law) is proportionately too long. The discussion of the interpretation of the facts is original and interesting. The author does not, like most recent physiologists, view the logarithmic ratio of stimulus to sensation as a purely physiological relation, due to what Mr. James has recently called the friction of the nerve-machine, but connects it with a more general psycho-physical law formulated by Hering, viz. "that the purity, distinctness, or clearness of a sensation or idea depends on the relation in which the weight of the same, *i.e.* the magnitude of the corresponding psycho-physical process, stands to the collective weight of all simultaneously present sensations and ideas, *i.e.* to the sum of the magnitudes of all the corresponding psycho-physical processes." At the same time the author is far from clear when he speaks of the conscious comparison of intensities as an "associative activity." This is an example of a tendency among the younger physiological psychologists to force psychical processes into a physiological framework. Comparison cannot, as Münsterberg's ingenious but futile attempts plainly show, be regarded as *merely* an associative process, though of course it depends on association, and in this way can be correlated with a nervous process. It must, however, be said in justice to Dr. Ziehen, that he is commendably free from the common tendency of physiologists to ignore psychical distinctions. Thus it is quite refreshing to find a physiologist contending that black and grey are positive sensations, having each its distinctive quality, like white or blue. It may be added that special interest is given to the exposition of sensation, as of the other psychical phenomena, by the frequent bringing in of the biological point of view, and the suggestion how, by the process of natural selection, particular psycho-physical arrangements have been brought about and rendered permanent.

The account of sensation is supplemented by a chapter on the affective or emotional tone of sensations, *i.e.* their pleasurable or painful aspect. Here, again, we have frequent references to the Darwinian theory, as when it is suggested, *à propos* of the fact that extreme intensities of skin-sensation, pressure, heat and cold, lose their distinctive sensational quality, and become purely affective phenomena or pains, that this arrangement has come about owing to the circumstance that in the evolution of the zoological series "intensive mechanical and caloric stimuli constitute the earliest, the most frequent, the most direct, and the greatest danger to the animal organism" (p. 85). The author refers the whole of the difference in affective tone among colours, and among combinations of musical sound, to association. This seems to be going too far. The contrast between the exhilarating effect of the warm colours, and the quiet effect of those at the violet end of the spectrum, seems to be connected in part with the difference in the underlying nervous processes; and this is certainly true, as Helmholtz has shown, with respect to the emotional aspect of certain accords, *e.g.* the major and minor triads.

Coming now to the account of the idea (image and concept), we note that Dr. Ziehen differs from the majority of contemporary psychologists in assigning a separate cortical element to the sensation and to the idea. These different cells (the author, in spite of Lewes's attacks on the cell-superstition, talks of the individual cell as the seat of a sensation) are closely connected, and in this way the after-effect of sensations in memory, as also the reflex effects of ideas in exciting sensations, as in hallucinations, are accounted for. The writer elaborates his peculiar anatomical hypothesis in an ingenious way. He seems to admit, however, that it is a pure hypothesis, for the facts of "mental blindness" referred to are not apparently put forward as a proof; and it may be added that rightly viewed they do not seem even to suggest the hypothesis. One may add that it appears to lack the only possible justification of such a hypothesis, viz. that it simplifies the interpretation of the facts. The other supposition, that the sensation and the idea involve the same group of central elements (not the same single cell), is more reasonable in itself, and seems to offer a readier explanation of most of the phenomena.

The account of the psycho-physical process in association is less clear and instructive than most of the exposition. The author follows Münsterberg a good way at least—in reducing all association to one form, viz. contiguous, and more particularly simultaneous, association. But the diagrammatic representation of the processes strikes one as needlessly complicated by the hypothesis of separate ideational nerve-cells. Much better is the account at the close of this lecture of the way in which the different psycho-physical factors co-operate and modify one another in the actual concrete processes of reproduction. Dr. Ziehen is particularly happy in explaining the great variability of the sequences of our ideas from moment to moment. The account of the ideational stage is completed by a discussion of the relation of association to judgment and reasoning—which is a little hasty, and ignores some of the main difficulties of the subject, of attention and the voluntary control of the thought-process, and of the abnormal modifications of ideation in mental disease, sleep, and hypnosis.

The unfolding of the third and finai stage, voluntary action, with which the volume concludes, offers little that is noteworthy. The author adopts the new and growingly fashionable view that all our active consciousness, sense of muscular effort, and so forth, is the result of afferent nerve processes, and he proceeds, much in the manner of Münsterberg, to resolve all volitional processes into complexes of sensations and ideas, more particularly ideas of movement. This seems to lead logically to the denial of any distinctive active or volitional psychosis answering to ideational or emotional psychosis; and Dr. Ziehen is not afraid to express this denial, and fortifies his position by the debatable statement that psychiatry, while acknowledging a special variety of intellectual and of emotional disturbance, knows no such thing as a distinct volitionary disturbance. It is to be added that the exposition concludes with a particularly good discussion of the final results of psycho-physical research. The author here shows himself a genuine psychologist, and while insisting upon the invariable concomitance of a physiological factor in psychical phenomena, is so far from regarding the psychical as a non-essential and negligible accompaniment of the material process, that he closes in a quite Kantian strain by reminding us that the psychical chain is that which is known primarily and immediately, and which as such must always possess more reality for us. J. S.

ACHIEVEMENTS IN ENGINEERING.

Achievements in Engineering. By L. F. Vernon-Harcourt, M.Inst.C.E. (London: Seeley and Co., Limited, 1891.)

THE object of this book is to describe some of the principal engineering works carried out during the last fifty years at home and abroad. The author has avoided technical phraseology to a great extent, thus making a very interesting subject as clear as may be to the general reader. Much subject-matter has been gleaned from many sources, and these are amply enumerated in the preface.

The London Metropolitan Railways and the New York elevated railways are described in chapter i. The growth of the Metropolitan system is very interesting, and is traced from the opening of the first section from Paddington to Farringdon Street in 1863 to the completion of the "Inner Circle" from the Mansion House to Aldgate in 1884. The author states that when the Metropolitan Railway was first designed, it was intended that the traffic should be worked by smokeless, hot-water locomotives not burning fuel, as it was supposed that the trains would be small, and that "foreign" locomotives would not travel over the line to any important extent. This, however, was not carried out, and locomotives of the ordinary type were adopted. The ventilation therefore proved defective, and even to this day improvement is greatly needed in many sections. The bad atmosphere is, of course, due to the locomotives in use, and the emission of steam considerably adds to the nuisance. Locomotive engineering is surely able to cope with this trouble. The dead weight of the trains might be considerably reduced with advantage, and the engines designed with ample condensing arrangements, even if the latter had to be attached to the engine as a separate vehicle. The boilers should, of course, be large enough to steam well with the ordinary blower, so that all the exhaust might be condensed.

The Metropolitan Railway represents an engineering achievement novel in many respects and made under circumstances of peculiar difficulty. On the other hand, the New York elevated railways illustrate how the American engineers solved a similar problem in a very different manner. Owing to the cost of "burrowing underground," as the author aptly describes it, they rejected the underground scheme, and for the same reason a railway on an arched viaduct was also considered undesirable. The railways have been carried along the streets, raised above the street traffic on girders resting upon wrought iron lattice columns standing at convenient places on the line of the curb of the pavements. An illustration is given representing a street in New York and the elevated railways running on each side. No payment has been made for placing these columns along the streets, and no compensation has been paid for damages to residential property fronting the railways. The author estimates the depreciation in value, due to the presence of the railway, as not less than 50 per cent. The cost per mile will therefore be considerably less than in the case of the London Metropolitan Railway, in which case all these items were heavily paid for. The London railway cost about £575,000 per mile, whereas the New York elevated railways only cost about £81,000 per mile.

Chapter ii. describes railways across the Alps, the Rocky Mountains, and the Andes. On p. 30 we find an interesting diagram representing the gradients and altitudes of the heavy portions of these lines, from which it is evident that the lines in North and South America are at higher elevations and are more subject to snow than the highest of the Alpine railways, and more severe gradients are to be found. Take, for instance, the heavy gradient on the Mexican Railway, rising 6400 feet in 54 miles, the maximum gradient being 1 in 25. This portion of the line is worked by Fairlie engines, which the author attempts to describe on p. 56.

The author in describing the Festiniog Railway says that the traffic is worked up the long incline by "duplex bogie engines, introduced in 1869, having two engines, united by a tender common to the two, and hinged at the centre." He goes on to say that these are called Fairlie engines, after the name of their designer. The Fairlie engines as used on the Mexican Railway certainly do not agree with this description, nor does this description agree with the usually accepted type of engine known as the "Fairlie." The Fairlie engine consists of a special type of boiler carried on bogies, one at each end. These bogies have either four or six wheels, as the case may be; each bogie is fitted with steam cylinders and gear complete, and all the wheels are coupled. The boiler has a smokebox at each end, and is fitted with fire-boxes in the centre, being fired from the side. The steam pipes from the boiler to the "steam" bogies are flexible, to allow the bogies to take the curves. The water is carried in side tanks, and the fuel on the top of the boiler and at the side. The author will observe that there is no central pivot and no tender; the engine is a tank engine; and that the whole of its weight is good for adhesion. The Fairlie engines at work on the Mexican Railway weigh in order about 92 tons. The total wheel base is 32 feet 5 inches, and the rigid wheel base of the bogie is 8 feet 3 inches.

Chapter iii. includes narrow gauge railways, as well as the Fell, Rigi, Pilatus, and Abt mountain railways. The use of a narrow gauge railway in place of the standard gauge is due to questions of cost of construction by diminishing the width of the line, and also enabling sharper curves to be adopted. Narrow gauge railways now in use were years ago of ample capacity for the traffic then available, but are now a continual source of trouble where the traffic has increased beyond their capacity. In some cases, where an increase of gauge is impossible owing to the cost, the rolling stock has to be designed to suit the abnormal requirements, and the locomotives recently designed have to be made to suit the conditions, and are working under adverse conditions from a locomotive engineer's point of view. The cost of a break of gauge is a serious matter, involving as it does the transshipment of passengers and goods, as well as two classes of rolling stock. In India, for instance, the metre gauge has given place to the broad gauge of 5 feet 6 inches in many cases, in order to obtain through communication without break of gauge. The author gives an excellent description of the various mountain railways named, and they are without doubt monuments of engineering daring and skill.

In chapter iv. an excellent description is given of the piercing of the Alps. To the rivalry of European Powers, each anxious to command a route, are due the several Alpine tunnels; from the design and execution of the Mont Cenis tunnel to the more recent schemes west of the St. Gothard. Had the author told us a little more about the difficulties encountered, he would have added considerably to the interest.

Tunnels under the Alps naturally give place to subaqueous tunnels in the sequence of subject-matter in the volume. The Mersey and Severn tunnels are described, and the tremendous difficulties encountered in the execution of the latter undertaking are pointed out. We also find a description of several subaqueous tunnels in the States, including the Sarnia tunnel recently opened under the St. Clair river, to connect the Grand Trunk Railway of Canada at Sarnia with the United States Railways at Port Huron. The chapter closes with an account of the proposed Channel Tunnel.

The progress and principles of modern bridge construction are treated in chapter vi. This gives a good account of the great advance made during the last fifty years in this important branch of engineering. Wrought-iron gradually superseded cast-iron in bridge construction, and steel has again superseded it. The manufacture of steel has now reached a stage in which there are no uncertainties in its quality. The earliest instance of the adoption of steel for a bridge is the St. Louis Bridge, over the Mississippi, constructed in 1867–74, and the most recent example is, of course, the cantilever bridge, with two spans of 1700 feet, over the Firth of Forth. The author gives the great Indian bridge over the Rori branch of the River Indus, at Sukkur, very little notice, and does scant justice to this "achievement in engineering," certainly a monument to its designer. Designed by Sir Alexander M. Rendel, K.C.I.E., M.Inst.C.E., and built by, and erected on the works of Messrs. Westwood, Baillie, and Co, of London, this bridge was taken to pieces and shipped to India, where it was re-erected. The chapter closes with an account of the proposed bridge over the Channel.

Submarine mining and blasting are treated in the chapter that follows. This chapter is interesting mainly owing to a detailed description of the operations for improving the entrance to New York Harbour by the removal of the obstructions at Hell Gate and Hallett's reef. With reference to the explosion at the latter site, it is interesting to observe that the earth-wave produced was carefully recorded at various places, and the rate of transmission of the shock was found to be more rapid and more uniform when the shock passed northwards through rock, than when it passed through drift in an easterly direction. In travelling through drift, it reached Goat Island, a distance of 145 miles, in 59 seconds, and Harvard College Observatory, 182⅝ miles, in 3 minutes 40 seconds; and in travelling through rock, it reached West Point, 42½ miles distant, in 11 seconds, and Litchfield Observatory, 174⅛ miles away, in 45⅛ seconds.

Chapters ix. to xv. deal with that branch of engineering which may be roughly included under the title of "Harbours and Docks." In a previous work by the author, bearing this title, and reviewed in these columns, this subject was amply dealt with, and it will now be sufficient to state that the present chapters are well up to the standard of excellence of his previous work. We find an interesting description of the Manchester Ship Canal works in these chapters—a work rapidly nearing completion, and one which, if successful, will be the forerunner of many similar works in this country. An illustration is given, showing the progress of the works forming the Eastham Locks, viewed from the Eastham end. This illustration gives a very good idea of the magnitude of the undertaking. Another Manchester undertaking occupies considerable space in this work, viz. the Manchester waterworks, and more particularly the Thirlmere scheme. The author tells us that the eventual maximum daily supply of 50 million gallons of water will be conveyed to Manchester by an aqueduct, or conduit, about 100 miles long. Another similar undertaking is also discussed; in the Liverpool Vyrnwy scheme we find how engineers have solved the difficulty of getting a pure water supply for that city.

The volume concludes with an account of the Eddystone Lighthouse and the Eiffel Tower.

The frontispiece is a portrait of Robert Stephenson, a very appropriate one for such a work. His name will ever be associated with the development of railways, as the author remarks; and he might also have pointed out that the railway has been in many cases the reason for many "achievements in engineering" being called into existence.

Taken as a whole, this work is a very interesting one. It is well written, and the author may be congratulated on having succeeded in his endeavour to describe briefly some of the principal engineering works carried out, at home and abroad, within the last fifty years. The book is well printed, and the illustrations are excellent, although there might perhaps have been more of them, considering that the general reader has to be provided for. N. J. L.

GEOLOGICAL EXCURSIONS.

Geologists' Association: a Record of Excursions made between 1860 *and* 1890. Edited by Thomas Vincent Holmes, F.G.S., and C. Davies Sherborn, F.G.S. (London: E. Stanford, 1891.)

THE Geologists' Association began its useful career of work more than thirty years since. It has stimulated—more, perhaps, than any other body—a real interest in geology among those who live in and about London, because it has enabled students, still near the outset of their work, not only to meet for mutual help and encouragement, but also to be aided by those of repute in science. Of its meetings, not the least pleasant and useful are the excursions. At first these were made generally once a week, so long as weather permitted, and they occupied a Saturday afternoon or at most a single day. Then an occasional journey of longer duration was attempted; now it is usual to undertake excursions, lasting two or three days, at Easter and Whitsuntide, and one of a week or more during the summer holidays. Before each excursion a flysheet is issued to the members with a brief description of the geology of the locality, illustrated by diagrams and containing references to books and papers. Afterwards, a report of the excursion is inserted in the Proceedings of the Association. It was a happy thought to collect together in one volume these scattered notices, for they give succinct descriptions of almost all the localities of geological interest readily reached from London, so grouped as to be conveniently accessible. Thus the student, instead of having to compile for himself, from books or maps, a plan of campaign, whether for an afternoon or for a longer time, finds everything arranged ready to his hand, and is directed to the sections best worth visiting. These diagrams and reports possess a further value, that they frequently record sections which can be no longer examined, because they now either are overgrown by vegetation, or have been removed in quarrying. The work therefore is a geological guide-book of an exceptional and a very convenient character to a large district around London, and to several other localities of special interest in England.

The plan which has been followed in compiling the volume is stated in the preface. The excursions are grouped, as far as possible, within county boundaries; where more than one visit has been paid to any place, the editors have "either suppressed the shorter, and retained the fuller, or given from each account that which is not to be found elsewhere." The reports have been condensed by the excision of matters of general or merely temporary interest, and although references are made to all excursions up to the year 1890, no reports are given of later dates than 1884, because since 1885 it has been customary to print all these in the November number of the Proceedings, so that they can be easily consulted.

The thanks of the Association—indeed of a wider circle of geologists—are due to the editors for the pains which they have taken in discharging a very laborious duty. It seems almost ungracious to criticize, and to do it effectively would require encyclopædic knowledge; but we think that, though it may have been "impossible to send each report to the original reporter for revision," it would have been prudent to submit it to someone with a special knowledge of each district. These reports occasionally contain *obiter dicta*, or the crude speculations of members who are better acquainted with their own locality than with the principles of the science. Hence obsolete notions are preserved like flies in amber: these may perplex, but they cannot help the beginner. By way of testing the results of the editors' method, we have examined the reports of two or three districts with which we are specially familiar. The statement on p. 203 about the section at Roswell Pit, near Ely, is misleading. The natural interpretation of its words would be that the Kimeridge clay formed a part of the great erratic. This, in reality, consists of Cretaceous rocks, the Jurassic clay being *in situ*. On p. 216, the sentence "at the base, as at the top of the Gault," should have been "below the base, as above the top." Again, the clay beneath the neighbouring Upware limestone, now admitted to be Coral rag, cannot well be Ampthill clay, and we are not aware of any evidence in favour of this view. Again, the account of Charnwood Forest needs correction. At p. 463 a statement is quoted, which was published without due authority, and has been recalled by the author. On pp. 465 and 466 the suggestion that the Charnwood Forest rocks "ought to be called Laurentian" should have been cancelled. It was groundless, even as Laurentian was defined in 1875: it is absurd now. All reference to the "Archæan Petrology" of Prof. Ansted might well have been omitted. On p. 472, Peldar Tor is twice misprinted Peddar Tor. We know of no ground for the statement, on p. 473, that "the quartz [in the rocks of this neighbourhood] appears to be of subsequent formation." Doubtless similar defects could be pointed out by others; indeed, our own list is not quite exhausted, but we have no desire to carp at a book on which so much labour has been bestowed, and prefer to welcome it as a valuable addition to British geology, which will be indispensable to all students who live in the neighbourhood of the metropolis. T. G. B.

