THURSDAY, MARCH 3, 1887

ENDOWMENT OF MEDICAL RESEARCH

OUR readers will probably have seen that a memorial, signed by some of the most able and trusted leaders in science and in medicine, has been presented to the Council of the Royal College of Surgeons, asking it to consider the propriety of establishing a new institution for the prosecution of such branches of science as are most closely connected with the objects of the College. There is no doubt that the memorial will be carefully and maturely considered in a spirit worthy of the eminent men who guide the policy of the College, but it seems fitting that in these columns the excellence of the suggestion should be acknowledged, whatever may be found to be the best method of meeting it.

In the first place, all who care for English biology and English surgery can heartily rejoice that the College which has done so much for both is now in a position not only of dignity but of affluence. Just before the foundation of the present College, the Company of Surgeons which preceded it was almost bankrupt, and, by want of observing a legal formality, well nigh forfeited its charter. But for fifty years past the College has grown in honour and in wealth. Its Membership stands deservedly first among the surgical diplomas which admit to practice. Its Fellowship involves higher training and more thorough examination than most University degrees. It possesses the second Medical Library in the kingdom, and the most complete, extensive, and well-arranged Museum of Anatomy—human, comparative, and pathological—which exists in the world. The original Hunterian Collection which was purchased by the nation after the death of the great anatomist, was intrusted to the care of the College of Surgeons on condition of providing a suitable building and a competent Curator. The trust has been nobly dealt with. The museum left by Hunter, still cherished with reverence and still remarkable in varied aspects, has been many times multiplied by successive additions. Buildings of great size and admirable design have again and again been added. Curators have been appointed who have made their names familiar through Europe—Clift, Quekett, Owen, and Flower. And Hunterian Professors and Lecturers have been appointed who have made the Museum as well known as that of the Jardin des Plantes—Sir Everard Home and Sir Richard Owen, Huxley, Flower, and Parker, among anatomists; and, among surgeons, Abernethy, Cline, Astley Cooper, Laurence, Hilton, Fergusson, and Paget. Far from reserving its theatre for the veterans only, the College has shown a laudable liberality in founding Junior Lectureships; and now some of the most industrious, thoughtful, and brilliant of the younger generation of anatomists and pathologists are describing their new investigations from the Chair of the Hunterian Museum.

Now, however, there seems to be a probability of the College making another and an enduring addition to the benefits which it has conferred on science.

A large bequest has enabled them seriously to consider the foundation of such an institution as is suggested in the memorial above mentioned. With some the impulse to save is stronger than the impulse to spend; and even if it is determined to spend the Wilson bequest, part at least might be safely applied to further extension and improvement of the Museum, fresh buildings, and an increased staff of officials. Still we hope that it may be found possible to meet such current needs by current income, and that the large sum placed at the free disposal of the College will be devoted to some new, useful, and appropriate scientific purpose.

The appropriate purpose is not far to seek. A museum is necessary for the study of anatomy, the one half of the science of living creatures; but for the prosecution of the other half, for the study of physiology, a laboratory is needful, where the physical, chemical, and vital phenomena of man and animals can be observed. Hunter himself was never content with the mere demonstration of a fact in living structures, normal or diseased. His acute and fertile intellect at once inquired: How came it about? What is its use? Of what process is it the evidence? How can that process be either checked or fostered for the relief of suffering and preservation of life?

The progress of knowledge since Hunter's day has vastly increased our power of dealing with these questions: many have been already more or less perfectly answered; more are ripe for solution to anyone who can give time and pains to the work; and most lie still untouched, a rich and virgin field ready to reward the man of thought as well as skill. But the methods of research have become more and more elaborate. The easy things have been done; or rather what was once hard has now become easy, and what once was impossible is now practicable, with greater expenditure of time and money. The change is only what has taken place in navigation, in war, and in engineering. Few scientific investigations can now be carried on except in properly equipped laboratories.

There are many departments in which work is urgently needed, and in which our own country is discreditably behindhand. In Germany and France and America, even in smaller countries like Holland and Sweden, adequate, or something like adequate, provision is made for the investigations of which we speak. Edinburgh has made great strides of late years, and there the University laboratories of physiology and pharmacology are worthy of the place. Cambridge has, since Prof. Foster was called to the University, been known through Europe for the first time as a great school of physiology. Oxford has lately built and furnished a laboratory for Prof. Sanderson. But London is still far behind the three chief Universities of the kingdom, and behind Paris and Lyons, Strassburg, Berlin, Leipzig, Bonn, and a host of petty towns in Germany.

It is true that before he was carried away to Oxford Dr. Burdon Sanderson had established a laboratory at University College which is a credit to London, and where work of the best kind has been and is being done. At King's College, though the accommodation is not what it should be, Prof. Gerald Yeo and his assistants put forth no less excellent results. In two at least of the great medical schools physiological laboratories have long existed, and have contributed to the progress of knowledge, as well as to instruction. Lastly, the titular University of London has, owing to the exertions of two or three of its medical graduates on the Senate, founded an institute for the study of comparative pathology which, under Sanderson, Klein, Greenfield, Roy, and Horsley, has accomplished results of great benefit both to domestic animals and to man.

If, however, physiology and pathology are to some extent provided with means for research, others of the sciences allied to medicine and surgery are absolutely destitute. Physiological chemistry has scarcely existed in England since the days of Prout, and at the present day there is not a single laboratory where this difficult and important branch of knowledge is pursued. When Dr. Gamgee's excellent text-book is completed, the Index Auctorum will scarcely contain an English name.

Pharmacology—the experimental investigation into the action of drugs—is another foreign science. Fraser and Brunton have done much to redeem this country from absolute sterility, but in London there ought to be a laboratory like that of Prof. Schmiedeberg for this most obviously and practically useful of all medical sciences.

A laboratory for the study of Physiology would be the most closely connected with the memory of Hunter, with the Museum, and with the traditions of the College. A laboratory of physiological, pathological, or therapeutical chemistry would perhaps fill the most absolutely vacant space. A laboratory devoted to the direct study of the nature, origin, and propagation of Diseases, to their prevention, and to surgical methods of treatment would be the most directly useful and probably the most immediately fruitful.