OUR BOOK SHELF.

Across East African Glaciers: An Account of the First Ascent of Kilimanjaro. By Dr. Hans Meyer. Translated from the German by E. H. S. Calder. (London: George Philip and Son, 1891.)

LONG before he thought of exploring any part of Africa, Dr. Meyer was an experienced and enthusiastic traveller. The idea of undertaking explorations in "the Dark Continent" was suggested to him by the fact that while the German colonial possessions in the west of Africa had been thoroughly investigated under Government supervision, and at the Government expense, those in the East had been left to the more limited resources of commercial companies. It occurred to Dr. Meyer that he might do good service to his countrymen by devoting himself to the task which the German Government seemed so unwilling to undertake. Accordingly, in 1886, he began to make preparations for the accomplishment of his plan and since that time he has organized no fewer than three important expeditions, in the third of which he succeeded in reaching the top of Kilimanjaro. It is this third expedition of which an account is given in the present work. The broad results of the journey were soon made known; but of course it is only from the explorer's full narrative that an adequate idea can be formed of the interest and importance of his achievements. The mountain mass of Kilimanjaro towers up to a height of nearly 20,000 feet, and Dr. Meyer describes well the feelings with which he saw it after his arduous march across the steppes. "It was a picture," he says, "full of contrasts—here the swelling heat of the equator, the naked negro, and the palm-trees of Taveta—yonder, arctic snow and ice, and an atmosphere of god-like repose, where once was the angry turmoil of a fiery volcano." The story of the ascent is told most vividly, and there are few readers who will not sympathize with the delight with which he speaks of the moment when he set foot on the culminating peak. Although the record of his experiences at Kilimanjaro forms the centre of the book, he has much to say about what he saw both on his way to the mountain and on his way back; and in appendices various writers present classifications of his collections, and the conclusions at which they have arrived in working out his astronomical and meteorological data. The book is admirably translated, and its value is greatly increased by illustrations and maps.

Chemistry in Space. From Prof. T. H. van 't Hoff's "Dix Années dans l'Histoire d'une Théorie." Translated and Edited by J. E. Marsh, B.A. (Oxford: Clarendon Press, 1891.)

WE have already reviewed the monograph of which this is a translation (NATURE, vol. xxxvii. p. 121), and need not therefore, at present, say anything of the subject with which it deals. The translator has done his work carefully, and "the invaluable assistance and advice" of the author have enabled him to make his rendering "a considerable extension of the French edition." Mr. Marsh advises those to whom the question is new to leave the first chapter till the end, as it contains a translation of the earliest memoirs on the subject, and the ideas are incompletely developed, obscure, and sometimes erroneous.

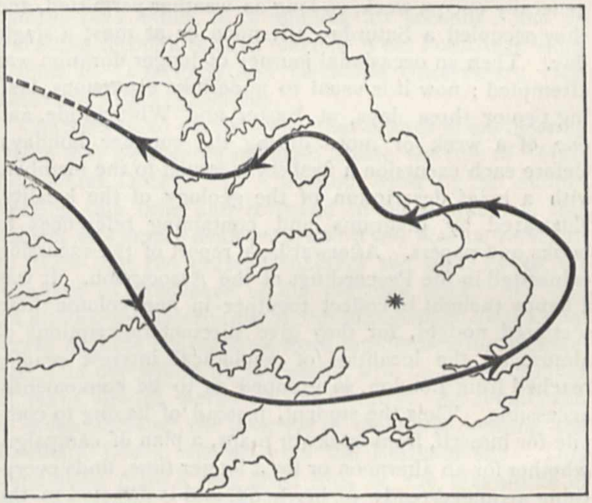
LETTERS TO THE EDITOR.

[*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.*]

Erratic Track of a Barometric Depression.

THE singular course of the cyclonic system which has, during the week terminating on May 29, circulated round and across the British Isles, deserves more attention than can be thus early given to it. I wish here, with your permission, first, to describe the path of its centre as correctly as can be done with the data at present in my hands, mentioning at the same time the principal modifications of the isobars and of the weather in the neighbourhood of the centre; secondly, to mention some remarkable facts in relation to the upper currents as observed by myself in its neighbourhood; and finally, to indicate the nature of those questions an examination of which will, I believe, in the instance before me, prove to be of most scientific value.

(1) The accompanying chart shows the course of the centre of depression, so far as we have yet been able to follow its track, the arrow-heads marking the position at 6 p.m. of each day. At 8 a.m. of the 23rd, the centre appears to have lain about 60 miles to the west of Erris Head, with a barometrical pressure of a little below 29·4. By 6 p.m. it had advanced south-eastwards into Connaught with a velocity of 6·5 English miles per hour, and by 8 a.m. of the 24th to a little west of St. Anne's Head. During the above period the depression was elongating itself, the position of its major axis changing from N.W.-S.E. into W.-E. The weather in the meantime was becoming rainy in the English Channel and home counties, while continuing fair in the north. At 6 p.m. of the 24th the eastward elongation of the whole system had become very marked; and at this hour the centre lay over the mouth of the Thames, after a somewhat lengthened thunder-storm over London, Woolwich, &c. The velocity of transit during the twenty-four hours had been 22 miles per hour, and the path of the centre was beginning to curve towards the left. By the morning of the 25th the centre had advanced to N.N.E., and lay about 53° 2′ N. lat., 0° 24′ W. long., with wet and cloudy weather over our eastern and midland districts. By 6 p.m. of that day the centre had begun to move slightly to the westward, having moved during the twenty-four hours with a velocity of 10 miles per hour. By the morning of the 26th the centre was near the mouth of the Humber, rainfall continuing over the north-east and north midland counties; at 6 p.m. of that day the centre lay over north-west Lincoln, having moved only with a velocity of about 3·8 m. per hour. The centre now moved to the neighbourhood of the Solway, with a velocity of about 10 miles per hour, and on the evening of the 27th began to recurve again a little to the left, the system at the same time becoming more circular in form, and the central pressures slightly decreasing. During this day rain and cloud prevailed on the west of the system, while in its rear there were some scattered thunder and hail



showers of the type prevalent in summer in the rear of cyclonic systems travelling to north-east. At 6 p.m. on the following day the central area had passed into Ulster, with a velocity of 5·5 miles per hour. The thunderstorms in the rear were on that day more pronounced. During the following night the centre travelled with increased velocity across Donegal to the Atlantic, and by 6 p.m. of the 29th the exterior isobars of the system had almost left our shores, finer weather setting in over Great Britain generally.

(2) The point marked with an asterisk on the chart marks the position of the writer during the progress of the depression, a position of vantage for the observation of upper currents, the value of which was much diminished by the predominant thickness of low cloud, and by the fact that there was little moonlight. Over the Midlands outlying threads of "cirro-filum" advanced with great velocity from north-north-west at noon of the 23rd, soon after which a great sheet of frozen veil-cloud rapidly overspread the sky, the exterior edge of which soon disappeared over the north-east horizon. A brilliant solar halo was completely eclipsed before 5 p.m. Meanwhile the lower cloud-current backed from south-west to south. At 7.32 p.m. there was a squall of wind from south-east with rain, and a "jump" in the barograph. About noon of the following day, when the centre was about 118 miles to the south-south-west a glimpse of the upper clouds was obtained; they were then moving from south. Further opportunities of observation were obtained in the

evening, which showed that the upper current had changed to south-east. No observations could be made during the two wet days which followed; but early in the morning of the 27th, when the centre was about 100 miles to the north, true cirri were observed moving slowly from north-east. These soon disappeared; but at 6 p.m. of the same day an important change took place, the bands of ice-cloud moving from south-south-west, from which point, or from a little west of it, the belts have continued to travel up to the time of my writing this, the lines being nearly parallel to the isobars, and to the general direction of the surface winds, and precisely resembling in character the stripes seen in most cases travelling from north-north-west when a depression, whose centre has passed a little to the north of the observer, has moved away to north-east.[1]

(3) In an elaborate paper in the Quart. Journ. of the R. Met. Soc. for October 1877, the writer pointed out that in the extreme left-hand segment of an approximately circular cyclone, moving in any direction in the northern temperate latitudes, the movements of the upper currents are by no means analogous to those in the right-hand segment.[2] In the case of cyclones travelling eastwards, the reason of this difference is, I think, now well understood. Owing to the great relative density of the lower atmosphere, attended with low barometric pressure, near the poles, the gradients for westerly currents are far more constant in the upper than in the lower strata of the atmosphere in the regions traversed by extra-tropical cyclones. Over a large number of these cyclones, therefore, many of the isobars in the upper regions of the atmosphere do not form closed curves, but curves somewhat resembling those which, at the earth's surface, accompanying what are popularly termed V-shaped depressions. It is a question of the utmost interest whether, during the periods in which depressions travel to the west, the distribution of gradients in the upper atmosphere is really for the time reversed, and, if so, what can be the causes of so remarkable a change. There is a further question correlated with the above, which deserves more attention than has been given to it. The writer long ago pointed out (Journ. Scot. Met. Soc., vol. iv. pp. 333–335) that in cases of depressions travelling westward across our islands, temperatures at the earth's surface are in general higher over Scandinavia than over France; and a considerable number of instances have occurred since 1875 which have confirmed this conclusion. But in most of these cases an anticyclone has lain to the north-east of us, so that the "gradient force" of the lower strata may have tended to send the depression westwards, in addition to the ascensional force, associated with condensation in the western segment, due to the indraught of relatively warm air from north and north-east. In the instance described in this paper pressure was not particularly high over Scandinavia, during the westward progress of the system, but temperature seems to have been higher, over Sweden at least, than in France. W. CLEMENT LEY.

May 30.

The Crowing of the Jungle Cock.

IN NATURE (vol. xliii. p. 295) Mr. Henry O. Forbes has a letter commenting on a statement of Mr. Bartlett to the effect that the wild jungle cock does not crow, and testifying that he once heard one. In reply, in the next number of NATURE, it was suggested that the cock heard by Mr. Forbes was a hybrid.

I think that no one who has travelled in the jungles of Burma, during the dry season, can have any doubt that the jungle cock crows; for he cannot fail to have heard them many times.

It so happens that, just after reading Mr. Forbes's letter, I had occasion to travel among the hills which form the watershed between the Irrawaddy and the Sittong rivers. In one region here a large kind of bamboo was seeding, so that the jungle fowl were very numerous, and I heard them crowing in great numbers. I remember one place in particular: the Karens had prepared us a hut in which to sleep just outside of their village, which consisted, like nearly all the villages in these hills, of a single house, each family having its separate room in the common building. "At cock crowing" in the morning we had, close to us, the crowing of the village cocks, and on every side, far and near, the answering crows of multitudes of wild birds. I do not remember ever to have been treated to such a chanticleer concert before.

The idea that these wild cocks were all hybrids is inadmissible, because (1) they were so very numerous, and (2) the country is very sparsely peopled, the villages all being small and far apart, and the greater part of the country still covered with primæval forest.

The crow of the jungle cock is shrill, like that of the smallest breeds of domestic fowl, and is, perhaps, a little less prolonged than that of the average domestic cock; but it can hardly be distinguished from the crow of a small breed of fowl kept by the Karens, some individuals of which so closely resemble the wild fowl that they are used as decoys.

I have several times heard wild fowl cackle, and in this journey, while in the midst of a heavy forest, miles from any human habitation, we came upon a flock of wild fowl cackling, and could tell by the tones that both cocks and hens were cackling. One of the followers being sent with a gun to try and get a shot, some of the birds saw him and flew, whereupon one of the cocks gave the peculiar call which the domestic cock gives when a bird flies over him.

I might add that, among the numerous birds shot in this region, there was one hen which had a pair of spurs about half an inch long. B. P. CROSS.

Rangoon, May 20.

Cordylophora lacustris.

IT is generally believed that this tube-dwelling Hydrozoa was originally a salt-water animal, and although now found a considerable distance from tidal water, it still dwells in rivers and canals more or less connected with tidal rivers. I have for many years found it in the Chester and Ellesmere Port Canal, growing principally on the shells of the fresh-water mussel, from two to three miles from the tidal river (the Dee). It seems to be a shade-loving animal, as I have always found it under the bridges, and from 4 to 6 feet beneath the surface of the water.

The tubes *only* remain during the winter and early spring, and the animal is fully developed in August and September. It is generally accompanied by *Fredericella sultana*.

THOMAS SHEPHEARD.

Kingsley Lodge, Chester, June 12.

Philosophical Instrument Makers.

I FIND in your paper of June 11 (p. 135) that Messrs. Newton and Co. have been appointed philosophical instrument makers to the Royal Institution of Great Britain. Allow me to state that they are not the only ones, and that I also was appointed on June 1 by the managers of the Royal Institution of Great Britain to be their philosophical instrument maker. I thought that in the interest of the public you should know this fact.

A. HILGER.

204 Stanhope Street, Hampstead Road, June 12.

The Earthquake of June 7.

THE earthquake of June 7, whose centre seems to have been in the province of Verona, was also perceptible at Basle. The seismometer of the Bernoullianum Observatory registered a horizontal shock at 1h. 47m. 29s. a. Basle mean time, which corresponds to 1h. 17m. 10s. Greenwich mean time.

At Thal, a village east of St. Gall, the shock was strong enough to be felt by several persons.

Basle, June 13. A. RIGGENBACH-BURCKHARDT.

NOTE ON EGYPTIAN IRRIGATION.

IN entering upon any account of Egyptian irrigation it is necessary, at first, to point out that it consists of two very broad subdivisions: (1) the irrigation effected by the Nile flood when there is rich muddy water in abundance for a land thrice as big as Egypt, and when everyone considers it his absolute right to have his fields

[1] These stripes of cirro-filum are so abundant in the rear of most depressions, towards the termination of the inversion disturbances accompanying squalls or thunder-showers, in Europe and the Northern States that it is singularly unfortunate that the statement of an English meteorologist, to the effect that they do not exist, should have found its way into the first edition of Ferrel's "Popular Treatise on the Winds."

[2] See also Ferrel, "Pop. Treat.," § 180; "Modern Meteorology," p. 111 (diagram).

flooded without the expense or trouble of raising the water artificially; and (2) the irrigation effected by the Nile at its lowest, in those hot months of May and June when the water surface is 20 feet below that of the field, and when it is only by the strictest economy that we can water an area not exceeding one-fourth of the whole of Egypt.

2. *The Irrigation of Old Egypt.*—The first irrigation is the ancient art of Egypt, the culture that, from the days of the Pharaohs, made this little valley the granary of Europe. The products are wheat, barley, beans, maize, and rice. These two last crops require special irrigation. For the growth of wheat, barley, and beans, it is enough to saturate the fields, during high flood, from August to October. The seed is scattered as the waters retreat, and the fields receive neither irrigation nor rain from that time till the harvest is gathered in at the end of April.

3. *Perennial Irrigation.*—The introduction of the second system is due to the sagacity of Mohamed Ali, who saw that the conditions of soil and climate were such as to favour the growth of cotton and sugar-cane, sub-tropical products greatly exceeding the value of cereals. But these crops require irrigation during the months when the Nile is at its lowest, hence a system of deep canals was necessary, and it was in trying to carry out this system in Lower Egypt that the Egyptians got into hopeless difficulties, for the canals got blocked with silt, and it was most difficult to clear them.

4. *The Barrage unused.*—The obvious remedy was to raise the water in the river, and divert it into the canals by a Barrage or dam at the apex of the Delta. Such a work was constructed, at a cost of about two millions sterling; but soon after its completion it cracked in a very alarming way, and, from 1867 to 1883, remained practically useless. The great network of canals continued to be cleared year after year to a depth of about 20 feet below the soil, and for half of each year the *corvée* was constantly employed on them.

5. *Pumping.*—The Egyptian Government had abandoned all hope of again using the Barrage. They had entered into a contract with a private company to irrigate Behera by a system of pumps, at an annual cost of from £50,000 to £60,000; and they were about to come to similar arrangements for the rest of the Delta, at an initial cost of £700,000, and an annual one of £250,000.

6. *Neglect of Drainage.*—Continuous irrigation like that of Lower Egypt requires to be accompanied by drainage, otherwise the land becomes soured and waterlogged. No attention was being paid to this subject in 1883.

7. *State of Upper Egypt.*—The first system of irrigation alluded to above continued to be practised in Upper Egypt. A few very costly bridges had been built to assist it, but little attention was being bestowed on it, and even in years of average Nile flood we found a loss of annual revenue amounting to about £38,000 taking place.

8. *Addition to Area of Egypt.*—Such was the state of affairs when we took charge of the irrigation in 1884. I am frequently asked whether, since then, there has not been a great addition to the cultivated area of Egypt. My reply is in the negative.

The question of extending cultivation into the desert is partly one of displacement of population, chiefly one of level, for above the point that the Nile flood can be brought to reach we must not look for an extension of cultivation. Some goes on—notably to the west of the province of Behera and in the Fayoum; but it is not on a very large scale.

9. *Reclamation of Marshes.*—An extension much more rapid, and of more importance, is in progress along all the north of the Delta, where land is being yearly reclaimed from marsh and lagoon by our drainage operations.

The cultivated and revenue-paying area of Egypt is about five millions of acres. The lagoons in the north cover an area of about 1,280,000 acres. I expect in a very few years to see at least half of this land reclaimed and cultivated.

10. *The Barrage repaired, and the Effect on Lower Egypt.*—What we have done, are doing, and propose to do, then, in future years is as follows:—

First. The Barrage has been completed, and placed in a condition to fulfil its original purpose. From upstream of it are derived three main trunk canals which irrigate the whole Delta, and three smaller canals which irrigate all the country north-east of Cairo and to the south of Zagazig; one of these takes water to Port Said and Suez. The outlay on the Barrage has been, since 1884, about £460,000.

Of the three trunk canals, that on the west had been neglected, and completely filled in with sand. It has been restored, and the system of pumps alluded to in paragraph 5 will, I hope, never be used again.

The canal supplying the East Delta (termed the Tewfikieh Canal) has been entirely made since 1886, at a cost of £372,000.

Practically, the whole summer supply of the Nile is diverted by the Barrage into these canals, and none flows out useless to the sea. The value of the work is this—that so long as there is water in the Nile it is under our control, and, however low the river may fall, the water will get on to the fields, and the great cotton crop will be secured. In former days, during low Nile, the canals were left high and dry, and what water there was flowed out to the sea, useless.

The Barrage has not much increased the area of cultivation, but it has very largely increased that of land bearing double crops—that is, the area producing cotton. It was in 1884 that, by employing temporary measures, we began to use the Barrage. Since then, the average annual yield of cotton has been 333,893 kantars (15,000 tons) greater than in the five years preceding 1884. This represents a value to the country of £835,000 a year, exclusive of the value of cotton-seeds.

11. *Provision for Navigation.*—Secondly. As the abstraction of water renders impossible the river navigation during four or five months every year, two main canals have been selected, one of them roughly parallel to each of the branches of the Nile, and fitted with locks and rendered navigable. This is not yet quite finished. When it is, it will enable laden boats to pass freely between Cairo and Alexandria on one side, and Cairo and Damietta on the other side, at all seasons of the year. Other locks have been built, and obstructions removed, so that navigation has had an impulse given to it throughout the whole Delta.

12. *Drainage Introduced.*—Thirdly. Year by year have been opened out new miles of drainage arteries, and in Behera, Gharbieh, Dakahlieh, Sharkieh in Lower Egypt, and in the Fayoum, large tracts have been reclaimed from salt-marsh, and now yield good crops. The Budget for the current year contains £140,000 for new drainage-works in Lower Egypt. No part of our work has been more appreciated than this, but, unfortunately, the defective system of revenue statistics makes it impossible to say what lands have been reclaimed. The mileage of drains is not less than 1500.

13. *Measures for Improving Irrigation of Upper Egypt.*—Fourthly. I have said, in paragraph 7, that there has been an annual loss of about £38,000 in average years, due to the Nile flood not attaining all the fields of Upper Egypt. In exceptional years this loss has been much greater. Thus, after the very deficient flood of 1877 it amounted to £1,111,880. After 1888 it was about £300,000. If such was the loss of revenue alone, it may be imagined what a heavy calamity was inflicted on the

cultivators. Colonel Ross, Inspector-General of Irrigation, has studied this subject most closely. Even in these deficient years there was water enough in the river if it could only be got on to the land. He has proved that, by a judicious system of canals, sluices, siphons, escapes, weirs, &c., it may be arranged that, even in the worst years, the whole Nile valley shall receive its share of mud-charged water. This involves the construction of no great work like the Barrage (the most expensive does not exceed £45,000), but of a great number of works costing from £5000 to £15,000 each, requiring very careful designing, and built often in remote spots, where construction of any kind is difficult.

These works have been going on now for more than a year. When finished, as I hope they will be in 1893, the whole outlay will be about £600,000. And then, I trust, the lands of Upper Egypt will yield their full crop, however defective may be the Nile flood.

14. *Agricultural Roads.*—Fifthly. A minor subject, and yet one of great value to the country, deserves notice here—namely, the introduction of agricultural roads, This reform is due to Riaz Pasha. Until two years ago. it would have been impossible to take a cart-load of agricultural produce from any one centre of population to another in the Delta. Comparatively few of the canals were adapted for boats, and the one means of transporting cotton to the railway stations or to the river was by camels, which, however well adapted for carrying burdens on the firm sand of the desert, are not suitable for the rich alluvial soil and the sloppy fields of the Nile valley. This is all being changed. The people have willingly accepted a tax never exceeding P.E. 4 or 5 per feddan for one year only, and, with the fund thus raised, a whole network of serviceable roads is being formed sufficiently adapted for this dry climate.

15. *Corvée Abolition.*—The above paragraphs describe generally the improvements that have been brought about in the last seven years. Second to none is the boon that has been conferred on Egypt in the abolition of the *corvée*. Previous to 1885, the whole of the earth-work in the clearance and repairs of canals and embankments was effected by the forced, unpaid, unfed labour of the peasantry. In 1884 this labour amounted to 85,000 men working for 160 days. We were told that this was quite a necessary state of things, that it would be impossible to maintain the irrigation-works otherwise, and that the Egyptian peasant, unlike that of any other country, would not work for wages, and must be forced. We estimated that to redeem this *corvée* and to pay for all this labour would cost £400,000. Nubar Pasha, in the face of the greatest financial difficulty and opposition, managed to give an annual grant of £250,000 for this object. Riaz Pasha, at the end of 1889, found means of granting the remaining £150,000, and in 1890, for the first time perhaps in all history, there was no *corvée* in Egypt.

16. *Canal Legislation.*—When we began work here, we were much hampered by the want of any canal legislation, there being no law corresponding to what is found in India, Italy, and elsewhere, treating of the many conflicting questions connected with irrigation. After three years' discussion, a very useful Canal Act now exists, and the only misfortune is that it is not binding on residents of foreign nationality.

17. *Storage of Nile Water.*—Lastly, as regards our programme for the future, there is abundance to do in carrying out, year by year, solid unpretending reforms; but, besides these, a very large question is coming to the front. The restoration of the Barrage placed at our disposal all the water of low Nile, but the increase in the area irrigated outruns the increase in the water available, and we have to look for means of storing the surplus volume of the flood, and utilizing it when the river is low.

There are two ways in which this may probably be done. The first, which is connected with the name of an ingenious American gentleman, Mr. Cope Whitehouse, is to divert a portion of the flood into a great natural depression existing west of the Nile valley, and there to form a storage reservoir, to be drawn upon as the water in the river decreases. This has been examined and found feasible, but the expense, probably $1\frac{1}{2}$ millions sterling, is against it. The alternative project is to pond up water in the valley of the river itself above Assouan. This project is being studied at present. There can be hardly any further extension of the cotton cultivation if one or the other of these schemes is not executed. There is room enough in the country to employ both.

COLIN SCOTT MONCRIEFF,
Under-Secretary of State, Public Works Department.

Cairo, March 5, 1891.

THE SECOND ORNITHOLOGICAL CONGRESS.

A FULL report of the proceedings of this important Congress can only be obtained when the official *Comptes rendus* are published, for the officers of one section were unable to attend the meetings of the other sections owing to the fact that all four sections sat at one and the same time. This is the only complaint we have to make concerning the recent proceedings, but as it affects the future of these useful reunions, we feel compelled to make our protest, because, by the simultaneous session of all the sections of a Congress, no man, however interested in the subjects under discussion, can hear all that he wishes to hear; the visitor has to choose between two meetings, both of which probably possess for him an equal interest. It must be obvious to everyone who had the privilege of attending the second Ornithological Congress that a great gathering of specialists such as that which took place last month must require more time than three days to discuss such varied problems as were placed before them at the recent meeting.

The city of Budapest was happily chosen as the meeting-place of the Congress, and it may well be questioned whether there is any country in the world that could have offered so many attractions to the ornithologist as Hungary. The hospitality of the Hungarians is proverbial, the accommodation in the beautiful capital is unlimited, and access thereto is easy. After an enjoyable trip down the Danube from Vienna, the travellers found themselves at the opening *conversazione* of the Congress, which was celebrated in the Grand Hotel "Hungaria." Here the Hungarian Committee had assembled with all the members of the Congress to welcome the guests, and the inaugural banquet served as a pleasant medium for the introduction of the strangers. On May 17 the first general meeting of the Congress took place in the sumptuous theatre of the Hungarian National Museum. After some words of welcome from the Burgomaster of Budapest, the officers for the Congress were chosen as follows:—Honorary Presidents: Count Bethlen, Minister of Agriculture; Count A. Csáky, Minister of Public Instruction; Mr. B. Kállay, Minister of Finance. Presidents: Prof. Victor Fatio (Geneva) and Mr. Otto Herman, M.P. Vice-Presidents: Dr. Rudolph Blasius (Brunswick), Prof. S. Brusina (Agram), Prof. R. Collett (Christiania), Mr. J. de Csató (Budapest), Dr. Otto Finsch (Bremen), Major Alex. von Homeyer (Greifswald), Dr. A. B. Meyer (Dresden), Dr. E. von Middendorf (Livonia), Dr. Emil Oustalet (Paris), Dr. Bowdler Sharpe (British Museum), Mr. E. von Szalay (Budapest), Victor Ritter Tschusi von Schmidhoffen (Hallein). General Secretary: Dr. G. von Horváth. Secretaries: Mr. E. Chernel von Chernelháza, Dr. A. Lendl, Dr. L. Lorenz von Liburnau, Dr. A. Lovassy, Dr. J. von Madarász, Mr. O. Reiser, Prof. G. Szikla. Hon. Secretaries: Mr. E. de Gaál, Mr. B. de Lipthay, Mr. J. d'Ottlik. Quæstor: Mr. J. von

Xántus. After preliminary reports, Major Alex. von Homeyer gave his reminiscences of travel in West Africa some years ago, and his imitations of the notes of African birds were strikingly rendered. Four different sections of the Congress were appointed, the names of the different delegates from foreign countries were read out, as well as letters of apology for their absence from several naturalists, Prof. Fürbringer, Baron de Selys Longchamps, and others.

The officers of the different sections were constituted as follows:—(1) Systematic Section: Presidents, Dr. Bowdler Sharpe (London) and Prof. Claus (Vienna); Vice-Presidents, Dr. A. Reichenow (Berlin) and Mr. C. G. Danford (Siebenburgen). (2) Biology and Oology: President, Dr. Rudolph Blasius. (3) Avigeographia: President, Dr. Palacky (Prag). (4) Economic Ornithology: President, Major Alex. von Homeyer.

On the afternoon of May 17 many of the members of the Congress ascended the Blocksberg, to enjoy a view of the city of Budapest and the Danube flowing below—a view not to be surpassed in beauty and interest in any country.

On Monday, May 18, the Systematic Section met in the lecture-theatre of the Polytechnicum, which was placed at the disposal of the Congress by Prof. Szabo, whose work is well known and appreciated in Great Britain. Papers were read by Prof. Klug, on some points in the anatomy of the stomach in birds, and by Dr. Bowdler Sharpe on the classification of birds, the latter lecture being illustrated by several large diagrams and a wax model of the phylogenetic tree, in which Prof. Fürbringer traces the evolution of birds from a reptilian stock. The remainder of the work of the Systematic Section consisted in the passing of the rules of nomenclature, as put forward by a committee consisting of Prof. Möbius, Dr. A. Reichenow, Count von Berlepoch, Dr. A. B. Meyer, and Dr. W. Blasius. The recommendations of this committee were adopted almost in their entirety by the meeting, after a two-days' discussion, notwithstanding some protests of Dr. Sharpe, and Mr. Büttikofer of the Royal Museum of Leyden, who found themselves in a hopeless minority. The chief points carried were: the adoption of the 10th instead of the 12th edition of the "Systema Naturæ" of Linnæus, the recognition of trinomial names in certain cases, and the adoption of names, even faulty in construction or misspelt, with all the consequences. The tone of the report, however, is so moderate, and exhibits so much consideration for the methods of other ornithologists, that it ought to be possible now to arrive at a definite conclusion for European usage at least; and then it would be easy to assimilate the American and European methods of nomenclature.

In the afternoon of the 18th, the Congress met in the Museum, and Dr. Otto Herman, M.P., gave an account of the distribution of birds in Hungary, and explained the collections which had been made specially for the Congress. These consisted of beautifully mounted cases of Hungarian birds with nests and natural surroundings: some very rare species were included in the collection, which was the work of four ornithologists—Dr. O. Herman, M.P., Dr. Julius von Madarász, Mr. Chernel, and Prof. Szikla. These gentlemen had each occupied a station in different parts of Hungary, and had not only collected the series of birds exhibited, but had also made exact observations on migration and distribution. The Hungarian National Museum is a very fine building, and contains a collection which fairly surprised most of the visitors, the series of native birds being especially complete. Large groups of Laemmergeiers, Sea Eagles, Ospreys, &c., with their nests, eggs, and young birds, are to be seen in the Bird-galleries, and these are principally the work of a well-known Hungarian ornithologist, Dr. J. von Madarász. The collection of Mammalia also comprises some great rarities, and the whole Museum teems with specimens procured by the veteran explorer, Mr. J. von Xántus, whose labours in Lower California and Central America, as well as in Borneo and the Sunda Islands, are also widely known. The Museum likewise contains a fine series of insects, especially Coleoptera, which were shown with much natural pride by Dr. Frivaldszky, who is responsible for the beautiful arrangement of the latter groups. The afternoon closed with an adjournment to the Hungarian Academy of Sciences, where Prof. Robert Collett read a paper on Arctic Bird-life before a crowded audience; and the evening concluded with a banquet at the "Archiduc Stephan" Hotel.

On Tuesday the debate on nomenclature was continued; and in the afternoon the Congress assembled on St. Margaret's Island, which forms a most delightful summer retreat for the inhabitants of Budapest, with its dozens of nightingales, its ruined cloisters, and its sulphur springs.

On Wednesday, the 20th, the general meeting of the Congress was held to receive the reports of the different sections and committees, and the business was concluded. A farewell banquet took place in the evening, and the second Ornithological Congress came to an end.

Next day the members were scattered in different directions—some to their homes, some to join one of the pre-arranged excursions. These were three in number—one to the Hanság marshes and Fertö, a second to the Platten-See, and a third to the districts of the Drave. Of the first excursion, in which the writer took part, he can only say that, under the direction of Dr. von Madarász, the members of the Congress who accompanied it underwent a never-to-be-forgotten experience. The species of birds observed were mostly those unknown to an English naturalist, and the hospitality dispensed by Prince Esterhazy, Baron von Berg, and Count Széchenyi, is not likely to disappear from the memory of those who had the good fortune to partake of it.

THE IMPERIAL PHYSICAL AND TECHNICAL INSTITUTION AT BERLIN.

THE Imperial Physical and Technical Institution which was founded in 1887 at Charlottenburg, near Berlin, under the auspices of the German Government, has now been for some time in active operation, and recently there has been issued by the executive Director, Dr. L. Loewenherz, a Report on the work of the Institution up to the end of last year.

It may be remembered that the Institution has two main objects in view: first, that of physical and technical research appropriate to the practical development of manufacture—researches for instance as to the qualities of metals and materials and as to methods of construction and measurement; the second object being that of fundamental research in theoretical problems in physics, and the testing of all kinds of measuring apparatus applicable for use in science, art, and manufacture. It appears to undertake, therefore, investigations and verifications similar to those undertaken in this country by the Board of Trade, or at the Kew Observatory; and, in France, by the Bureau International des Poids et Mesures. Its staff includes (exclusive of the clerical staff) a President, nominated by the Reichstag; a Director, with a Committee of seven members; seven scientific officers in the department of research; four technical assistants, and several mechanics and machinists.

From time to time, as new methods of testing are adopted, or as fresh work is undertaken, explanatory papers are issued by the responsible officers of the Institution (printed by Julius Springer, Berlin); and the following papers have, amongst others, been already issued:—Karl Scheel, H. F. Wiebe, and Allr. Böttcher, on meteorological measurements; Dr. K. Feussner and Dr. St. Lindeck, on electrical measurements; Dr. O. Lummer and Dr. E. Brodhun, on optical measurements, including photometry; Dr. F. Foerster and Dr. F. Milius, on chemical analysis of glass.

We gather from the Director's Report above referred to, that the Institution has provided itself with fundamental standards of length and mass; with primary thermometers and barometers; with electrical standards of resistance, current, and pressure; and with apparatus for testing the flashing point of petroleum and inflammable liquids. Its metrological work for the public has included the proving of clinical thermometers, pyrometers, aneroid barometers, manometers, alcohol thermometers for low temperature, and thermometers for chemical research.

In October 1888, the official testing of thermometers was transferred from the Normal Aichungs Commission at Berlin to the Imperial Institution, and all thermometers are still tested on the basis of the regulations laid down by the Commission on November 10, 1885; excepting that, in place of basing the errors of scientific thermometers on a mercurial thermometer, thermometer readings are now reduced to the more accurate scale of the air-thermometer or hydrogen-thermometer.