So much is needful before England can begin to contribute her fair share to the common sum of knowledge, that it is scarcely possible to go far wrong in deciding what branch of medical science should first be taken up.

The Royal College of Surgeons has a great opportunity, and one that is not likely to return. If the great accession to its resources should be frittered away on a multitude of objects, the opportunity will be missed, and probably for ever. But we cannot doubt that the leading scientific surgeons in the kingdom will decide on using the Wilson bequest for the endowment of some new and urgently needed institution for research, which will be an honour to the College, a credit to the nation, and an instrument for increasing knowledge and diminishing suffering for centuries to come.

THE ELECTRIC MOTOR

The Electric Motor and its Applications. By T. C. Martin and Jos. Wetzler. (New York: Johnson, 1887.)

CONSIDERING the very rapid strides that have been made during the past six years in the industrial application of electric motors, the appearance of this handsome volume, giving the latest information on this topic, is thoroughly timely. It constitutes, though somewhat popular in style, a welcome addition to the library of the electrical engineer. Those who are accustomed only to the slow and steady development of industries in the Old World can hardly appreciate the revolution that is setting in in consequence of the employment, especially in small workshops and factories, of electric motors in place of steam-engines or gas-engines. They win their way because, though the actual cost of power is no cheaper, the expense of the electric motor is less than that of the steam-engine or gas-engine. It is less troublesome to keep in order, takes less room, runs at a more uniform speed, and is more cleanly. What wonder, then, that thousands—literally—of electric motors are already in use in New England, where an invention is welcomed, not sneered at, because it is new.

Much of the volume before us has already seen the light in another form in the pages of our American contemporary, the *Electrical World*, but the matter has been very carefully edited and arranged. It is by no means a scissors-and-paste affair; but a well-considered treatise, abundantly illustrated with drawings of motors and of their various applications. It treats the subject both historically and systematically.

The first chapter is devoted to an exposition of the elementary principles of electric motors. Almost at once we are plunged into the essence of the matter, the development in the armature of the motor of the counter-electromotive force, that *crux* of the untrained electrician. In this connection Jacobi's law, that the electric motor does its greatest possible work when it diminishes the original current to one-half, is given, and correctly given, not as a law of maximum efficiency, for which it has been so often mistaken, but as a law of maximum activity. But the authors have missed the point that Jacobi's law even in this sense is only true when the condition of supply of the electric energy is that of a given constant electromotive force. Jacobi's law would obviously not apply to motors placed in a circuit in which the given condition of supply was that of a constant current. The chapter concludes with some very apposite remarks on the general principles of construction of electric motors, quoted from a paper in the *Philosophical Magazine* by an English electrician, Mr. W. Mordey.

Chapter II. is devoted to early motors and experiments in Europe, from Barlow's wheel and the primitive engines of Jacobi and Froment down to the famous Pacinotti machine. The complement to this narrative is found in Chapter III., which deals with the early motors and experiments in America, beginning with Davenport in 1837. The most celebrated of these was that of Prof. C. G. Page, who succeeded in constructing a motor of 10 horse-power. The authors incidentally mention that, in the period of the Civil War, between 1860 and 1867 not a single patent on electric motors was issued in America.

Chapter IV. deals with the electric transmission of power, as developed successively by Pacinotti, Fontaine, and Marcel Deprez. In this connection the theory of the efficiency of electric transmission is explained by the use of graphic diagrams in which the areas are proportional to the energy transmitted or to the work performed. The experiments of Marcel Deprez are mildly criticised, and rules for calculating the cost are given.

The modern electric railway and tramway in Europe occupy Chapter V. Here several of Siemens's tramways are described, also those at the Giant's Causeway, at Brighton, and at Blackpool. Chapter VI. gives a similar account of the modern electric railway and street-car line in America. From this account it appears that Mr. Stephen D. Field is in America awarded the sole right to use "the combination of an electric motor operated by means of a current from a stationary source of electricity conducted through the rails," which "combination" he patented in 1880. Drawings of the electric locomotives of Field, Edison, Daft, and others, are given. Several electric railroads of some magnitude are at work in the States. Chapter VII. resumes the subject of street railways in which storage batteries are employed for driving the electric motors. The work done in this country by Mr. Reckenzaun receives due recognition, and Mr. Elieson's tramway engine is also described. The industrial application of electric motors in Europe and in America occupies the next two chapters, the special form of motors devised by Profs. Ayrton and Perry being noticed in the one and those of Griscom and Daft in the other. Electrically-propelled boats and balloons are treated by themselves; so also is the subject of telpherage. This subject—the transmission of freight along a wire road by electricity—originated with the late Prof. Fleeming Jenkin, and it has found imitators in America. The twelfth and last chapter is devoted to the latest American motors and motor systems, the motors of Brush, Sprague, Van de Poele, and others, being here described at length.

And here we must pause to point out the one blot on this otherwise excellent work: namely, that the entire theory of the self-regulating motor, which was discovered and worked out in 1882 by Profs. Ayrton and Perry, and which forms the basis of their epoch-making paper read in 1883 before the Society of Telegraph-Engineers, is appropriated *en bloc*, and accredited to Lieut. Sprague. From p. 160 it appears that Sprague's method of securing self-regulation is to use a differential compound winding; but this is exactly Ayrton and Perry's method. Even the equation on p. 161, which is given as the Sprague law of winding, is identical with the equation given on p. 367 of the present writer's book (edition of 1884) on dynamo-electric machinery in the section on the theory of the differential compound winding. Another matter credited to Mr. Sprague by the authors is the discovery of a motor which, when supplied at constant potential, runs faster when the strength of the magnetic field is diminished. But this is no new principle: it is an inherent law of nature, common to all motors old and new, being the simple converse to the equally fundamental fact that a dynamo, if it is to generate a constant electromotive force, must be run faster in a weak field, and may be run slower if the field is strengthened. Lieut. Sprague has done good work in producing motors of excellent design and having points of original merit: this we may freely acknowledge without ascribing to him what was known before his work was begun. The authors will do well to correct these slips in the second edition, which will probably soon be demanded. The book is creditable alike to authors and publisher.