The use of thermometers for determining pressures, or altitudes, &c., on the occasion of journeys of exploration, &c., seems of late to have increased, for many such have been already presented for examination at the Institution. If the thermometers are made of Jena glass (or of other hard thermometer glass), it would appear to be possible to ascertain pressures with but little trouble to $\pm$ 0·25 millimetre. The necessity for using proper glass is shown in an experiment carried out at the Institution with two thermometers, Nos. 42 and 43, made of ordinary Thuringian and crystal glass. On September 7, 1888, the corrections of these thermometers at 87° C. were found to be—

No. 42, $-$ 0°·05; No. 43, $-$ 0°·24 C.

The thermometers were then heated for 15 minutes to a temperature of 100° C.; they were then allowed to cool, and subsequently retested on September 10, when their errors were found to be—

No. 42, $+$ 0°·08; No. 43, $-$ 0°·09 C.

Such variation in the reading of a thermometer after its exposure to a high temperature would unfit it for use in the exact determination of pressures or altitudes.

With reference to the testing of various sorts of glass Dr. F. Milius points out that Weber's process, generally made use of, and which consists in exposing the body to be examined to an atmosphere of muriatic acid vapour for a space of twenty-four hours, is not always trustworthy. Thus, according to the quality of the glass, it appears to be covered more or less, after exposure to the acid vapour, by a thick rime (or hoar frost); and that although the experienced observer finds Weber's method tolerably certain, yet the less experienced observer may sometimes be left in doubt, particularly where rough surfaces are treated, as to whether the rime exists or not; Dr. Milius therefore proposes an optical form of test other than that of the muriatic acid test, as is explained at length in his paper.

Dr. Milius, in conjunction with Dr. F. Foerster, has also investigated the solubility, in water, of potash and soda glass, particularly with reference to Schott's experiments as to the capacity of potash water-glass for absorbing water without losing its vitreous quality. This latter fact can be ascertained by keeping pulverized water-glass under water, when, as in the case of hydraulic cement, a hardening of the paste begins to take place. This process is connected with a development of heat; in the case of water-glass in which there was one atom of potash to three of silicic acid it was observed at the Institution that within a quarter of an hour the moistened matter had been heated 10° Centigrade, and it became hard in one day; if the proportion of silicic acid is larger, the glass requires from two to three days for solidification. Their researches appear to show that for purposes connected with mercurial electrical standards, the glass used should be very little soluble in water and acids; hard glass, for instance, which had a base of soda, and not potash, being little hygrometric.

In the important field of electrical measurements, the Institution appears also to be doing good work. It is preparing to undertake the verification of all kinds of apparatus; including voltmeters, ammeters, meters for the measurement of power and efficiency, galvanometers, and resistance coils.

In the field of practical photometry we have to compare the intensities of different sources of light as experienced by the eye; but unfortunately we have not, even for commercial purposes, any satisfactory method by which intercomparisons may be made between the relative intensities of coal-gas, electric and oil lights respectively. In practical photometry much is being done in this country by Abney, Vernon-Harcourt, Chaney, and others, as well as by Lummer, Brodhun, and others in Germany, but as yet no standard photometer has been produced. The standard light is still also the ancient "sperm-candle," and the method of comparison is still the old-fashioned "grease-spot" Bunsen photometer more or less modified. The German authorities appear to be fully alive to the necessity of improvement in this field of technical research; and have investigated M. Violle's incandescent platinum-standard of light, and also the Hefner lamp and Aubert's apparatus; and for electrical light purposes they have followed a form of standard glow lamp.

Among the papers above referred to, we notice also one by Dr. Loewenherz, on the testing of tuning-forks. The Institution undertakes the testing of tuning-forks, on payment of a small fee, the object of the examination being to ascertain the correctness of the height of the tone of the fork in terms of an international diapason; or the number of the vibrations of the fork per second, at the temperature of 15° Centigrade, the pitch of the note A being fixed at 435 entire vibrations per second, or 870 half or single vibrations according to the French method of counting. Tuning-forks sent to the Institution for examination are required to be constructed in accordance with conditions laid down by the Institution. Unity of pitch is of fundamental importance in music and in the construction of musical instruments, and it is to be desired that some authoritative testing of tuning-forks might be similarly undertaken in this country.

In metallurgy the work of the chemical laboratories of the Institution does not appear to be extensive; it has included more particularly analyses of the metals platinum, cadmium, and rhodium. In the Physical Laboratory, measuring instruments of precision for workshop use, such as speed and power indicators, screw-thread gauges, have also been examined by the Institution; and its geodetical work has included the verification of instruments of precision for General Schreiber, of the Imperial Prussian Land Survey. The department has undertaken also the verification of polariscopes, lenses, prisms, and other optical instruments, to a limited extent.

The above observations may serve to show that the Institution is alike prepared to verify a standard—as a measurer of electrical resistance—with the utmost accuracy, or to test an instrument for common purposes—as a gas meter. How far the Institution may be self-supporting is not stated in the Director's Report; but as the demands for verification work of this kind are largely voluntary, it would appear to be evident that the excellent staff of the Institution could not be maintained unless it received valuable support from the State.

CRYSTALLIZATION.[1]

THERE is something very fascinating about crystals. It is not merely the intrinsic beauty of their forms, their picturesque grouping, and the play of light upon their faces, but there is a feeling of wonder at the power of Nature, which causes substances, in passing from the fluid to the solid state, to assume regular shapes bounded by plane faces, each substance with its own set of forms, and its faces arranged with characteristic symmetry: some, like alum, in perfect octahedra; others, like blue vitriol, in shapes which are regularly oblique. It is this power of Nature which is the subject of this discourse. I hope to show that crystalline forms, with all their regularity and symmetry, are the outcome of the accepted principles of mechanics. I shall invoke no peculiar force, but only such as we are already familiar with in other facts of Nature. I shall call in only the same force that produces the rise of a liquid in a capillary tube and the surface-tension at the boundary of two substances which do not mix. Whether this force be different from gravity I need not stop to inquire, for any attractive force which for small masses, such as we suppose the molecules of matter to be, is only sensible at insensible distances is sufficient for my purpose.

We know that the external forms of crystals are intimately connected with their internal structure. This is betrayed by the cleavages with which in mica and selenite everybody is familiar, and which extend to the minutest parts, as is seen in the tiny rhombs which form the dust of crushed calcite. It is better marked by the optical properties, single and double refraction, and the effects of crystals on polarized light. These familiar facts lead up to the thought that it is really the internal structure which determines the external form. As a starting-point for considering that structure, I assume that crystalline matter is made up of molecules, and that, whereas in the fluid state the molecules move about amongst themselves, in the solid state they have little freedom. They are always within the range of each other's influence, and do not change their relative places. Nevertheless, these molecules are in constant and very rapid motion. Not only will they communicate heat to colder bodies in contact with them, but they are always radiating, which means producing waves in the ether at the rate of many billions in a second. We are sure that they have a great deal of energy, and, if they cannot move far, they must have very rapid vibratory motions. It is reasonable to suppose that the parts of each molecule swing, backwards and forwards, through, or about, the centre of mass of the molecule. The average distances to which the parts swing will determine the average dimensions of the molecule, the average space it occupies.

Dalton fancied he had proved that the atoms of the chemical elements must be spherical, because there was no assignable cause why they should be longer in one dimension than another. I rather invert his argument. I see no reason why the excursions of the parts of a molecule from the centre of mass should be equal in all directions, and therefore assume, as the most general case, that these excursions are unequal in different directions. And, since the movements must be symmetrical with reference to the centre of mass of the molecule, they will in general be included within an ellipsoid, of which the centre is the centre of mass.

Here I may, perhaps, guard against a misconception. We chemists are familiar with the notion of complex molecules; and most of us figure to ourselves a molecule of common salt as consisting of an atom of sodium and one of chlorine held together by some sort of force, and it may be imagined that these atoms are the parts of the molecules which I have in mind. That, however, is not my notion. I am paradoxical enough to disbelieve altogether in the existence of either sodium or chlorine in common salt. Were my audience a less philosophical one I could imagine I heard the retort from many a lip: "Why, you can get sodium and chlorine out of it, and you can make it out of sodium and chlorine!" But no, you cannot get either sodium or chlorine out of common salt without first adding something which seems to me of the essence of the matter. You can get neither sodium nor chlorine from it without adding energy; nor can you make it out of these elements without subtracting energy. My point is that energy is of the essence of the molecule. Each kind of molecule has its own motion; and in this I think most physicists will agree with me. Chemists will agree with me in thinking that all the molecules of the same element, or compound, are alike in mass, and in the space they occupy at a given temperature and pressure. The only remaining assumption I make is that the form of the ellipsoid—the relative lengths of its axes—is *on the average* the same for all the molecules of the same substance. This implies that the distances of the excursions of the parts of the molecule depend on its constitution, and are, on the average, the same in similarly constituted molecules under similar circumstances.

I have come to the end of my postulates. I hope they are such as you will readily concede. I want you to conceive of each molecule as having its parts in extremely rapid vibration, so that it occupies a larger space than it would occupy if its parts were at rest; and that the excursions of the parts about the centre of mass are on the average, at a given temperature and pressure, comprised within a certain ellipsoid; that the dimensions of this ellipsoid are the same for all molecules of the same chemical constitution, but different for molecules of different kinds.

We have now to consider how these molecules will pack themselves on passing from the fluid state, in which they can and do move about amongst themselves, into the solid state, in which they have no sensible freedom. If they attract one another, according to any law, and for my purpose gravity will suffice, then the laws of energy require that for stable equilibrium the potential energy of the system shall be a minimum. This is the same, in the case we are considering, as saying that the molecules shall be packed in such a way that the distances between their centres of mass shall on the whole be the least possible; or, that as many of them as possible shall be packed into unit space. In order to see how this packing will take place, it will be easiest to consider first the particular case in which the axes of the ellipsoids are all equal—that is, when the ellipsoids happen to be spheres. The problem is then reduced to finding how to pack the greatest number of equal spherical balls into a given space. It is easy to reduce this to the problem of finding how the spheres can be arranged so that each one shall be touched by as many others as possible. In this way the cornered spaces between the balls, the unoccupied room, is reduced to a minimum. You can stack balls so that each is touched by twelve others, but not by more. At first sight it seems as if this might be done in two ways.

In the first place we may start with a square of balls, as in Fig. 1, where each is touched by four others. We may then place another (shaded in the figure) so as to rest on four, and place four more in adjacent holes to touch it, as indicated by the dotted circles. Above these four more may be placed in the openings *a b c d*, so as to touch it—making twelve in all. If the pile be completed, we shall get a four-sided pyramid, of which each side is an equilateral triangle, as represented in Fig. 2. It will be seen that, in these triangular faces, each ball (except, of course, those forming the edges) is touched by six others.

[1] A Discourse delivered at the Royal Institution of Great Britain on Friday, May 15, 1891, by G. D. Liveing, F.R.S.

Again, if we start with such a triangle, as in Fig. 3, where each ball is touched by six others, we can place one ball —the shaded one—so as to rest on three others, and can then place six more round it and touching it, as indicated by the dotted circles. In three of the triangular holes between the shaded ball and the dotted balls touching it we can place three more, so as to touch the shaded ball—again twelve touching it in all. If we complete

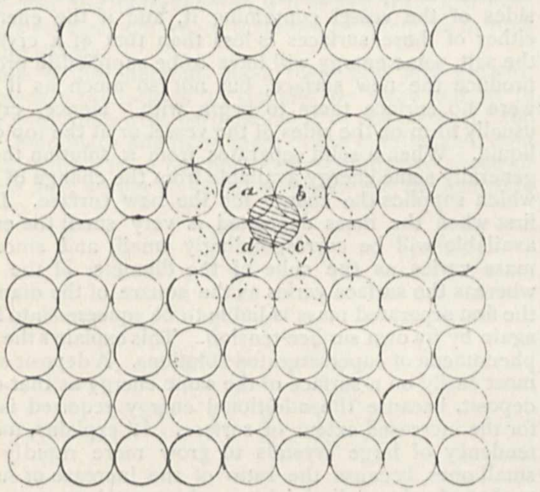


FIG. 1.

the pile, we shall get the triangular pyramid represented by Fig. 4, where each of the three sides is a right-angled triangle, while the base is an equilateral triangle. It will be seen that in the faces of this pyramid each ball (except those outside) is touched by four others. In fact, the arrangement in these faces is the same as in the base of the former pyramid; and the two arrangements are really identical in the interior, only one has to be

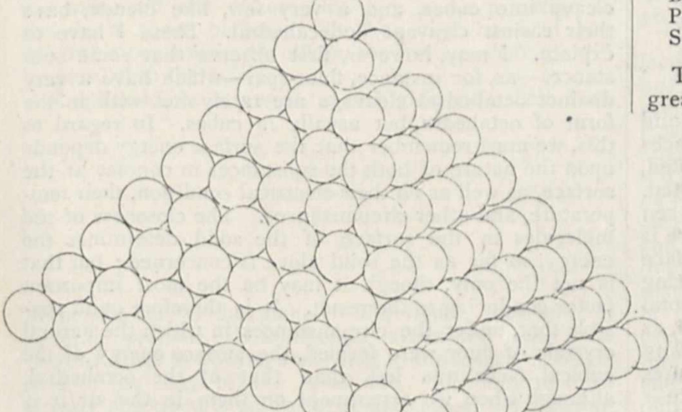


FIG. 2.

turned over in order to bring it into parallelism with the other. Fig. 2 represents half a regular octahedron; Fig. 4 the corner of a cube. Ellipsoids, if they are all equal and similar to one another, can be packed in precisely the same way, so that each is touched by twelve others, provided their axes are kept parallel to each other —that is, if they are all oriented alike. This, then, by the laws of energy, will be the arrangement which the molecules will assume, in consequence of mutual attraction, in passing from a fluid to a solid state.

Next, let us see how the packing of the molecules will affect the external form. And here I bring in the surface-tension. We are familiar with the effects of this force in the case of liquids, and if we adopt the usually received theory of it, we must have a surface-tension at the boundary of a solid, as well as at the surface of a liquid. I know of no actual measures of the surface-tension of solids; but Quincke has given us the surface-tensions of a number of substances at temperatures near their

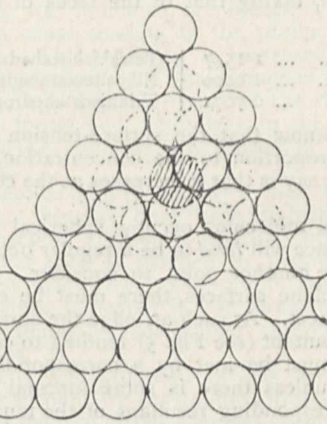


FIG. 3.

points of solidification, in dynes per lineal centimetre, as follows:—

Platinum	1658	Antimony	244
Gold	983	Borax	212
Zinc	860	Sodium carbonate ...	206
Tin	587	Sodium chloride ...	114
Mercury	577	Water	86·2
Lead	448	Selenium	70·4
Silver	419	Sulphur	41·3
Bismuth	382	Phosphorus	41·1
Potassium	364	Wax	33·4
Sodium	253		

The surface-tensions of most of the solids are probably greater than these, for the surface-tension generally

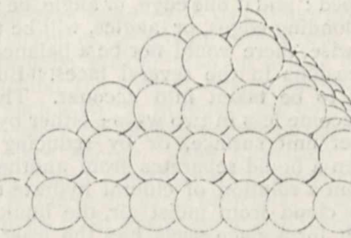


FIG. 4.

diminishes with increase of temperature; and you see that they amount to very considerable forces. We have to do, then, with an agency which we cannot neglect. In all these cases the tension measured is at a surface bounded by air, and is such as tends to contract the surface. We have, then, at the boundary between a crystallizing solid and the fluid, be it gas or liquid, out of which it is solidifying, a certain amount of potential energy; and by the laws of energy the condition of equilibrium is, that this potential energy shall be a minimum. The accepted theory of surface-tension is that it arises from the mutual attraction of the molecules. The energy will therefore be a minimum for a surface in which the molecules are as closely set as possible.

Now, if you draw a surface through a heap of balls packed so that each is touched by twelve others, you will find that the surfaces which have the greatest number of centres of balls per unit area are all plane surfaces. That in which the concentration is greatest is the surface of a regular octahedron, next comes that of a cube, then that of a rhombic dodecahedron, and so on according to the law of indices of crystallographers.

The relative numerical values of these concentrations are as follows, taking that of the faces of the cube as unity:—

Octahedron	1·1547	Tetrakishexahedron	0·4472
Cube	1·0000	Eikositessarahedron	0·4083
Dodecahedron ...	0·7071	Triakisoctahedron ...	0·3333

We do not know that the surface-tension is exactly in the inverse proportion to the concentration, all that we can at present say is that it increases as the concentration diminishes.

If, then, the molecules occupy spherical spaces, the bounding surface will *tend* to be a regular octahedron.

But we have another point to consider. If a solid is bounded by plane surfaces, there must be edges where these planes meet. At such an edge the surface-tensions will have a resultant (see Fig. 5) tending to compress the mass, which must be met by a corresponding opposite pressure, and unless there is some internal strain there must be a corresponding resultant of the tensions on the opposite side of the crystal. Hence, if one face of a form

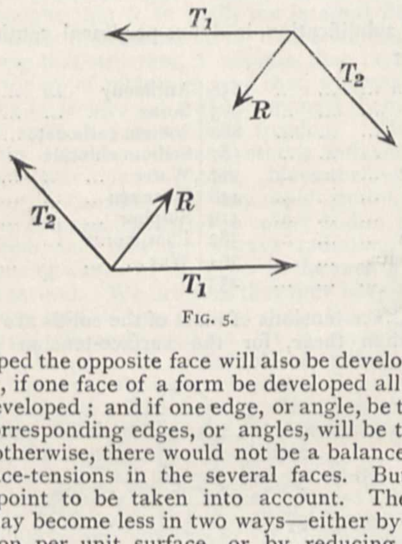


FIG. 5.

is developed the opposite face will also be developed; and generally, if one face of a form be developed all the faces will be developed; and if one edge, or angle, be truncated, all the corresponding edges, or angles, will be truncated. Were it otherwise, there would not be a balance between the surface-tensions in the several faces. But there is another point to be taken into account. The surface energy may become less in two ways—either by reducing the tension per unit surface, or by reducing the total surface. When a liquid separates from another fluid, as chloroform from a solution of chloral hydrate on adding an alkali, or a cloud from moist air, the liquid assumes the form which, for a given mass, has the least surface—that is, the drops are spherical. If you cut off the projecting corners and plane away the projecting edges of a cube or an octahedron, you bring it nearer to a sphere, and if you suppose the volume to remain constant, you still diminish the surface. And if the diminution of the total surface is not compensated by the increased energy on the truncations, there will be a tendency for the crystals to grow with such truncations. The like will be true in more complicated combinations. There will be a tendency for such combinations to form, provided the surface energy of the new faces is not too great as compared with that of the first simple form.

But it does not always happen that an octahedron of alum develops truncated angles. This leads to another point. To produce a surface in a continuous mass requires a supply of energy, and to generate a surface in the interior of any fluid is not easy. Air may be supersaturated with aqueous vapour, or a solution with a salt, and no cloud or crystals be formed, unless there is some discontinuity in the mass, specks of dust, or something of the kind. In like manner, if we have a surface already, as when a supersaturated solution meets the air or the sides of the vessel containing it, and if the energy of either of these surfaces is less than that of a crystal of the salt, some energy will have to be supplied in order to produce the new surface, but not so much as if there were no surface there to begin with. Hence, crystals usually form on the sides of the vessel or at the top of the liquid. When a solid separates from a solution there is generally some energy available from the change of state, which supplies the energy for the new surface. But at first when the mass deposited is very small the energy available will be correspondingly small, and since the mass varies as the cube of the diameter of the solid, whereas the surface varies as the square of the diameter, the first separated mass is liable to be squeezed into liquid again by its own surface-tension. This explains the usual phenomena of supersaturated solutions. A deposit occurs most easily on a surface of the same energy as that of the deposit, because the additional energy required is only for the increased extent of surface. It explains, too, the tendency of large crystals to grow more rapidly than small ones, because the ratio of the increase of surface to that of volume diminishes as the crystal grows.

While speaking of the difficulty of creating a new surface in the interior of a mass, the question of cleavage suggests itself. In dividing a crystal we create two new surfaces—one on each piece, and each with its own energy. The division must therefore take place most readily when that surface energy is a minimum. Hence the principal cleavage of a crystal made up of molecules having their motions comprised within spherical spaces will be octahedral. As a fact, we find that the greater part of substances which crystallize in the octahedral, or regular system, have octahedral cleavage. But not all; there are some, like rock salt and galena, which cleave into cubes, and a very few, like blende, have their easiest cleavage dodecahedral. These I have to explain. I may, however, first observe that some substances—as, for instance, fluor-spar—which have a very distinct octahedral cleavage are rarely met with in the form of octahedra, but usually in cubes. In regard to this, we must remember that the surface energy depends upon the nature of both the substances in contact at the surface, as well as on their electrical condition, their temperature, and other circumstances. The closeness of the molecules in the surface of the solid determines the energy, so far as the solid alone is concerned; but that is not the only, though it may be the most important factor conducing to the result. It is therefore quite possible that, under the circumstances in which the natural crystals of fluor were formed, the surface energy of the cubical faces was less than that of the octahedral, although when we experiment on them in the air it is the other way. This supposition is confirmed by the well-known fact that the form assumed by many salts in crystallizing is affected by the character of the solution. Thus alum, which from a solution in pure water always assumes the octahedral form, takes the cubic form when the solution has been neutralized with potash.

To return to the cubic and dodecahedral cleavages. If we suppose the excursions of the parts of the molecule to be greater in one direction than in the others, the figure within which the molecule is comprised will be a prolate spheroid; if less, an oblate spheroid. Now, as already explained, the spheroids will be packed as closely as possible if the axes are all parallel and each is touched by twelve others. Now suppose the spheroids arranged as in Fig. 6, with their axes perpendicular to the plane of the figure; place the next layer in the black triangular spaces, and complete the pyramid. The three faces of the pyramid will be equal isosceles triangles; and if the spheroids be oblate, and the axis half the greatest diameter, the three angles at the apex of the pyramid will be right angles. The crystal will have cubic symmetry, but the relative condensation in the faces of the cube, octahedron, and dodecahedron, will be as $1 : 0{\cdot}5774 : 0{\cdot}7071$. The easiest cleavage would therefore be cubic, as in rock salt and galena.

Again, if the spheroids have their axes and greatest diameters in the ratio of $1 : \sqrt{2}$, and we place four, as in Fig. 7, with their axes perpendicular to the plane of the figure, then place one upon them in the middle, and then four more upon it, in positions corresponding to those of the first four, we get a cubical arrangement, the centre of

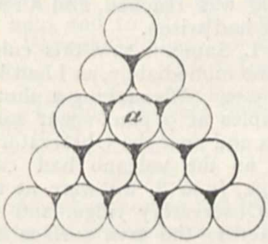


FIG. 6.

a spheroid in each angle of a cube, and one in the centre of the cube. Crystals so formed will have cubic symmetry, but the concentration of molecules will be greatest in the faces of the dodecahedron, and their easiest cleavage will be, like that of blende, dodecahedral.

If spheroids of any other dimensions be arranged, as in Figs. 1 and 2, with their axes perpendicular to the plane of Fig. 1, we shall get a crystal with the symmetry of the pyramidal system. If the spheroids be prolate, the fundamental octahedron will be elongated in the direction of the axis, and if sufficiently elongated, the greatest condensation will be in planes perpendicular to the axis, and the easiest cleavage, as in prussiate of potash, in those planes. On the other hand, if the spheroids be sufficiently oblate, the easiest cleavage will be parallel to the axis.

If spheroids be arranged, as in Fig. 6, with their axes

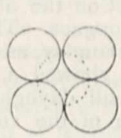


FIG. 7.

perpendicular to the plane of the figure, they will, in general, produce rhombohedral symmetry, with the rhombs acute or obtuse, according to the length or shortness of the axes of the spheroids. The cubical form already described is only a particular case of the rhombohedral. If the ratio between the axes of the spheroids and their greatest diameters be only a little greater, or a little less, than $1 : 2$, the condensation will be greatest in the faces of the rhombohedron, and the easiest cleavage will be rhombohedral, as in calcite. If the spheroids be prolate, the easiest cleavage will be perpendicular to the axis of symmetry, as in beryl and many other crystals. Such crystals have a tendency to assume hexagonal forms—equiangular six-sided prisms and pyramids. To explain this, it may be seen in Fig. 6 that, in placing the next layer upon the spheroids represented in the figure, the three spheroids which touch that marked *a* may occupy either the three adjacent white triangles or the three black ones. Either position is equally probable. The layer occupying the white triangles is in the position of a twin to that occupying the black triangles. So far as the central parts of the layer are concerned, it will make no difference in which of these ways the molecules are packed. It is only at the edges that the surface-tension will be affected. If the form growing be a rhombohedron, a succession of alternating twins will produce a series of alternating ridges and furrows in the rhombohedral faces, which will give rise to increased surface-tension, which will tend to prevent the twinning. On the other hand, an hexagonal form and its twin, formed in the way indicated, are identical, and we have in this fact a cause tending to the production of hexagonal forms. This tendency is increased by the fact that, for a given volume, the total surface of the hexagonal forms is in general less than that of the rhombohedral. Indeed, such forms lend themselves to the formation of almost globular crystals, as is well seen in pyromorphite and mimetite.

If the spheroids be arranged with their axes in other positions than those we have been discussing, or if the molecules occupy ellipsoidal spaces, they will, when packed so that each is touched by twelve others, give figures of less symmetry. The results may be worked out on the lines indicated in the foregoing discussion, and will be found to correspond throughout to the observed facts.

Bravais long ago proposed various arrangements of molecules to account for crystalline forms, and Sohncke has extended them to further degrees of complication in order to account for additional facts in crystallography. But neither of them has given any reason why the molecules should assume such arrangements. To me it seems that only one arrangement can be spontaneously assumed by the molecules, and that the varieties of crystalline form depend on the dimensions of the ellipsoids and the orientation of their axes. Curie also has indicated that the development of combined forms, as those of cube and octahedron, will depend on the surface-tensions in the faces of these forms, but he has not indicated how the surface-tension is connected with the crystalline arrangement, or why the energy of a cubic face should be greater or less than that of an octahedral face.

We are now in a position to understand the interesting facts brought forward by Prof. Judd in a discourse delivered at the Royal Institution early this year. However long a crystal has been out of the solution, or vapour, from which it was formed, its surface-tension will remain unaltered, and when it is replaced it will grow exactly as if it had not been removed. Also, if any part be broken off it, the tension of the broken surface will, if it be not a cleavage face, be greater than on a face of the crystal, and in growing, the laws of energy necessarily cause it to grow in such a way as to reduce the potential energy—that is, to replace the broken surface by the regular planes of less surface energy. The formation of "negative crystals" by fusing a portion in the interior of a crystalline mass, is due to the same principle. Surfaces of least energy will be most easily produced inside as well as outside, and in a crystalline mass of course they will be parallel to the external faces of the crystal. We see the same thing in the action of solvents. Most metals assume a crystalline texture on cooling from fusion, and when slowly acted on by dilute acids the surfaces of greater energy are most easily attacked, in accordance with the laws of energy, and the undissolved metal is left with surfaces of least energy which are the faces of crystals. This is easily seen on treating a piece of tin plate, or of galvanized iron, with very dilute aqua regia. In fact, solution is closely connected with surface energy. It is probably the low surface energy of one form of crystals of sulphur which makes them insoluble in carbon disulphide, and this low surface energy may be an electrical effect.

I pointed out that the development of all the faces of a form, and the similar modification of all corresponding edges and angles of a crystal, is in general necessary in order to produce equilibrium under the surface-tensions. But we sometimes find crystals with only half the modifications required for symmetry. In such cases the surface-tensions must produce a stress in the interior tending to deform the molecules. When the crystal was growing, there must have been equilibrium, and therefore a pressure equal and opposite to this effect of the surface-tension. There are various ways in which we may suppose that such a force would arise. The electric field might give rise to a stress in opposition to the aggregation of the molecules in the closest possible way, and then the crystal would grow such faces as would produce an equal and opposite stress. Inequalities of temperature, or the presence of molecules of other kinds amongst those of the crystal, might produce similar results. When the stress due to electricity, or to temperature, was removed by change of circumstances, that due to the surface-tensions would persist, and the crystal would be left with an internal strain. Crystals of this sort, with unsymmetric faces, generally betray the internal strain, either by developing electricity of opposite kinds at the two ends when heated or cooled, or they affect polarized light, rotating the plane of polarization. That these effects are due to the internal strain is shown by the fact that tourmalines, and other crystals, which are pyro-electric when unsymmetrical, show no such property when symmetrically grown. Also sodium chlorate in solution, quartz when fused, and so on, lose their rotatory power. Substances which in solution show rotatory power, as a rule develop unsymmetric crystals. This is well seen in the tartrates. The constitution of the molecules must be such that they will not, without some strain, form crystals; and equilibrium, when the crystal is growing, is attained by means of the opposing stress due to want of symmetry in the surface-tensions. In all such crystals the rotatory power of the solution disappears in whole or in part. We cannot test this in biaxial crystals, but, according to Des Cloiseaux, sulphate of strychnine is the only substance which shows rotation both in the solution and in the crystalline form, and in it the rotatory power is much increased by the crystallization. Effects comparable with these may be produced by mechanical means. A cube of rock salt, which has no effect on plane-polarized light in its ordinary state, changes the plane of polarization when it is compressed in a vice. And a cleavage slice of prussiate of potash, which is uniaxial, may by compression be distorted so as to give in a convergent beam of polarized light elliptical rings, and two eyes like a biaxial crystal.

THE ERUPTION OF VESUVIUS OF JUNE 7, 1891.

DURING the latter part of 1890 and the early part of the present year, the central activity of Vesuvius has very slightly varied, except about the new year, when it was considerably increased, rising to the third or fourth degree, simultaneous with the stoppage of the lateral outflow of lava that had been going on since August 7, 1890. Since then, up to the present outburst, the central activity has been generally at the first degree, and the cone of eruption has slowly grown in height.

On June 1 there was a crater within the central eruptive cone, of about 50 m. in diameter, near the centre of which was the eruptive vent, surrounded by another embryonic eruptive cone. On that day, four small eruptive mouths opened around the embryonic cone in the bottom of the central crater, the smallest being to the east.

Thus the volcano remained till June 7, at 10 a.m., when activity stopped, only a small quantity of vapour escaping from central vents. At midday a radial cleft opened at the north toe of the cone of eruption (May 1889, June 1891) traversing towards its east end, the little sickle-shaped ridge, the remnant of the 1885–86 crater, but, as yet, gave out little vapour. At 4 to 4.30 p.m., shocks of earthquake commenced, limited only to the upper slopes of Vesuvius, and simultaneous with the extension of the radial fissure down the side of the great Vesuvian cone for nearly half its way opposite the Punta del Nasone of Monte Somma, from which, at about 5.30 p.m., issued a little lava, whilst from the upper extremity of the fissure at the toe of the cone of eruption much vapour escaped, so that from Naples the smoke-plume arose from this point. From 5.30 to 7 p.m. the fissure still extended lower, accompanied from time to time by local earthquakes, noises, and the elevation of columns of black dusty smoke. At a few minutes to 7 the floor of the Atrio del Cavallo was reached, and a remarkably black column of smoke had arisen.

My friend Dr. L. Sambon saw this column arise, and came to inform me immediately, as I had left off watching the mountain at 5.30. After taking a photo of the mountain, we left Naples at 9 p.m., spent some time in inquiries at Resina and near the Observatory. Everything was now dark, as the volcano had calmed down at 8 p.m. At 2 a.m., June 8, we were at the eastern extremity of the Observatory ridge, and commenced to wend our way across the lava surface towards Monte Somma. We were at the lowest part of the depression at the west end of the Atrio del Cavallo, where it joins the Fossa della Vetrana, and along which some of the largest lava-streams have flowed (1855, 1872, &c.), when suddenly on our right above us (2.23 a.m.) a vast quantity of bright red vapour arose from the new outpour of lava. We hastened our steps as much as the road and our lantern would allow us, so as to reach the escarpment of Monte Somma, the foot of which was followed till near the Punta del Nasone, and close to the theatre of eruption. Here we clambered up some distance above the level of the Atrio to watch events whilst we ate our late supper or early breakfast. Along the slope of the great cone in the line of fissure were a few luminous points from some pieces of still uncooled lava of the little that had oozed forth from the lower half of the fissure. At about 60 or 80 yards from the foot of the great cone two or three fountains of lava were throwing up jets of molten rock for 2 or 3 m., and the lava was slowly spreading out on the almost horizontal plain of the Atrio in several tongues. The lava must have still been high in the main chimney, as the vapour that issued at the top of the fissure showed a slightly red illumination. So we remained till daylight, when we could see the fissure on the side of the cone. The mouth that formed at 5.30 the previous day was still smoking a little, whilst the fissure below it sent off several ramifications at an acute angle like the branches of an inverted tree, from several of which little streams of lava had been given out, where they had soon consolidated. We now followed the base of the great cone to the lower railway station, where we found all the people up and dressed, frightened by the strong shock and noises at 2.23 a.m., coincident with the fresh outflow of lava that we had witnessed, but which shocks we had not felt, although they were described as the strongest that had been felt.

Having ascended to the summit of Vesuvius, we found the central crater rapidly enlarging by the falling in of its edges. From the new fissure at its summit was issuing much vapour under pressure, and rich in sulphurous acid, which is, even in traces, intolerable; and the hot air coming from innumerable new fissures rendered approach very difficult. We did, in fact, once jump across part of the fissure, but returned much quicker on account of the hot irritant vapours. An approach from the opposite side was equally unsuccessful. At some old fumaroles on the 1872 crater plain, I collected some crusts of boric acid and alum, both rare products at this volcano.

One of three terminations we may expect to these phenomena, which are very characteristic of a lateral disruption, so common at Vesuvius:—

(1) Should the lava cool sufficiently to plug the radial dyke, no further phenomena will occur, and activity will be restored to the central vent.

(2) If this plugging only partially takes place, lava may dribble forth for months, but probably the escape of vapour will soon be restored to the central vent.

(3) If the rent should widen, considering how low it extends, we may expect a grand eruption which might rival that of 1872, which commenced near the same spot and much in the same way; the mechanism by which this occurs I have explained elsewhere.[1]

My best thanks are due to Mr. L. Sambon for his company and help, and to Mr. E. Treiber, Inspecting Engineer of the Vesuvian Railway, for kind information.

Naples, June 9. H. J. JOHNSTON-LAVIS.