SILVANUS P. THOMPSON

THE FLORA OF LEICESTERSHIRE

The Flora of Leicestershire, including the Cryptogams. With Maps of the County. Issued by the Leicester Literary and Philosophical Society. 372 Pages and 2 Maps. (London and Edinburgh: Williams and Norgate, 1886.)

THE county of Leicestershire covers an area of 800 square miles of the centre of England, at the summit of drainage between three of the great streams, the Trent, the Severn, and the Midland Ouse. Almost the whole of the county is at least 100 feet above sea-level. A large portion of the surface is between 300 and 500 feet, and Charnwood Forest rises at its highest point to 900 feet, so that Leicestershire is very different from such low-lying level Midland counties as Cambridgeshire, Bedfordshire, and Huntingdonshire. Half the area of the county is in grass, about one-quarter is under arable cultivation, and there are 20 square miles of woodlands. In Charnwood Forest there are slate and granite, and the sedimentary rocks are represented in the county from the middle of the Palæozoic to the middle of the Mesozoic series—Carboniferous Limestone, Coal-measures (Permian missed out), Trias, Lias, and Lower Oolite—so that there is every variety of soil.

Competent botanists have resided in the county for the last three generations. The fathers of Leicestershire botany are Dr. R. Pulteney, F.R.S., who was a surgeon at Leicester, and the author of "A General View of the Writings of Linnæus" (1781), and the well-known "Historical Sketches of the Progress of Botany in England up to the date of the general adoption of the Linnæan System" (1790); and the poet Crabbe, who lived at Belvoir from 1782 to 1813, when he removed to Wiltshire. Between 1820 and 1850 Leicestershire was the home of three clergymen, all of whom were enthusiastic botanists. The Rev. Andrew Bloxam lived at Twycross for more than forty years. He is best known as one of the special investigators of the British brambles, and partly, perhaps, because he worked them so thoroughly there is a general idea that Leicestershire is the richest county in England in forms of this complicated genus. He was one of the last survivors who kept up the old tradition of botany as it was in the days of Smith, Hooker, Turner, Dillwyn, and Forster, when a collector swept through the whole vegetable kingdom, from the flowering plants down to the fungi. The Rev. W. H. Coleman was a most energetic and capable botanist. He was for many years one of the masters of the Ashby-de-la-Zouch Grammar School, and it was he who laid the basis of the present work, dividing the county into a dozen districts, and tracing out the distribution of the plants through them as fully as he had opportunity. He died in 1864, and in 1875 his manuscript was handed over by his friend Mr. Edwin Brown, of Burton-on-Trent, to the Leicester Literary and Philosophical Society, which appointed a Committee to amplify and revise it. Of this Committee Mr. Mott, of Leicester, has acted as Chairman, and Mr. Carter, Dr. Finch, and Messrs. E. and C. Cooper are the other members. The other clergyman who worked in conjunction with Messrs. Bloxam and Coleman was the Rev. Churchill Babington, for many years the Disney Professor of Archæology at Cambridge, and now Rector of Cockfield, in Suffolk. In 1850 Miss Mary Kirby (now Mrs. Gregg) published a small flora of the county, which contained a substantially complete list of the flowering plants and ferns of Leicestershire, but no attempt was made to trace out their distribution in detail.

In the present work the number of flowering plants and ferns, native and naturalised, in Britain is estimated at 1546, and of these, 825 are admitted for Leicestershire. This number of 1546 is reached only by counting the subspecies of such variable types as *Ranunculus aquatilis* and

Rubus fruticosus, and by including a large number of plants that have no claim to be considered as really wild, such as *Linaria Cymbalaria*, *Corydalis lutea*, and the wall-flower. Mr. Watson's estimate was 1425, and, as compared with this, the flora of Leicestershire will stand at a little over 700. He worked out carefully in detail the distribution over the island of all these species, and showed that they fall into, broadly speaking, three geographical or climatic groups: that 532 species are spread generally over the whole island; that 606 species represent southern climatic and geographical influences; and that 238 species represent the boreal element in our flora, and are plants that are thoroughly at home only in the north of Scotland, and are found in England and Wales only in mountainous tracts. In any county, or other tract of land, the great mass of the flora always consists of the 532 generally-diffused plants, and the climatic difference between one county and another is shown by the extent to which the characteristically northern and southern types are represented. It adds very much to the interest which any book on local botany has for the non-resident general reader, if the writers keep these three climatic groups distinct in their minds, and give as complete an idea as possible of the way in which, and the extent to which, the austral and boreal types are represented in the area of which they treat. The writers of the present "Flora" have not attempted to give any general summary worked out upon this basis, and they are quite mistaken in supposing that their county includes three out of Watson's six climatic zones. Watson's infer-agrarian zone includes the low-level country south of the Humber and the Dee. Its characteristic types are such plants as *Clematis Vitalba*, *Rubia peregrina*, *Geranium rotundifolium*, *Trifolium subterraneum*, *T. suffocatum*, *Lathyrus Nissolia* and *L. Aphaca*, and *Centaurea Calcitrapa*. Watson's mid-agrarian zone includes the low levels of the north of England, up to a height of 900 feet above sea-level on the mountains of Yorkshire and the Lake District. Its upper limit is marked by the cessation (essential from climatic causes, not accidental) of fruticose Rubi, *Rosa arvensis*, *Pyrus Malus*, *Viburnum Opulus*, and *Alnus glutinosa*. Above this, up to the line of possible arable cultivation, extends the super-agrarian zone, with an average annual temperature of 42° to 45° F. The only county south of the Humber and Trent in which it is represented is Derbyshire. There do not appear to be in Leicestershire more than ten or a dozen out of the 238 boreal plants, such as *Lycopodium Selago*, *Empetrum nigrum*, and *Drosera anglica*, and these are either very rare or quite extinct. There is no saxifrage except *granulata* or *tridactylites*, no wild bird-cherry, no *Andreæa*, no *Polypodium Phegopteris* or *Dryopteris*. To understand their county and its flora in their proper relation to the rest of England, Mr. Mott and his colleagues must revise completely their ideas on this subject. The county would appear to be essentially a mid-agrarian outpost, pushed out from the Pennine Chain into the centre of England; for, out of the 600 austral types, not more than about 150 enter into it, which is fewer than there are either in North Yorkshire or at the Lakes. The limestone types, the occurrence of which is regulated more by soil than climate, appear to be well represented.

For the way in which the details of the flora are worked out, we have nothing to give but commendation. In the identification of the Phanerogamia, great pains has evidently been taken by the Committee. No doubt some of the species, which they admit on the authority of their predecessors, will prove to be blunders, as, for instance, *Tofieldia palustris*, *Carduus heterophyllus*, and *Asplenium viride*. When the members of the county society make their excursions into the different districts, they will be able to see at a glance what plants have been gathered there by their predecessors. The flora includes, not only the Phanerogamia and ferns, but also the mosses, Hepaticæ, lichens, Algæ, and fungi. It is not likely that there are many fresh Phanerogamia or ferns still to find; but as only 4 Characeæ, 179 mosses, 49 Hepaticæ, 177 lichens, and 446 fungi are known, there is ample scope for further work in all these orders. The portion of the book devoted to Algæ, which is ably edited by Mr. F. Bates, of Leicester, contains descriptive notes on many of the less known species. There is an interesting note on p. 344, on the species which have become extinct. They are 30 in number, and are nearly all plants of swamps and heaths, amongst them being *Lycopodium Selago*, *Osmunda regalis*, *Pinguicula vulgaris*, *Drosera anglica*, and *D. rotundifolia*.

The book will be still more interesting when we have good floras of Warwickshire, Nottinghamshire, Derbyshire, and Cheshire to compare it with, and for all these counties "Floras" are in course of preparation.

J. G. BAKER

GEOLOGY OF JERSEY

Géologie de Jersey. Par Le P. Ch. Noury, S.J. (Paris: F. Savy; Jersey: Le Feuvre, 1886.)

CONSIDERING that Jersey became subject to the Crown of England at the time of the Norman Conquest, English geologists may agree with M. de Lapparent's complaint as to the neglect the island has hitherto received. Although the Geological Society of London made it their earliest care to publish in 1811 (not 1817, as quoted in the opening of this little volume) MacCulloch's paper on the Channel Isles, although at the present time more than one worker is engaged in further removing the reproach, M. Noury is even now well to the front in providing in a handy form an account of the structure of Jersey serviceable to inhabitants and visitors alike. The character of this well-printed *brochure* presupposes, however, some general knowledge of geology, and the author is perhaps not so uniformly happy as, let us say, the Rev. W. S. Symonds in placing his facts before the intelligence of the untrained tourist. Some controverted matters, moreover, of purely speculative value are introduced, such as the construction of the primitive crust (p. 126), the succession in time of granite, syenite, and diorite, and the formation from these of schists and gneisses by disintegration in a heated ocean. The description of the prevailing rocks is the work of a close observer in the field; and the careful mention of such materials as have been artificially introduced ("cultivated rocks," one might almost call them) cannot be too highly praised. Future geologists will thus be spared the description of gneissic fragments (p. 6) imported as ballast from Brazil.

The suggested derivation of "pyromeride" (p. 29)—

"*partagée dans le feu*"—is not historic, Haüy's and Monteiro's name referring to the different fusibilities of the two constituents of the spheroids. We doubt also the primary origin assigned to the chalcedony with which the hollows of these old rhyolites are so often filled. Here, as is so frequently the case among Continental writers, the immense importance of secondary changes appears to be overlooked. In one of these lavas M. Noury has found a spherulite measuring 18 inches in diameter. The "sphérolithes," however, of certain diabase veins (p. 41) would appear to correspond to the spheroidal structure of weathered basalt rather than to the contemporaneous volcanic bombs suggested by the author.

The account of the connection between open fissures and the decomposition of dykes, and of the origin of the numerous bays, as well as of the larger inland features, is full of interest to the visitor. In the review of the history of the island the discussion of recent elevation and depression is too lengthy to allow of justice being done to the evidence relied on for the ages assigned to the various types of rock—evidence derived solely from comparison with the mainland of France. The scanty preservation, moreover, of Secondary deposits in the Hebrides makes one cautious in accepting the conclusion (p. 139) that Jersey has remained above water since Permian times. M. de Lapparent has, indeed, recently stated that the final conglomerate may be of Triassic age.

The book is written in the lucid and attractive style that French men of science have taught us to expect. A coloured geological map forms a handsome and valuable addition. G. C.

OUR BOOK SHELF

General Biology. By William T. Sedgwick, Ph.D., and Edmund B. Wilson, Ph.D. Part I. Introductory. (New York: Henry Holt and Co., 1886.)

THIS work has been planned by the authors as an "introductory study" to biological science, after digesting which the learner may proceed to Huxley and Martin's "Practical Biology," Brooks's "Hand-book of Invertebrate Zoology," or to a second part of the present book, which is promised to be ready some time this year.

In the first four chapters of the introductory portion, Messrs. Sedgwick and Wilson deal with the generalities of biology—that is, with the nature and properties of protoplasm and the origin and modification of cellular tissues. In the remaining chapters they discuss at full length the two types selected to illustrate the two principal modifications of life. These are, the common brake (*Pteris*) and the earthworm (*Lumbricus*). The embryology and physiology of the selected types are as fully dealt with as the pure morphology. At the end of each chapter a scheme of practical work is given, which may in some cases be of much value.

On p. 123 it is stated that "all the organs of the body are originally developed from the walls of these chambers"—that is, the chambers of the body-cavity formed by the dissepiments. But it is a well-known fact that, as has been previously stated by the authors themselves (p. 152), the nerve-cords and ganglia are developed from the epiblast, or, as Messrs. Sedgwick and Wilson prefer to call it, the "ectoblast." Such being the case, it is obvious that the nerve-cords are not developed from the mesoblastic chambers.

Another and more serious error will be found on p. 143, where the *vesiculæ seminales* of the earthworm are described as the *testes*. It has been conclusively shown by Bloomfield that the large white bodies which fill up the tenth and eleventh somites of *Lumbricus* are really the *vesiculæ seminales*. The true *testes* are very small bodies, only present at certain periods of the year. There are two pairs of them, in the eleventh and twelfth somites. The *spermatozoa* are not fully matured in the *testes*, but pass into the *vesiculæ seminales* to complete their development.