[1] H. J. J. L., "The Relationship of the Structure of Igneous Rocks to the Conditions of their Formation," Scientific Proceedings R. Dublin Soc., vol. v., New Ser., pp. 112-56.

NOTES.

A LARGE and influential meeting was held at Edinburgh on Monday to consider the arrangements which ought to be made for the visit of the British Association to that city next year. The Lord Provost presided. On the motion of Sir William Turner the following were elected Vice-Presidents:—The Lord Provost, the Marquis of Lothian, the Earl of Rosebery, Lord Kingsburgh, Principal Sir William Muir, and Prof. Sir Douglas Maclagan. A local executive committee was chosen, and Mr. A. Gillies Smith was appointed honorary local treasurer. In a letter from Mr. Griffiths, secretary of the Association, it was stated that Sir Archibald Geikie, who will preside over the Edinburgh meeting, was in favour of the meeting being held early in August. A considerable majority, however, voted in support of a proposal that the meeting should begin on Wednesday, September 28.

ON July 28 and the three following days, at Bournemouth, the British Medical Association will hold its fifty-ninth annual meeting under the presidency of Dr. J. Roberts Thomson. The scientific business of the meeting will be conducted in nine sections. An address in medicine will be given by Dr. Lauder Brunton; an address in surgery by Prof. Chiene; and an address in public medicine by Dr. Cox Seaton.

A PHYSICAL Observatory, furnished with specially designed apparatus for the prosecution of investigations in radiant energy and other departments of telluric and astro-physics, has been established as a department of the Smithsonian Institution. The communication of new memoirs bearing in any way on such researches is requested, and for them it is hoped that proper return can be made in due time.

THE *Standard* understands that on the vote for the salary of the President of the Board of Trade, either Sir Henry Roscoe or Sir Lyon Playfair will call attention to the action of the Government with regard to the proposed Institute of Preventive Medicine.

THE Committee of the French Academy has decided, by five votes to four, that the prize of 20,000 francs should be given to M. Elisée Reclus, author of the well-known "Nouvelle Géographie Universelle." It is expected that the Academy will ratify the decision.

ACCORDING to a Reuter's telegram from Simla, dated June 12, Drs. Rake and Buckmaster have succeeded in cultivating the leprosy bacillus in serum. They were aided in their researches by Surgeon-Major Thomson.

IN reply to Mr. Bryce, in the House of Commons on Monday, the Lord Advocate stated that it would be the duty of the Government during the ensuing year not only to weigh very carefully the claims of secondary education in Scotland as one of the interests competing for a share of the additional Scotch grant, but also to prosecute further inquiries as to the means by which any grant available for that purpose might be usefully applied. Many proposals had already been submitted to and considered by the Scotch Education Department, and these, as well as any suggestions which might be made, would receive further careful consideration. The Government would also endeavour to bring all necessary statistics down to the latest date, so as to afford the necessary information for the solution of all branches of this difficult question.

THE funeral of Sir Richard Burton took place on Monday at the church of St. Mary Magdalene, Mortlake. The tomb represents an Arab tent, with a crucifix over the entrance. The interior is a small chapel with altar and some Oriental lights.

IT has been decided that a Geographical Society shall be formed at Liverpool. A preliminary committee has been appointed, and it has issued a circular stating the objects of the new body.

ACCORDING to a telegram sent through Reuter's Agency from Naples on June 16, the flow of the lava stream from Vesuvius had stopped, and Signor Palmieri, the Director of the Observatory on the mountain, had expressed his belief that the outflow might be regarded as at an end.

SLIGHT but continuous earthquake shocks were felt at Verona on June 10; and on the 11th, at 8.30 a.m., a very violent shock occurred at Tregnano and Badia Calavena. This was plainly felt in Verona also. Another violent shock occurred at Tregnano on the 13th, and on the 15th shocks were reported from Castelnuovo, Peschiera, Somma Campagna, and Desenzano.

THE first volume of a new meteorological Review has been published, containing observations taken in the south-west of Russia for the year 1890. This system was organized by Prof. A. Klossovsky in 1886, and now numbers nearly 600 observers. The observations refer chiefly to temperature, wind, rainfall, &c., for climatological and agricultural purposes. The Review also contains several articles of importance, *e.g.* (1) on phenological phenomena; (2) on the harvests in connection with meteorological observations; (3) on the movements of clouds; (4) actinometric observations made at Kieff. These are written in the Russian language only; the positions of the stations, and various data referred to in the text, are illustrated by maps and diagrams.

AT a meeting of the Royal Statistical Society, on Tuesday, a paper was read by Mr. Noel A. Humphreys, Secretary of the Census Office, on the results of the recent census and estimates of population in the largest English towns. The first part of the paper was devoted to the consideration of the recently-issued results of the census in April last in the twenty-eight large English towns dealt with in the Registrar-General's weekly returns. It was pointed out that, although the increase of population within the present boundaries of these towns showed an increase of nearly a million in the last ten years, the increase was less, by considerably more than half a million (605,318), than would have been the case if the rate of increase had been the same as in the preceding ten years, 1871–81; and that the rate of movement of population showed striking variations in the different towns. The rate of increase in these twenty-eight towns, it was stated, has pretty constantly declined in recent years, and has fallen with scarcely a break during the last five intercensal periods from 24·3 per cent. in 1841-51 to 11·0 per cent. in 1881-91. The percentage of increase within the boundaries of registration London (practically those of the county of London) declined in the same period from 21·2 to 10·4. The rate of actual decline of population in central London continues to increase, and the rate of increase of the other parts of the metropolis, including even the aggregate outer ring of suburban districts, continues to decline. Examined in detail, the provincial towns show, with few exceptions, the operation of similar laws; actual decrease in the central portions, and marked decline in the rate of increase in the other portions, the latter being specially noticeable in those towns with comparatively restricted areas. This examination, while showing the marked general decline in the rates of increase in these towns, discloses striking variations in the rates of increase in successive census periods. Mr. Humphreys called attention to the fact that these striking changes in the rates of movement of population in the large towns interpose the greatest difficulty in estimating, even approximately, their population in intercensal periods. The estimate of population in Liverpool, based upon the rate of increase between 1871 and 1881, exceeded the recently enumerated number by more than 100,000, or by 20 per cent.; while in Salford the percentage of over-estimate, by the same method, was 26 per cent. Thus the recent birth-rates and death-rates in these two towns have been under-estimated by no less than a fifth and a fourth, respectively. The various methods that have been at different times suggested for estimating the population of towns in intercensal years, in substitution of Dr. Farr's method, still used by the Registrar-General's Department, were severally considered, and it was shown that no hypothetical method yet devised affords reasonable promise of satisfactory results. It was therefore urged that a quinquennial census could alone supply a remedy for the present difficulty, which threatens to impair the public faith in death-rates, the failure of which would most seriously hinder and imperil the health progress of the country.

AT the meeting of the Linnean Society of New South Wales, on April 29, Mr. T. W. Edgeworth David exhibited, on behalf of Mr. J. E. Carne, Mineralogist to the Department of Mines, Sydney, a specimen of precious opal from the White Cliffs about fifty miles northerly from Wilcannia. Precious opal and common opal have lately been discovered in this locality in a formation corresponding to the Desert Sandstone of Queensland. The opal occurs disseminated as an infiltrated cement throughout the mass of the sandstone in places, and also replacing the calcareous material of fossils. It also occurs in cracks in the sandstone and in fossil wood, which is somewhat plentifully distributed throughout the sandstone, and occasionally replaces part of the original woody tissues of the silicified trees.

MRS. J. KING VAN RENSSELAER contributes to the Proceedings of the U.S. National Museum an interesting paper on the playing cards used in Japan. They are more distinctly original, she says, than any others, and show no marks of the common origin which the Italian, Spanish, German, French, Hindoo, and Chinese cards display. Forty-nine in number, they are divided into twelve suits of four cards in each suit. One card is a trifle smaller than the rest of the pack, and has a plain white face not embellished with any distinctive emblem, and this one is used as a "joker." The other cards are covered with designs that represent the twelve flowers or other things appropriate to the weeks of the year. Each card is distinct and different from its fellows, even if bearing the same emblem, and they can be easily distinguished and classified, not only by the symbolic flowers they bear, but also by a character or letter that marks nearly every card, and which seems to denote the vegetable that represents the months. The only month that has no floral emblem is August, and that suit is marked by mountains and warm-looking skies.

PROF. D'ARCY W. THOMPSON has edited an interesting volume of "Studies from the Museum of Zoology in University College, Dundee." The volume consists of the first twelve numbers of a journal in which the zoologists connected with the Dundee University College hope to find "an incentive to their own diligence, a way of communication with the outer world, and a means of giving direction and consecutive purpose to all their work." The editor contributes five papers, and the writers associated with him are Miss Mary L. Walker, Prof. H. Leboucq, Dr. H. St. John Brooks, Mr. Alexander Meek, and Prof. W. K. Parker.

AN interesting illustration of the antagonistic action of poisons is mentioned in the current number of the *Pharmaceutical Journal*. Dr. Mueller, of Yackandandah, Victoria, has written a letter in which he states, says our contemporary, that in cases of snake bite he is using a solution of nitrate of strychnine in 240 parts of water mixed with a little glycerine. Twenty minims of this solution are injected in the usual manner of a hypodermic injection, and the frequency of repetition depends upon the symptoms being more or less threatening, say from 10 to 20 minutes. When all symptoms have disappeared, the first independent action of the strychnine is shown by slight muscular spasms, and then the injections must be discontinued unless after a time the snake poison reasserts itself. The quantity of strychnine required in some cases has amounted to a grain or more within a few hours. Both poisons are thoroughly antagonistic, and no hesitation need be felt in pushing the use of the drug to quantities that would be fatal in the absence of snake poison. Out of about 100 cases treated by this method, some of them at the point of death, there has been but one failure, and that arose from the injections being discontinued after 1¼ grain of strychnine had been injected. Any part of the body will do for the injections, but Dr. Mueller is in the habit of making them in the neighbourhood of the bitten part or directly upon it.

THE Rev. J. Hoskyns-Abrahall writes to us that on June 10, about 10.30 p.m., near Woodstock, he saw what he describes as "a beautiful phenomenon." "Suddenly," he says, "at the zenith, east of the Great Bear, shone forth a yellow globe, like Venus at her brightest. Dropping somewhat slowly, it fell obliquely southward. As it passed in its brilliant career, it lighted up its dusky path with a glorious lustre. When it had descended about half-way down toward the horizon, it burst into a sparkling host of glowing fragments, each dazzlingly shot over with all the hues of the rainbow."

THE Register of the Johns Hopkins University for 1890–91 has been issued. It contains a great mass of well-arranged facts relating to the work of that flourishing institution.

MR. C. FRENCH, Government Entomologist at Melbourne, is contributing to the *Victoria Naturalist* a series of notes on the insectivorous birds of Victoria. In the first paper, which appears in the May number, he describes the Australian Bustard (*Choriotis australis*). Some months ago Mr. French made an appeal to the Victorian Government for the permanent protection of this, the most useful insect-destroying bird in the colony. His appeal was supported by the Council of the Zoological Society of Melbourne; and the Government has not only acceded to the request, but has placed the matter before the Government of New South Wales, who, it is hoped, will at once see the necessity for the preservation of so valuable a bird.

DR. A. KOENIG has issued as a separate volume the account of his ornithological observations made during his explorations in Madeira and the Canary Islands. It is a notable memoir, and several new species and sub-species of birds are described. He is somewhat severe on some British ornithologists for having tried to forestall him in the description of the Chaffinch of Palma, which he was the first to discover. The editor of the *Journal für Ornithologie*, in which the paper first appeared, also adds some strictures on the ways of British naturalists. Dr. Koenig apparently has some grounds for his complaint, but a *tu quoque* argument could be upheld against him, for he persists in calling a *Regulus* by his new name of *satelles*, though he admits that it is *Regulus teneriffæ* of Seebohm, and he does not refer to the British Museum "Catalogue of Birds," in which he will find that his identifications of the Madeiran and Canarian *Fringillæ* were all published long before he gave them to the world as new facts. These small matters do not, however, affect the importance of the essay, which is worked out with remarkable care, and is, in fact, a monographic review of the ornithology of Madeira, Teneriffe, and Palma. Eight coloured plates illustrate the article.

IN a paper lately read before the Scientific Section of the Manchester Literary and Philosophical Society, Mr. John Watson maintains that the re-development of lost limbs is not unusual among insects. He himself has had three cases in which limbs have been re-developed, and one case of complete cicatrization. Re-development, he says, can take place either at the larval or the pupal stages of an insect's metamorphosis.

THE British Consul at Hankow, writing of the varnish exported from that city, says he is informed that it is the gum of a tree—the *Rhus vernicifera*. On this tree, before daylight, incisions are made; the gum that runs out is collected in the dark, and strained through a cotton cloth bag, leaving behind a large amount of dirt and refuse. This operation can only be performed in the dark, as light spoils the gum and causes it to cake with all the dirt in it. It cannot be strained in wet weather, as moisture causes it to solidify. When the Chinese use this varnish, they rub it on with a sort of mop, or swab, made of soft waste silk. It should only be used in wet weather, as, if the atmosphere is dry when it is rubbed on, it will always be sticky. As used by the Chinese, the varnish takes about a month to dry, and during the time it is drying it is poisonous to the eyes. The Consul thinks that this gum may have been one of the ingredients of the celebrated Cremona varnish, and he suggests that it might be worth the while of musical instrument makers to make experiments with it with a view to producing a varnish that would give a mellow instead of a glassy sound.

THE Insect-house in the Zoological Society's Gardens is now in excellent order, and well deserves a visit. In addition to the Silk-moths that are usually present during the warm weather, the Papilioninæ, or Swallow-tail butterflies, afford at the present time the chief display. The perfect insects of several species of the genus *Papilio* have appeared—*P. cresphontes*, *ajax*, and *asterias* from North America, *P. alexanor* from the Mediterranean shores, and the handsome *P. maackii* from Japan. The last-named has been seen for the first time in the house this year, and offers a striking contrast to the other species of the genus that have previously been exhibited in the Gardens, it being of black and golden-green colours instead of the yellows and blacks that we are accustomed to in our European Swallow-tails. *P. cresphontes* has appeared in large numbers in the house, but no varieties have been obtained. This also is the first season for two other beautiful Papilioninæ, viz. *Doritis apollina* from Asia Minor, and the Japanese *Sericina telamon*. The latter shows considerable difference in the markings of the sexes. The North American *Limenitis disippus* can be at present seen in all its stages, and is well worthy of attention, the caterpillar moving along the leaf-stalks with a peculiar interrupted gait. Of the Sphinx moths, the South European *Deilephila alecto* has already appeared, and *D. nicæ* is expected. These insects are, however, not seen to advantage in confinement, as their superb powers of flight cannot be displayed in a small compartment. Two examples of the Orthoptera are alive in the house—*Diaphemora femorata*, one of the Stick- or Twig-insects from North America, and *Empusa egena* from Southern Europe. The former has been reared from eggs laid in the Insect-house, but these progeny are not so healthy as those obtained from freshly-imported eggs. The *Empusa* is of a most bizarre form, and belongs to the family Mantidæ, the species of which feed only on living creatures. The public is indebted to Mr. S. H. Carver for the opportunity of seeing living scorpions; he has sent examples of two species of this group from Egypt, both of which unfortunately are unidentified, there being obvious difficulties in the way of carrying about live scorpions and comparing them with dried specimens. There is a third scorpion, from South Europe, living with its Egyptian congeners; it has a small delicate tail, and is altogether a less frightful creature, though assuming a menacing attitude with equal readiness. A spider, *Lycosa portosantana*, from Madeira, is healthy, and is a fine creature, though insignificant by the side of its neighbour, a huge *Mygale* from South America. The latter, as well as the scorpions, is fed with mice, which are given to it dead, though in its native haunts a *Mygale* has been known to prey on living individuals of these small mammals.

IN the current number of the *Board of Trade Journal* some interesting facts as to cotton cultivation in Russian Turkestan are given, on the authority of a Russian correspondent of the *Monde Économique*. After the submission of the Khanates of Central Asia, the trade of the country was carried on chiefly with the towns of Russia in Europe, and was confined at first to the export in small quantities of cotton grown from native seeds, of rice, raw silk, and other similar products. It is only during the last ten years that the industry of the country has extended to any considerable degree, owing to the ingress of speculators, and has changed its primitive character. There have been established all kinds of works and factories, and in 1884 the cultivation of cotton of American origin was essayed. This trial succeeded so well that all classes of society, including even public officials, devoted themselves to this culture, which has become one of the chief branches of industry in the country. The new cotton produced in Central Asia is equal to that of America, and finds an excellent outlet among the cotton spinneries and mills of Russia. But the consumption in European Russia does not suffice for the ambitious aims of native producers, and they look forward to the possibility of opening up trade in the foreign markets of Europe.

THE new number of the *Internationales Archiv für Ethnographie* fully maintains the reputation of this excellent periodical. Among the contents is a paper in which Dr. J. D. E. Schmeltz continues his elaborate account of the collections from Corea in the ethnographical museum at Leyden. Dr. Heinrich Schurtz has an interesting article on the geographical distribution of negro costume. As usual, the plates illustrating the various contributions are most carefully executed.