Notwithstanding these few errors, Messrs. Sedgwick and Wilson's introductory essay is well adapted for the use of junior students in biology. Moreover, it is adequately illustrated by well-drawn woodcuts, far exceeding in clearness of execution the average of those found in American text-books.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Industrial Studentships

I AM directed to request that you will be so good as to allow me, through the medium of your columns, to inform manufacturers and others engaged in industries in which art is more or less concerned, that the Lords of the Committee of Council on Education have decided to make arrangements for the admission of a limited number of persons employed in those industries to study in the South Kensington Museum, Library, and Schools, without the payment of any fees, for periods of from two to nine months according to circumstances.

Detailed rules with regard to these working studentships will be sent on application to the Department. Briefly, the conditions may be stated to be that the designer or workman for whom admission is sought shall show that he has sufficient power of drawing and sketching to be able to profit by the opportunities afforded; that he is actually engaged in some art industry; and that the proprietors of the works in which he is engaged undertake to maintain him while he is studying at South Kensington. When admitted, the working student will be set, under direction, to study in the Museum and Art Library from examples relating to the industry in which he is employed, and he will also receive instruction in drawing and designing in the Art School, suited as far as may be to his special case.

My Lords have taken this step with a view to render the Museum of more special and direct use to the country, and they trust that the valuable collection of examples of applied art which has now been brought together may thus be more fully appreciated and taken advantage of by the directors of industry in the country. J. F. D. DONNELLY

Science and Art Department, February 28

Top-shaped Hailstones

IN connection with the abnormal fall of rain which is taking place this cold weather in the North-West Provinces of India, and which has clothed the outer ranges of the Himalaya with snow down to the 5000-feet level, I should like to mention a fall of hailstones which occurred on January 21 near Ramnagar, in the Terai. The hailstones were not very remarkable for size, being generally one-third of an inch across, with here and there a larger one half an inch in diameter. Some peculiarities of shape and structure, however, arrested my attention. Nearly every one that was not deformed by collision was top- or pear-shaped. Owing to their rebounding from the ground, it was impossible to see whether the broad or pointed end fell foremost; but in every case the broad end was composed of perfectly hyaline, amorphous ice, whilst the pointed end was banded crosswise by alternate layers of clear and white ice. In every case this distinction was perfectly well marked.

In some few instances I found hailstones of another, but probably derived form. Instead of being circular in section at right angles to the long axis, they were triangular, so that they bore a strong resemblance to the kernels of a beech-nut. The

broad end in this case also was perfectly transparent, and the sharper end banded as before.

I append three diagrams representing typical forms.

Ramnagar, Terai, January 25 C. S. MIDDLEMISS

Snowflakes

IN your issue of January 20 (p. 271) is an interesting sketch of the snowstorm of January 7, 1887, with mention of snowflakes 3½ inches long. Without vouching for the exact details I send you some statements from a letter in the *New York World* of to-day's issue. The letter is dated Fort Keogh, Montana, U.S., February 13. "The winter of 1886–87 will be long remembered throughout the north-west for the extreme severity of the temperature and the unusual depth of snow. From January 6 to 11 the degree of cold was something frightful. Mercury thermometers were often congealed, and spirit thermometers were kept jumping from 40° to 60° below zero. Half a dozen times has the 60° notch been touched, and once this season 62½° below zero has been scored on the Saskatchewan plains. But the authorities in weather in this country are the Indians. The oldest members of the Crow tribe say there have been few such winters as the present since they settled in the Yellowstone Valley. Curious phenomena sometimes attend a snowstorm. Near Matt. Coleman's ranch on January 28 the flakes were tremendous, some were larger than milk-pans. Some flakes measured 15 inches square and 8 inches thick. For miles the ground was covered with such bunches, and they made a remarkable spectacle while falling. A mail-carrier was caught in the same storm and verifies it." The narrative is one of great suffering, and loss of human lives and cattle. "Miss Maggie Bunn, school-teacher at Highmore, while going from the school to her house was frozen to death. The bodies of three Indians who belonged to Berthold Agency were found frozen near Ashland." And so on, in harrowing detail, for a number of whites perished. SAMUEL LOCKWOOD

Freehold, New Jersey, U.S.A., February 14

"Invisible at Greenwich"

I WRITE to note an apparent oversight which I have detected in the *Nautical Almanac* for 1888. The partial solar eclipse of August 7 is stated to be "invisible at Greenwich," but on applying a rigorous calculation I find that it will be visible there to a small extent, the times of contact being as follows:—

	G.M.T. h. m.	Angle from N. pt.	Angle from vertex
First contact	6 53 ...	11° to E. ...	26° to W.
Greatest phase ...	7 3 ...	·013 (sun's diam. 1)	
Last contact	7 13 ...	30° to E. ...	7° to W.

the angles being for the direct image.

I am aware that this is a very insignificant eclipse, but the greatest attainable accuracy is desirable in our national ephemeris, which, indeed, inserts eclipses much slighter than the above, *e.g.* the lunar eclipse of November 26, 1890, whose magnitude is only ·002. A. C. CROMMELIN

Trinity College, Cambridge, February 15

Lunar Halos

LAST evening (February 8), about a quarter-past eight o'clock (75th meridian time), I saw around the moon a series of coloured rings lying close together. The inner one was two or three diameters of the moon from the moon and *red*, the next was violet, then red, and finally violet again, this last one being very faint. From their proximity to the moon these rings seem to constitute the coronal, but I am puzzled by the fact that the inner ring was red. Do halos ever occur so close to the moon and without an interval between the two pairs of red and violet rings?

February 12.—Since writing to you on the 9th inst. I have found that my colleague here, Prof. W. G. Brown, noticed the rings around the moon about half an hour before I saw them. He says the colour nearest the moon was *yellow*, passing into red outwards, and that immediately following the red was violet, then the colours of the solar spectrum in order from violet to red on the outside. This indicates that the first red was really outside a violet ring which for some reason was invisible, and brings the phenomenon properly under diffraction: in fact, we had a good example of the coronal with the innermost rings wanting. S. T. MORELAND

Washington and Lea University, Lexington, Va., U.S.A.