A FURTHER communication upon the new peroxide of sulphur, SO_4, by Prof. Traube, of Breslau, will be found in the current number of the *Berichte*. This interesting substance is obtained when solutions of sulphuric acid containing at least 40 per cent. of acid are subjected to electrolysis, as a crystalline deposit upon the anode. The crystals were first observed some time ago by Berthelot, but were considered by him as identical with the oxide S_2O_7, which he had previously obtained by the action of the silent electrical discharge upon a mixture of sulphur dioxide and oxygen. Prof. Traube, however, finds that the substance obtained at the anode in the electrolysis of 40 per cent. solutions of sulphuric acid is represented by the formula SO_4, and is quite a different substance from Berthelot's S_2O_7. It is, as predicted by

Mendeleeff, not the anhydride of an acid, but a neutral oxide of a similar chemical character to hydrogen peroxide. It may be best separated from the excess of 40 per cent. acid by removing the latter, after dilution with three times its volume of water, by means of freshly prepared barium phosphate. It cannot, however, be preserved in pure water, as it parts with oxygen so readily, becoming reduced thereby to ordinary sulphuric acid. That it is not an anhydride is proved by the fact that it yields no salts of the type K_2SO_5 with alkalies. Neutral solutions containing it, in which it appears to be permanent, may be readily prepared by neutralizing the solution in 40 per cent. acid with caustic soda, potash, or magnesia. The properties of SO_4 in either acid or neutral solution are somewhat remarkable. When boiled in contact with platinum wire or platinum black it is energetically decomposed with evolution of quantities of oxygen. If the neutral solution is employed, it becomes strongly acid. Indigo solution is oxidized and decolorized slowly, but instantly if a little ferrous sulphate is added. SO_4, however, in spite of this ready decomposition into oxygen and sulphuric anhydride, is but a weak oxidizing agent, being incapable even of oxidizing oxalic acid or carbon monoxide. But under certain circumstances it acts as a powerful reducing agent. For instance, if an emulsion of peroxide of lead in 40 per cent. sulphuric acid is brought in contact with a quantity of similar acid which has been subjected to electrolysis so as to charge it with SO_4, a rapid evolution of oxygen gas occurs, and the peroxide of lead is converted into ordinary sulphate of lead. In a similar manner precipitated peroxide of manganese is rapidly reduced to manganous sulphate with evolution of oxygen, and silver peroxide likewise dissolves up to a clear solution of silver sulphate with violent effervescence due to the escape of oxygen. Prof. Traube regards sulphur peroxide as built up on the type $SO_2(O_2)$, resembling hydrogen peroxide, H_2O_2. He considers that Berthelot's oxide, S_2O_7, is a molecular compound of SO_3 and SO_4, for it does not dissolve in water without decomposition, breaking up into sulphuric anhydride and oxygen, which is evolved. On the other hand, it appears, like SO_4, to be perfectly stable in a moderately concentrated solution of sulphuric acid.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. James B. Leckie; a White-fronted Amazon (*Chrysotis leucocephala*) from Cuba, presented by Mrs. Lacabra; a Radiated Tortoise (*Testudo radiata*) from Madagascar, an Angulated Tortoise (*Chersina angulata*), three Smooth-bellied Snakes (*Homolosoma lutrix*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Green Lizard (*Lacerta viridis*) from France, presented by Mrs. Hill; three Horned Lizards (*Phrynosoma cornutum*) from Texas, presented by Mr. James E. Talmage; five Squirrel-like Phalangers (*Belideus sciureus* ♂ ♂ ♂ ♀ ♀) from Australia, a Grand Eclectus (*Eclectus roratus*) from Moluccas, deposited; two Elliot's Pheasants (*Phasianus ellioti* ♀ ♀) from China, two Rufous Tinamous (*Rhynchotis rufescens*) from Brazil, purchased; two Marbled Newts (*Molge marmorata*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

NEWLY-DISCOVERED MARKINGS ON SATURN.—*Edinburgh Circular* No. 16, issued by Dr. Copeland on June 10, contains the following information:—

Mr. A. Stanley Williams, of Burgess Hill, Sussex, has discovered three delicate but distinct markings in the equatorial region of Saturn. The first and third of these are round bright spots, somewhat brighter than the white equatorial zone in which they occur. The second is a smaller dark marking on the equatorial edge of the shaded belt which forms the southern boundary of the white zone. Mr. Williams has obtained abundant proof of the reality of these markings, but points out that it requires patience and practice to see them readily. It is very desirable to obtain repeated observations of their times of transit across the planet's central meridian. To facilitate these observations, Mr. Williams has prepared the following table, using 10h. 14·6m. as the provisional time in which the planet rotates on its axis:—

Approximate Greenwich Mean Time at which the Spots may be expected on Saturn's Central Meridian.

1891.	Spot 1 (white). h. m.	Spot 2 (dark). h. m.	Spot 3 (white). h. m.
June 20	7 50	8 47	10 9
21	4 20	5 17	6 39
22	11 5	12 2	13 24
23	7 32	8 29	9 51
24	4 2	4 59	6 21
25	10 47	11 44	13 6
26	7 14	8 11	9 33
27	3 44	4 41	6 3
28	10 29	11 26	12 48
29	6 56	7 53	9 15
30	3 26	4 23	5 45
July 1	10 11	11 8	12 30
2	6 38	7 35	8 57
3	3 8	4 5	5 27
4	9 53	10 50	12 12
5	6 20	7 17	8 39
6	2 50	3 47	5 9
7	9 35	10 32	11 54
8	6 2	6 59	8 21
9	2 32	3 29	4 51
10	9 17	10 14	11 36

THE ROTATION PERIOD OF VENUS.—The *Bulletin de l'Académie Royale de Belgique*, No. 4, contains a paper, by M. Niesten, of Brussels Observatory, *à propos* the rotation of the planet Venus. The observations and drawings made by M. Stuyvaert and the author from 1881 to 1890 do not appear to confirm the persistence of the dark markings during a long period, as found by Schiaparelli and others. It is also shown that De Vico's period of 23h. 21m. 21·93s. is more in accordance with the observations than Schiaparelli's period of 224·7 days. Twelve drawings of the planet, and a map showing all the markings, accompany the paper.

A NEW ASTEROID (310).—M. Charlois discovered the 310th minor planet on May 16. Its magnitude was 13.

THE ROYAL GEOGRAPHICAL SOCIETY.

THE anniversary meeting of the Royal Geographical Society was held in the University of London on Monday afternoon, the President, Sir Mountstuart Grant-Duff, in the chair. The first business was the award of the medals and other honours for the year. The Founder's Medal was delivered to Sir Dillon Bell, Agent-General for New Zealand, for transmission to Sir James Hector, K.C.M.G., F.R.S., Director of the New Zealand Geological Survey. The Swedish Minister received the Patron's Medal on behalf of Dr. Fridtjof Nansen, who was unable to attend. Other honours were awarded to Mr. William Ogilvie, for his explorations of the Mackenzie and Yukon regions; Lieutenant B. L. Sclater, for instruments to be used in the exploration of Nyassaland; Mr. A. E. Pratt, for his journeys in Szechuen; Mr. W. J. Steains, for his investigations on the Rio Doce, South America. Mr. H. J. Mackinder then introduced the students of the Training Colleges who had been successful in obtaining the prizes offered by the Society annually on the results of the Christmas examinations in geography. Mr. Mackinder spoke briefly on the progress of geographical education, and on the results of the four years' awards to the Training Colleges.

The Secretary then read the annual report of the Society, from which it appears that on May 1 last the total number of Fellows was 3579, being a net increase of 84 on the previous year. The total income up to the end of December 1890 was £9531, and expenditure £8218. The estimated value of the Society's investments is £25,648, and of its total assets £46,248. During the past year, 900 books and pamphlets have been added to the library, and 936 sheets of maps to the map collection, besides 25 atlases, 700 photographs, 151 lantern-slides, and 51 views.

The President then proceeded to deliver the annual address on the progress of geography during the past year, dealing mainly with the explorations which have been carried on in various parts of the world.

"The year," he said, "of which I am about, with your permission, to give some account, has not been, so far as geographical discoveries are concerned, a very brilliant or sensational one. Brilliant and sensational years are, alas! likely to grow fewer and fewer as the globe we inhabit becomes ever better known to us. If, however, the year has not been made memorable by much *extensive* exploration it has put to its credit no small amount of *intensive* exploration. A good many gaps in our knowledge have been filled up, and a great deal of solid useful work accomplished. All this healthy activity has been represented in our Proceedings, and much of it has found its way to our Fellows through the papers which have been read in this theatre. Many of these have been extremely interesting. I may mention particularly the account of Messrs. Jackson and Gedge's journey to Uganda, Colonel Tanner's observations on the Himalayan Range, and Mr. Pratt's journey to Szechuen. These last were illustrated, as it will be remembered, by drawings and by photographs of exceptional merit, which were examined carefully by large numbers after our meetings closed. As you will have learnt from the report of the auditors, the total assets of the Society have considerably increased, and we are in a position to give most efficient assistance to any thoroughly well considered schemes which are laid before us. I am very sure, however, that the Fellows will consider that, although we are rich, it is none the less our duty to scrutinize carefully all proposals which are made to us, and to see that the money which they give so generously is applied only to really promising objects. Such we considered to be Mr. Ramsay's explorations in Asia Minor, and Mr. Theodore Bent's examination of the remarkable ruins at Zimbabye in South Africa. Instruments to the value of over £600 have been lent during the past year to intending travellers, and thirty-six gentlemen have received instruction from Mr. Coles, partly at the expense of the Society, for the purpose of making them more efficient as explorers. Our duties dividing themselves into two great classes—the acquisition of knowledge and the diffusion of knowledge—I think the Society will hail with pleasure a considerable increase of our expenditure under the head of 'Scientific Purposes,' which amounted for last year to nearly £600. That sum included £178 for the purpose just alluded to, £120 for the promotion of geographical education in connection with the Training Colleges, the University Local Examinations, and the Oxford University Extension Movement, and a contribution of £150 towards the salaries of each of the Geographical Lecturers at the Universities of Oxford and Cambridge. I am happy to be able to report that our efforts to promote geographical education in the first of these great national institutions are being crowned with success, thanks to the enlightened views now prevailing there, to the powerful assistance of the Warden of Merton and other friends in high place, and to the zeal and high intelligence of Mr. Mackinder, who is rapidly winning not only golden opinions for himself, but an excellent place for his science on the banks of the Isis. Negotiations are now in progress which will, I hope, result in the establishment of a Travelling Scholarship at the joint expense of our Society and of the University of Oxford. Our Fellows will, no doubt, have observed that efforts are being made to have the Ordnance Survey pushed on more rapidly than hitherto, as well as to make more generally accessible to the public the results of so much well-directed labour. They will approve, I feel sure, of the Society's assisting these efforts in all legitimate and reasonable ways."

The President then proceeded to review the exploring work of the year, most of which has already been dealt with in NATURE.

PARKA DECIPIENS.[1]

THIS very interesting fossil is derived from various localities in Scotland, all of which are believed to be Lower Devonian. It was first described in 1831 by Dr. Fleming, and since then has been noticed on several occasions, and variously regarded as the spawn of Mollusca or Crustaceans, and as of vegetable origin.

The material upon which the present observations are based was collected by Mr. James Reid[1] and Mr. Walter Graham, both of whom have offered many valuable suggestions as to the probable nature and affinities of the fossil. As found, the *Parka decipiens* usually consists of oval masses bearing rounded impressions or disk-like bodies of carbonaceous matter. Associated with these are also stems and linear leaves of two dimensions, and a third form having a general resemblance to Pachytheca, which is found in the same beds, and differing from it in having a more discoid form, and being devoid of structural markings.

The authors show that the fossil is probably a rhizocarp allied to *Pilularia*, and that there are at least three forms recognizable, of which one is referred to the species, and the other two to varieties. The views thus stated are based upon differences of size and upon the fact that certain of the disk bodies show spores of two kinds, and in some cases prothalli in various stages of development, all derived from the same sporocarp.

The paper is illustrated by a plate of figures.

[1] "Notes on Specimens from the Collections of Messrs. Graham and Reid," by Sir Wm. Dawson, LL.D., F.R.S., and D. P. Penhallow, B.Sc., F.R.S.C. Abstract of a paper read before the Royal Society of Canada, May 1891.

[1] Mr. Reid acknowledges his indebtedness to Mr. Langlands, the lessee of Myreton quarries, whose kind permission to examine these quarries was so freely granted.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—In the list of the Mathematical Tripos (Part II.) Mr. Bennett, of St. John's, the Senior Wrangler, Mr. Crawford, of King's, the fifth Wrangler, and Miss Philippa G. Fawcett, "above the Senior Wrangler," are placed in the first division of the First Class.

SCIENTIFIC SERIALS.

THE *American Meteorological Journal* for May contains the following articles:—Cold waves, by Prof. T. Russell. In the report of the Chief Signal Officer for 1889, he expressed the view that the origin of cold waves was due to mixture of upper and lower air causing cooling of the layer next to the ground. On further examination of the subject, in connection with the observations at mountain stations, he admits the incorrectness of those views, and states that, while it is essential to connect the low temperature and high pressure in some way, the cooling of the ground by radiation, and of the air by contact and conduction, will not completely explain the cause of cold waves.—How could the Weather Service best promote agriculture?, by M. W. Harrington. The American Weather Service has hitherto devoted itself more particularly to the interests of commerce, while the State Services have had the interests of farmers more distinctly in view. What the farmer wants to know is, where and when a local shower will fall. While the complete solution of this problem may be impossible, the approximate solution lies in the multiplication of local forecasting stations, and in the intelligent use of the indications of the Central Office, combined with the indications which he can himself observe. The author recommends more attention to climatology as distinct from weather changes, and to the relations between plants, soil, and meteorology.—Is the influenza spread by the wind?, by H. H. Hildebrandsson. This is a translation, by the author, from an article in the Journal of the Medical Society at Upsala, and is, practically, a reply to an article in NATURE of December 19, 1889, where it is stated that the malady is probably spread by the wind. The author shows, by a map and table, the places and dates at which influenza occurred in Sweden, from inquiries of medical men. The result of the research goes to show that the influenza is propagated by infection, that it is conducted from place to place through human circulation, and that the time of incubation is two to three days. The state of the weather seemed to have no influence on the spread of the malady; in fact, it raged with the same severity in countries possessing very different climates, and during very different weather conditions.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 4.—"On a Determination of the Mean Density of the Earth and the Gravitation Constant by means of the Common Balance." By J. H. Poynting, D.Sc., F.R.S., Professor of Physics, Mason College, Birmingham.

In a paper printed in the Proceedings of the Royal Society, No. 190, 1878, an account was given of some experiments undertaken in order to test the possibility of using the common balance in place of the torsion balance in the Cavendish experiment. The success obtained seemed to justify the continuation of the work, and this paper contains an account of an experiment carried out with a large bullion balance, in place of the chemical balance used in the preliminary trials. The work has been carried out at the Mason College, Birmingham.

The Principle of the Experiment.—The immediate object of the experiment may be regarded as the determination of the attraction of one known mass on another. If two spheres, of masses M and M′, have their centres a distance *d* apart, the attraction is, according to the law of gravitation, GMM'/d^2, where G is the gravitation constant. Astronomy justifies the law in certain cases as regards M'/d^2, but does not give the value of G or M, except in the product GM. To find G we must measure GMM'/d^2 in some case in which both M and M′ are known. Having found G, we may determine the mean density of the earth, for, assuming that it is a sphere of radius R, the weight of any mass M′ at its surface is

$$G \times \tfrac{4}{3}\pi R^3 \Delta M'/R^2$$
$$= \tfrac{4}{3} G\pi R\Delta M'.$$

But if *g* is the acceleration of gravity the weight of M′ may be expressed as M′*g*. Equating these values, we get

$$\Delta = \frac{3}{4}\frac{g}{G\pi R}.$$

Method of Using the Common Balance.—With the length of beam used (about 123 cm.) a differential method was applicable, in which the attraction on the beam was eliminated. Two spherical masses of lead and antimony, about 21 kilos. each, were hung from the two arms of the balance, so that their centres in the first position were about 30 cm. above the centre of a large attracting mass, a sphere of lead and antimony about 153 kilos., placed on a turntable, so that it could be brought in turn immediately under either of the suspended attracted masses. A balancing mass of half the weight, and at double the distance from the centre of the turntable, was found necessary, so that the centre of gravity should be in the axis of rotation. Before this was used, the ground level was seriously altered by the rotation of the turntable. The attraction of the balancing mass was calculated and allowed for.

The alteration in the weights of the attracted masses, due to the motion of the attracting masses from one side to the other, was the quantity to be measured. When this was determined in the lower position of the attracted masses they were raised to about double the distance, and the attraction again determined. The difference eliminated the pull on the beam, suspending wires, &c. To lessen the effect of want of homogeneity or sphericity in the masses, or of want of symmetry in the turntable, the masses were all inverted and changed over each to the other side, and the weighings repeated.

The position of the beam was determined by the reflection of a scale in a mirror used with "double suspension." The mirror was suspended by two silk threads, one attached to the end of the ordinary pointer about 60 cm. below the central knife edge, the other parallel to it, being attached to a fixed support. The mirror turned through an angle about 150 times as great as that through which the beam turned, and one scale division corresponded to an angle of tilt in the beam of about 2/15ths of a second.

The value of a scale division was determined by the use of two equal riders which could be placed on or taken off wire frames representing the scale pans of a small subsidiary beam, 2·5 cm. long, fixed parallel to and at the centre of the large beam. When one rider was placed on one supporting frame the other was at the same instant lifted off the other frame.

The balance was left free throughout a series of weighings, and no moving parts of the apparatus were connected with the case.

The values obtained are as follows:—

$$\text{The gravitation constant } G = \frac{6{\cdot}6984}{10^8}.$$

$$\text{Mean density of the earth } \Delta = 5{\cdot}4934.$$

In the paper a description is given of a new form of cathetometer used to measure the diameters of the masses.