The Beetle in Motion

IF it can interest Prof. Lloyd Morgan I am in a position to communicate that I have many times observed the progressive movements of insects, spiders, and myriapods. I have not noticed the retardation of hind-legs; it seems to me that this occurs only in the case of bulky and slow-moving beetles, like the larger Melasomata. In general, I find that the mode of progression in articulates does not differ essentially from what we see in vertebrates; the process is only, at first sight, a little obscured by the plurality of the legs. If we consider only the prothoracic ring of a beetle, we find that it walks like all bipeds, alternating one leg with another. Two segments walk in the manner of quadrupeds, which are not amblers. Now the legs of the third segment must necessarily repeat the movements of the legs of the first segment, for the sake of equilibrium. The fourth ring would repeat the movements of the second, and so on.

Tashkend A. WILKINS

A Recently-Discovered Deposit of Celestine

WITH reference to Mr. Madan's letter (p. 391), on "A Recently-Discovered Deposit of Celestine," I beg to inform him that a note was read by me at the last meeting of the Mineralogical Society, describing these crystals as exhibiting a habit and size unknown till then to occur with such crystals of celestine in England. I obtained the crystals at Christmas, from Mr. Henson, of the Strand, and am expecting to receive more material, which I hope to work on at the end of Term; but, unlike Mr. Madan, I have at present been unable to visit the locality where they are found. R. H. SOLLY

Mineralogical Museum, Cambridge, February 28

The Vitality of Seeds

MAY I ask, through the columns of your widely-circulated paper, whether there is any really trustworthy evidence for the following statement made by Prof. Judd in his address to the Geological Association (p. 393 in your last issue): "The botanist cites the germination of seeds, taken from ancient Egyptian tombs, as a striking illustration of how long life may remain dormant in the vegetable world." I know that this is a popular belief, but should like to learn upon what foundation it rests. Probably it would interest other botanists besides.

February 26 N. E. P.

THE RELATIONS BETWEEN GEOLOGY AND THE MINERALOGICAL SCIENCES[1]

II.

LET us now turn from the statical aspect of minerals, their morphology, to the dynamical aspects, their physiology.

Minerals are not fixed and unchangeable entities, as they are sometimes regarded. On the contrary, they exhibit varying degrees of instability, and pass through very definite series of metamorphoses.

We have already seen that every alteration in the temperature or other conditions which surround a crystal leads to striking modifications of molecular structure, which are at once revealed by the delicate tests of optical analysis. So sensitive, indeed, are some crystals to the action of external forces, that even the passage of the

[1] Address to the Geological Society at the Anniversary Meeting on February 18, by the President, Prof. John W. Judd, F.R.S. Continued from p. 396.

light-waves through their substance leads to permanent molecular rearrangements which are evidenced by marked changes in colour, translucency, and other properties.

Many minerals have their atoms so arranged that the action of external forces causes them to fall readily into new combinations. In this way there are brought about such paramorphic changes as that of aragonite into calcite, and augite into hornblende. Excessively slight manifestations of force are sometimes sufficient to induce such paramorphic changes.

But the most significant fact of all is that every crystal possesses certain peculiarities of molecular structure, and as the result of this internal "organisation," it responds in a definite manner to the action of various external forces, undergoing in this way well-marked series of physical and chemical changes without losing its identity. As the final result of such successive changes, however, the bonds which hold the "organised" structures together are gradually weakened, and at last break down altogether. In this way the separate existence of the mineral comes to an end; but the materials of which it was composed, resolving themselves into new compounds, may go to build up the substance of other "organised" structures. Need I point out that in all these respects minerals behave exactly like plants and animals?

But in the case of plants and animals changes such as these, which are the direct outcome of external forces acting on a special organisation, are called *physiological*, and I know of no valid reason why the same term should not be employed in the case of minerals. It is true that the accomplishment of the cycles of change in minerals often requires periods of time of enormous duration, and that during incalculable intervals they may appear to be wholly suspended; but in these respects the "life" of a mineral differs from that of a plant in just the same manner as the latter does from the life of an animal.

I must ask your attention for a few moments to these peculiarities of internal organisation in minerals, and to the way in which the various physical and chemical forces act and react upon them in consequence of their special organisation.

Recent researches have shown that every crystal possesses a number of planes, all of which are related to its peculiar symmetry, along which the several physical forces operate in a marked manner to produce changes in the physical and chemical properties of the crystal. These planes have been called the "structure-planes" of the crystal.

By far the most obvious of these structure-planes of crystals are those of cleavage. When crystals are subjected to the action of mechanical force they break up along one, two, or three definite planes, with varying degrees of ease. In some cases when this separation cannot be readily effected by percussion or pressure, it may be brought about by the unequal expansion and contraction in a crystal resulting from alternate heating and cooling. We cannot arrive at the limit of this liability of a crystal to separate along its cleavage-planes; if we powder a calcite-crystal and examine the fine dust under a microscope, each minute grain will be seen to have the form of a cleavage-rhomb of the material.

Now the exquisite molecular structure of a crystal, of which this wonderful property of cleavage is the outcome, is borne witness to, not only by the perfection of the cleavage-surfaces—presenting, as they do, a lustre which no artificial polish can imitate—but by the fact that each particular set of cleavage-surfaces presents definite characteristics, analogous to those seen in the actual faces of crystals. Each exhibits striking peculiarities in its mode of reflecting light; each yields in varying degrees to a hard point drawn across it in different directions; and each, when treated with appropriate solvents, is attacked in a characteristic fashion, giving rise to the geometrical forms known as the etching-figures. Wonderful as these cleavage-surfaces are, however, it must be remembered that the power of cleavage is one that, under ordinary circumstances, remains altogether *latent* in crystals.

Cleavage-planes, however, are not the only latent structure-planes in crystals. Long ago it was shown by Brewster, Reusch, and Pfaff, that when minerals are subjected to pressure in certain directions, their molecules appear to glide over one another along certain definite planes within the crystal; and, if we examine optically a crystal which has been treated in this manner, it is actually found to exhibit a series of twin-lamellæ arranged parallel to the so-called "gliding-planes." It thus appears that in the movements set up within a crystal by the application of force from without, certain of the molecules of which the crystal is built up, lying in bands parallel to the gliding-plane, are actually made to rotate through an angle of 180°.