"Quadrant Electrometers." By W. E. Ayrton, F.R.S., J. Perry, F.R.S., and W. E. Sumpner, D.Sc.

In 1886 it was noticed, on continuously charging up the needle of Sir William Thomson's bifilar suspension quadrant electrometer No. 5, made by Messrs. White, of Glasgow, and in use at the laboratories at the Central Institution, that the deflection of the needle, when the same P.D. (potential difference) was maintained between the quadrants, instead of steadily increasing, first increased, and then diminished; so that, both for a large charge on the needle as well as for a small, the sensibility of the instrument was small. A similar effect had been described by Dr. J. Hopkinson, in the Proceedings of the Physical Society, vol. vii. Part 1, for the previous year, and the explanation he gives of this curious result is, that if the aluminium needle be below the centre of the quadrants, the downward attraction of the needle, which varies with the square of the needle's charge, increases the pull on the bifilar suspension, and so for high charges more than compensates for the increased deflecting couple due to electrical action. On raising, however, the needle of our electrometer much above the centre of the quadrants, the anomalous variation of sensibility of the instrument with increase of charge in the needle did not disappear; and even when the needle was raised so that it was very close to the top of the quadrants, and when, if Dr. Hopkinson's explanation were correct, the sensibility (or deflection corresponding with a given P.D. between the quadrants) ought to have been very great for a large charge on the needle, it was, on the contrary, found to be small.

The needle was carefully weighed, with the platinum wire attached and the weight dipping into the acid, and a calculation was made as to the magnitude of the effect that should arise from the change of the pull of the fibres due to any upward or downward attraction of the needle by the quadrants. This calculation showed that for a P.D. of 3000 volts between the needle and the quadrants, the amount of such attraction was quite unable to account for the observed diminution of sensibility with large charges in the needle. Dr. Hopkinson says in his paper, "Increased tension of the fibres from electrical attraction does not therefore account for the whole of the facts, although it does play the principal part." The experiments that we made at the end of 1886 and beginning of 1887, confirmed by the calculation above referred to, proved that, at any rate in our specimen of the quadrant electrometer, the principal part of the anomalous action was not caused by an increased tension of the fibres, and that therefore some other cause must be looked for to explain the observed results.

We therefore decided to make a complete investigation of the laws connecting the variation of the sensibility of the instrument with the potential of the needle, the distance between the fibres, the distance between the quadrants, and the position of the needle.

The results of the investigation, briefly summed up, are as follows:—

(1) The quadrant electrometer, as made by Messrs. White, although it may be carefully adjusted for symmetry, does not usually even approximately obey the recognized law for a quadrant electrometer when the potential of the needle is altered.

(2) The peculiarities in the behaviour of the White electrometer are due mainly to the electrical action between the guard tube and the needle, and to the slight tilting of the needle that occurs at high potentials.

(3) By special adjustments of the quadrants of the White electrometer, the sensibility can be made to be either nearly independent of the potential of the needle, or to be directly proportional to the potential, or to increase more rapidly than the potential of the needle.

(4) By altering the construction of the instrument, as described, the conventional law for the quadrant electrometer is obtained without any special adjustment of the quadrants beyond that for symmetry, and the instrument is rendered many times as sensitive as the specimen we possess of the White pattern.

Linnean Society, June 4.—Prof. Stewart, President, in the chair.—After nominating as Vice-Presidents Mr. A. W. Bennett, Dr. Braithwaite, Mr. F. Crisp, and Dr. St. G. Mivart, the President took occasion to refer to the loss which the Society had sustained by the recent death of a Vice-President, Prof. P. Martin Duncan, F.R.S. His genial presence at the meetings, no less than his valued contributions to the publications of the Society, would, he felt sure, be missed by everyone.—Sir Walter Sendall, who was present as a visitor, exhibited a curious cocoon of a moth belonging to the genus *Tinea*, and made some remarks on its construction and peculiar coloration.—The President exhibited a case of Lepidoptera and Coleoptera, which he had selected to illustrate some of the more notable secondary sexual characters in insects, and made some interesting explanatory observations.—Dr. John Lowe exhibited some eggs of *Mantis religiosa* which he had found adhering to the underside of stones on mountain-sides in the Riviera.—On behalf of Mr. F. J. Hanbury, Mr. W. H. Beeby exhibited and made remarks on a sterile form of *Ranunculus acris*, on which some criticism was offered by Prof. H. Marshall Ward.—A paper by Mr. M. C. Potter was read, on diseases of the leaf of the cocoa-nut tree. The specimens examined had been received from Ceylon through Dr. Trimen, and in Mr. Potter's opinion the diseases noticed were referable to three causes—namely, to the rays of the sun, to the ravages of insects, and to Fungi. These were separately considered, and descriptions were given of the different appearance which the leaves, thus variously affected, presented. A discussion followed, in which Prof. H. Marshall Ward criticized in some detail the observations which had reference chiefly to Fungi.—Two papers followed by Dr. P. H. Carpenter, on some Arctic *Comatulæ* and on some *Crinoidea* from Madeira, upon which Mr. W. Percy Sladen offered critical remarks.—The President then gave an abstract of a paper which he had prepared on a hermaphrodite mackerel, and exhibited the specimen on which his observations were founded, referring also to the recent cases of hermaphroditism in the trout and cod which had been brought to the notice of the Society. A commentary by Prof. G. B. Howes brought the proceedings to a close.

EDINBURGH.

Royal Society, May 18.—The Hon. Lord Maclaren, Vice-President, in the chair.—Dr. Buchan read a paper on the barometer at Ben Nevis Observatory, in relation to the direction and strength of the wind. In arranging the results, Dr. Buchan has referred the direction of the wind to sixteen points of the compass, although the observations are actually made with reference to the thirty-two points. The readings of the barometers at the high level and the low level stations, when reduced to sea-level, exhibit marked differences dependent upon the direction of the wind. The investigation extends over the period of nine months commencing in August last. During that time, all the very high winds have been from the east-south-east and the south-east, these being the directions in which the wind blows freely along the top of the mountain to the Observatory. In eleven cases the wind from these directions attained a speed of 120 miles an hour or more; and the (reduced) barometer at the high level station read about one-sixth of an inch lower than the instrument at the low level station. In no other direction was a higher velocity than 70 miles an hour noted; and in the directions from west to north-north-west, east, and east-north-east, the velocity was never greater than 30 miles an hour. With northerly winds the instruments at the top of the mountain record a much lower speed than that which, from observations of the drift of the clouds, is seen to be reached at a small height above the top of the mountain. The cause of this comparative calm immediately at the top is the impact of the air upon the face of the cliff which lies to the north of the Observatory. The stream lines are thus suddenly deflected upwards. In such cases the depression of the barometer is about three times as great as that which occurs with an equally strong wind from other directions, and indicates the formation of a region of low pressure around the Observatory. A peculiar result which is observed with other directions of the wind is that the (reduced) high level barometric reading exceeds the (reduced) low level reading when the wind blows at about the rate of 5 miles an hour. The reverse is always true when the speed of the wind exceeds that rate, on the one hand, or is extremely small, on the other. This seems to indicate an increase of pressure in air-currents which ascend the mountain, and so may explain the fact that the top of the mountain is frequently clear, while dense cloud is being constantly formed at a short distance above it.—Dr. J. Berry Haycraft gave an account of some experiments which show (1) that the displacements of the heart, which since Harvey's time are supposed to take place with every contraction, do not really occur in the unopened chest, and (2) that the cardiogram has been misinterpreted by physiologists. It is usually supposed that, during each contraction, the heart twists towards the right while its apex moves forward, and, pressing against the wall of the chest, causes the "apex beat." Again, it has been supposed by some that, during expansion, all diameters of the heart are not increased, but that, on the contrary, one diameter is diminished in length. Dr. Haycraft's experiments show that all diameters are increased during expansion, and that all are diminished during contraction. They show also that the motions, above described, do not occur in the unopened chest. The heart, in order that it may be observed in the opened chest, is necessarily separated from its attachments and falls towards the back of the chest (the animal operated upon being supposed to be placed upon its back). During expansion, the heart becomes flaccid, and so is flattened against the back of the chest. The first effect of the stiffening which occurs during the muscular contraction is therefore an elevation of the heart, against gravity, towards the front of the chest. Similarly, if the animal be turned upon one side, the heart, during contraction, moves towards the upper side of the chest; and the "beat" can even be made to take place towards the back. In the unopened chest, the heart on the whole remains in position during contraction, and therefore its boundaries move from the chest walls. But the cardiogram, as usually interpreted, shows that the chest wall is thrown outwards by the impact of the heart during contraction. Dr. Haycraft asserts that this is due to deformation of the heart by pressure of the chest wall when the button of the cardiograph is pressed against the exterior of the chest. The first effect of the muscular contraction and stiffening of the heart is therefore increased pressure against the chest-wall, which gives rise to the up-stroke of the cardiogram. When the cardiograph is made as light as possible, the up-stroke is greatly diminished; but it never entirely vanishes, because the flaccid heart is always slightly distorted by the chest-wall even when the cardiograph is not pressed against it. Dr. Haycraft further shows that the sinuosities, which always appear to a greater or less extent on the cardiogram, are not due to peculiarities in the action of the heart, but are instrumental in their origin, being caused by oscillations which result from the inertia of the cardiograph.—Dr. Hugh Robert Mill read a paper on the physical geography of the Clyde sea area, and the salinity and chemical composition of its waters. He described records, and discussed observations, made by himself and other members of the staff of the Scottish Marine Station. The observations dealt with extend over a period of three years, and their reduction has occupied, in addition, the greater part of two years. In the first part of the paper the author gives a detailed description, illustrated by a bathymetric chart, of the configuration of the Clyde sea area, with a special account of the various loch basins. The area and volume of each of these depressions are calculated, and the area of land which drains into each of them is measured on accurate maps. The rainfall is discussed in detail, and the river discharge is calculated indirectly, tables being drawn up to show the volume of rain water which flowed into each of the lochs during each month of the year. The month of maximum rainfall over most of the area is January, that of minimum rainfall is May. The whole sea area is conveniently divided into two parts—the seaward, of great extent, bordered with comparatively low ground, and lying in a region whose average rainfall is 44 inches; and the landward, made up of deep narrow loch basins, bordered by lofty mountains, and occupying a region whose average rainfall approaches 60 inches. In the latter part of the paper the positions of thirty-four stations (twenty-seven in the landward, and seven in the seaward division), at which observations were regularly made, are described. The method of collecting water samples, and the method of determining the density by means of a *Challenger*-type hydrometer, are given in detail. A record of 850 determinations of density made during twelve trips, which extended over two years, are given in an appendix. Twenty tables are given, which show the relations of salinity to configuration, tides, and rainfall, and which exhibit the relative amounts of pure sea-water and of fresh-water which were present in each of the divisions of the sea area at certain selected times. It was found that the amount of salt present in the water of the Clyde sea area varies with the season, the water being, as a rule, freshest in February, one month after the maximum rainfall, and saltest in July or August, two months after the minimum rainfall. The surface water exhibited the greatest changes, the seasonal variations being more regular at greater depths. Even at the head of lochs 50 or 60 miles distant from the open sea the percentage of pure sea-water present was rarely less than 88; the fresh river-water which poured in in enormous volume after heavy rain rapidly mixing with the sea-water, which was constantly renewed by the tide. So rapid and complete is this process of interchange, that the amount of river-water actually present diluting the water of the Clyde sea area is much less than the amount which passes through it every year, and is not equal to half of the average rainfall. In an average year 1·25 cubic miles of water, 97·5 per cent. of which is pure sea-water, and 2·5 per cent. fresh-water, enters the area at every tide; and a slightly greater amount is withdrawn, the whole being freshened a little so as to contain 2·7 per cent. of its volume of fresh-water. The great saltness of the deep water of the sea lochs, on which their importance as fishing-grounds depends, appears to be due to two causes. One of these is the thorough mixture of the tidal water from bottom to surface as it pours across the shallow bars at the mouths of the lochs. The saltest surface water was always found at flood-tide, off Otter Spit in Loch Fyne, where the salt water welled up from beneath in consequence of the rapid shoaling of the channel. Another cause of thorough mixture is the influence of the wind, which seems to set up a complete vertical circulation. Thus if wind is blowing strongly down Loch Fyne, the freshened surface water is driven out of the loch, and very salt water rises at the head of the loch to take its place. In a down-loch wind the surface water is almost always saltest at the head of the loch, and diminishes in salinity towards the open sea. The paper concludes with a summary of the chemical composition of the water.

PARIS.

Academy of Sciences, June 8.—M. Duchartre in the chair.—On the currents which give rise to cyclones, by M. H. Faye. The views held by Dr. Hann and Prof. Ferrel concerning cyclones and anticyclones are compared. The author believes that cyclones, but not anticyclones, are dynamical phenomena, with which local circumstances of temperature have nothing to do, and he shows that they depend on the general movements of the atmosphere due to Polar cold and equatorial heat. On this point, therefore, M. Faye agrees with Dr. Hann.—Note on the presence of the *Kophobelemnon* in the waters of Banyuls, by M. H. de Lacaze-Duthiers.—The mastodon of Cherichira, by M. Albert Gaudry.—A new chemical balance for rapid weighings, by M. Victor Serrin.—Partial eclipse of the sun on June 6, observed at Nice, by M. Perrotin. With a power of 280, the time of first contact was observed to be 5h. 54m. 26s.; and of second contact, 6h. 53m. 26s. Nice mean time.—Observations of the new asteroid discovered at Nice Observatory on May 16, by M. Charlois. The observations are for May 16 and 25.—Observations of Brooks's comet (1890 II.), made with the great equatorial of Bordeaux Observatory, by MM. G. Rayet and L. Picart. Twenty-three observations for position were made between February 3 and April 29. The comet has been followed from March 27, 1890, to April 29, 1891.—On the theory of shooting-stars, by M. Callandreau. The author develops the equation of condition to be fulfilled by radiant-points belonging to the same family of meteors. According to Mr. Denning's observations, the Perseid radiant-point moves towards the east during the period of activity, a fact indicated as probable by Leverrier in 1871. This is in conformity with the equation of condition, which shows that if the latitude of a radiant-point varies slightly the longitude increases.—On two systems of differential equations, of which the hyperelliptic functions of the first order form the integrals, by M. F. Caspary.—Determination of the mechanical equivalent of heat, by M. Constantin Miculesco. The method adopted was similar in principle to that used by Joule. Thirty-one experiments made with this apparatus gave very accordant results, and the mean of them all give 426·7 as the mechanical equivalent of a calorie in kilogram-metres.—Dielectric properties of mica at high temperatures, by M. E. Bouty. The principal result of the research is that the dielectric constant is almost invariable for rapid alternations.—Application of the principle of the transmission of pressures to widely separated telephone transmitters, by M. P. Germain.—Action of ammonia on some compounds formed with halogen salts of mercury, by M. Raoul Varet. The author has studied the action of ammonia on compounds formed with mercury iodide and metallic cyanides, with the idea of determining the *rôle* of certain compounds of ammonia in double decompositions.—On a new method of preparing silicon chloro-iodides, by M. A. Besson.—On three cases of free development observed in Bryozoas ectoproctæ, by M. Henri Prouho.—On the locusts of Algeria, by M. Charles Brongniart.—On the morphological nature of the phenomena of fecundation, by M. Léon Guignard. It results from the observations that the phenomenon of fecundation consists not only in the copulation of two nuclei of different sexual origin, but also in the fusion of two protoplasms, also of different origin, and represented essentially by the directing spheres of the male and the female cell.—On the inclosures of nephelinic syenites found in the middle of phonolites from Höhgau and in some other beds; conclusions to be drawn from them, by M. A. Lacroix.—Observations of the parallelism of Upper Cretaceous strata of the Western Pyrenees (Lower Pyrenees and Landes), by M. Jean Seunes.—The sympathetic nerve of accommodation for the observation of distant objects, by MM. J. P. Morat and Maurice Doyon.—Researches on the existence of parasitic organisms in diseases of the crystalline lens of the eye of man, and on the possible *rôle* of these organisms in the pathology of certain ocular affections, by MM. Gallippe and L. Moreau.—On the employment of carbon bisulphide dissolved in water for the destruction of Phylloxera, by M. A. Rommier.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Glimpses of Nature: Dr. A. Wilson (Chatto).—Revelation of the Trinity: S. B. G. McKinney (Stock).—Oysters and all about Them, 2 vols.: J. R. Philpots (Richardson).—Die Veränderlichkeit der Temperatur in Österreich: J. Hann (Wien).—Monograph of the British Cicadæ, vol. ii. Part 6: G. B. Buckton (Macmillan).—A Guide-book to Books: edited by E. B. Sargant and B. Whishaw (Frowde).—Our Country's Flowers: W. J. Gordon (Day).—Primo Resoconto dei Risultati della Inchiesta Ornitologica in Italia; Parte Terza ed Ultima Notizie d'Indole Generale: E. H. Giglioli (Firenze).—Chambers's Encyclopædia, vol. vii. (Chambers).—Hand-book of the London Geological Field Glass: H. G. Seeley (Philip).—Teaching in Three Continents: W. C. Grasby (Cassell).—Bulletins de la Société d'Anthropologie de Paris, 4e fasc. (Paris, Masson).—Journal of the Chemical Society, June (Gurney and Jackson).—Quarterly Journal of Microscopical Science, vol. xxxii. Part 3 (Churchill).

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