At one time these "gliding-planes" were regarded as being peculiar to a few minerals, such as calcite and rock-salt; but the investigations of Frankenheim, Baumhauer, Foerstner, and especially of Mügge, have shown that they exist in crystals belonging to every group in the mineral kingdom, including all those minerals which occur as common rock-forming constituents, such as the feldspars and pyroxenes.

As is the case with the cleavage-planes, so with the gliding-planes, there may exist one, two, or three in the same crystal. One of these is usually a principal gliding-plane—the slipping movement with its accompanying twin-lamellæ being produced parallel to it with the greatest facility—while the others are subordinate ones.

Strange to say, however, the particular gliding-plane along which a crystal yields appears to be determined, not only by the direction in which the force is applied, but to some extent also by the nature of that force, whether percussive, or a sustained pressure, or a violent stress; in some cases where the application of external force fails to produce the gliding movement with its accompanying lamellar twinning, it may be induced by the strains which result from unequal expansion and contraction during the heating and cooling of a crystal. Some mineralogists have, indeed, proposed to apply distinctive names to the results which follow from the application of different kinds of force—whether a blow (*Schlagfiguren*), pressure (*Reissflachen*), or the effect of heating and cooling (*Contractionrisse*).

The gliding-planes of crystals are quite distinct from the cleavage-planes, though some very curious and interesting relations have in certain cases been shown to exist between them. That the artificial formation of twin-lamellæ, like the production of cleavage, is rendered possible by complicated molecular structures, it is scarcely necessary to point out. The application of external force to such crystals is like the putting of a spark to a train of gunpowder: the molecules lying in parallel bands are in unstable equilibrium, ready, so soon as set in motion, to roll through an angle of 180°.

There is still a third and even more subtle set of structure-planes in crystals to which I must now allude, those, namely, for which the name of *solution-planes* has been proposed.

It was long ago shown by Daniell that when crystals are exposed to the action of solvents they are attacked in such a manner as to give rise to peculiar geometrical forms. The subject has been followed up by Baumhauer, Leydolt, Becke, and others, who have shown what a wonderful variety of "etching-figures" may be produced by operating upon the various faces and cleavage-surfaces of different crystals.

Quite recently, however, it has been shown by Von Ebner, as the result of his studies of calcite and aragonite, that all the complicated phenomena of the etched figures arise from the existence of planes along which solvent or chemical action takes place most readily within a crystal. It thus appears that the complicated etched figures, with their curved and striated surfaces, are indications of the combination or oscillation of tendencies to chemical action along the different solvent-planes of the crystal.

My own experiments have enabled me to show that the chemical action taking place along the solution-planes of crystals leads to the development of cavities, often assuming the forms of negative crystals, which may become wholly or partially filled with the product of the chemical action.

Although the solution-planes are quite distinct, both from the gliding-planes and the cleavage-planes of crystals, I have been able to show that some curious and interesting relations exist between them. If lamellar twinning has been already developed in a crystal, then chemical action takes place along the gliding-planes in preference to the normal solution-planes.

It is only when we study the minerals building up the rock-masses of the globe that we fully realise the importance of these molecular structures, and the wonderful changes which crystals are capable of undergoing, as a consequence of their internal "organisation." Then, and then only, do we begin to understand the significance and the far-reaching consequences of the physiological changes of which minerals are susceptible.

The crystals forming the rock-masses of the globe have been subjected to every variety of mechanical force—violent fracture, long-continued strain, steady but enormous pressure—prolonged over vast intervals of time, to which must be added the potent effects of alternate heating and cooling. Such crystals, moreover, are transfused through their whole substance by various liquids and gases acting under tremendous, and sometimes varying, pressures.

Under such circumstances it is not surprising to find that the crystals have often yielded along their cleavage-planes, and that cleavage-cracks have been produced. These, by affording a ready channel for the passage of solvents, not unfrequently determine the course of various chemical operations going on within the crystal.

Not unfrequently, too, the rock-forming minerals have yielded along their gliding-planes, and the development in them of twin-lamellæ is the result. Every crystal of calcite in an ordinary metamorphic limestone, and many of the plagioclase feldspars in igneous rocks, exhibit the secondary lamellar twinning which has arisen from the action of mechanical forces upon the mass.[1] The microcline structure in orthoclases, with many other similar structures in other minerals, must almost certainly be ascribed to the same cause.

Still more remarkable are the consequences which follow from the existence of the solution-planes in crystals. By the action of various solvents under pressure, augite is made to assume the forms known as diallage and pseudo-hypersthene, the ferriferous enstatite of bronzite or hypersthene, while the feldspars acquire their avanturine, schiller, and chatoyant phenomena. When, in addition to the statical pressures due to thousands of feet of superincumbent rocks, these solvent agencies work with those tremendous dynamical aids afforded by deforming stresses, such as make the rocks to flow during mountain-making, it is not surprising to find the molecules of the original crystals breaking from their old allegiances, and the liberated atoms uniting to form new minerals, the position of which is determined by the lines of flow in the mass.

Not a few of our gems owe their exquisite beauties to these physiological changes which have taken place in them since their first formation. The ardent glow of the sunstone and the pale watery gleam of the moonstone, no less than the lovely play of the azure tints in Labrador-spar and the bronzy sheen of Paulite, are the result of physiological processes taking place in crystals which were originally clear and translucent. In the profound laboratories of our earth's crust slow physical and chemical operations, resulting from the interaction between the crystal, with its wonderful molecular structure, and the external agencies which environ it, have given rise to new structures, too minute, it may be, to be traced by our microscopes, but capable of so playing with the light-waves as to startle us with new beauties, and to add another to

"The fairy tales of science, and the long results of time."

Yes! minerals all have a *life-history*, one which is in part determined by their original constitution, and in part by the long series of slowly-varying conditions to which they have since been subjected. In spite of the circumstance that their cycles of change have extended over periods measured by millions of years, the nature of their metamorphoses and the processes by which these have been brought about are, in all essential respects, analogous to those which take place in a *Sequoia* or a butterfly. In spite, too, of the limitations placed upon us by our brief existence on the globe, it is ours to follow in all its complicated sequence this procession of events, to discover the delicate organisation in which they originate, to determine the varied conditions by which they have been controlled, and to assign to each of them the part which it has played in the wonderful history of our globe during the countless ages of the past.

The subject of distribution, or chorology, is one of no less importance in the study of the mineral than in that of the vegetable and animal kingdoms. The relations of minerals to one another, and the manner in which they make their appearance in respect both to time and place, constitute a most instructive and suggestive field of research.

The older mineralogists paid some attention to the question of the mode of association of minerals with one another, which they described under the term "paragenesis." But this was at a time when only large and freely crystallised specimens received much attention. At the present day this question of the varied distribution of minerals in space and time, and the manner in which they are associated with one another to build up rock-masses, constitutes a most important branch of our science, that to which the name of petrology is given.

Under the name of "petrography" an attempt has been made to establish a branch of natural-history science which shall bear the same relation to mineralogy as that science does to chemistry. As minerals are formed by the union of certain chemical compounds, so rocks, it is argued, may be regarded as being built up of different minerals. But it must be remembered that while minerals possess a distinct individuality—the result of their different chemical constitution and their characteristic crystallographic form—we are quite unable to point to anything analogous to these in the case of rocks.

How is a rock-"species" to be defined? It is not enough to state its ultimate chemical composition; for rocks of the most varied character and origin may agree in this respect. Equally futile is it to take mineralogical constitution as the basis of our classification; for, in the

[1] It has often been asserted that the "striation" on the faces or cleavage-surfaces of crystals is an indication of the existence of polysynthetic twinning. But in the oligoclase of Ytterby and other localities, I have found that many crystals which exhibit striation do not affect polarised light differently in the alternate striæ. But on submitting the crystals to alternate heating and cooling, and sometimes by percussive force, the twinning may be easily developed in them. It appears from these observations that the crystals are built up of lamellæ, in which the molecules are alternately in stable and unstable equilibrium. I have in some cases found that the stresses upon a slice of feldspar which is being heated and cooled and then ground into a thin section, while cemented to a glass plate during the preparation of a microscopic slide, are sufficient to cause the rotation of the molecules in the alternate lamellæ. In some cases, I have no doubt that twin-lamellation, like cleavage-cracks, may be induced in the crystals of our rock-sections during the processes to which they are submitted in their preparation.

same rock-mass, the species of minerals which are present and their proportions to one another may, and, indeed, often do, vary from point to point. Nor does minute structure, though affording admirable criteria for distinguishing certain *types* of rock, supply a sufficiently definite means of diagnosis for all the different varieties which occur. A system of "lithology" may, indeed, be devised, if we confine our attention to the hand-specimens in our museums; but it breaks down the moment that we attempt to apply it in our researches in the field.

I have long felt assured that all attempts at a nomenclature and classification of rocks must, for the reasons just stated, be regarded as tentative and provisional only; but the careful study of rock-types is nevertheless bringing to light a number of facts calculated to profoundly modify mineralogical no less than geological thought and speculation.

Petrology forms the link between mineralogy and geology, just as palæontology does between biology and geology. Mineralogy has justly been styled the alphabet of petrology; but if the orthography and etymology of the language of rocks lie in the province of the mineralogist, its syntax and prosody belong to the realm of the geologist. In that language, of which the letters are mineral species and the words are rock-types, I am persuaded that there is written for us the whole story of terrestrial evolution.

Petrology, it is clear, could make but little progress until the improvement of microscopic methods enabled us to make accurate determinations of the minerals in a rock, even when these are present as the most minute particles. The characteristic peculiarities of the different rock-forming minerals, so carefully studied by Zirkel, their accurate optical diagnosis, at which Rosenbusch has laboured with so much success, these with the microchemical methods of Knop, Bořický, Streng, and Behrens, and the pyro-chemical method of Szabó, have already done much to render exact our methods of recognising the minerals in a rock. The contrivances, for which we are principally indebted to the French petrographers, for effecting the isolation of the minerals in rocks, so that they may be submitted to accurate chemical analysis, enable us in cases of difficulty or doubt to confirm or check the results of our microscopical studies.

But there is at present, perhaps, a tendency to confound the end with the means in such researches as these. When all the varieties of minerals in a rock have been correctly identified, the work of the petrologist is not ended; on the contrary, it is only just begun.

The relationship of the several minerals in a rock to one another, the discrimination between such as are original and those of secondary origin, and the recognition among the former of the essential, as distinguished from those that are accessory or accidental,—these are problems of even greater importance than the exact determination of the species or varieties to which each belongs. In not a few rocks it can be demonstrated that every one of its present mineral constituents is different from those of which it was originally made up; in some cases, indeed, it may be shown that the recombination of the elements of the rock into fresh mineral aggregates has taken place again and again. As well might we try to give a rational account of our English speech without taking into account the series of changes through which it has passed in its evolution from the Anglo-Saxon dialects, as to explain the nature of a rock without studying the influence upon it of the forces by which it has gradually acquired its present characters.

With respect to the geographical distribution of the different mineral species, many suggestive observations have been made. Some, like the feldspars, the pyroxenes and the olivines, appear to be ubiquitous in our earth's crust, and even make their appearance again in those bodies of extra-terrestrial origin—the meteorites. Others, like leucite, nepheline, hauyn, sodalite, and melilite, are exceedingly abundant in certain areas of the earth's surface, while they appear to be wholly wanting in others.

Still more remarkable are the relations which are found to exist between the types of rocks occurring in different geographical areas. The study of this subject is leading us to the recognition of the fact that there are distinct petrological provinces. In closely adjoining areas—such as Hungary and Bohemia, for example—widely different types of rock have been erupted during the same geological period; and this is a fact not less striking and significant than that of the meeting of two perfectly distinct biological provinces along a line which traverses the Malayan archipelago. It cannot be doubted that the prosecution of this hopeful branch of study—the geographical distribution of minerals and rocks—will lead us to results of the highest interest and value.

That there will be shown to be a distribution of rocks in time, as well as in space, I am perfectly prepared to believe. I cannot but think, however, that some of the generalisations on this subject which have been hazarded are somewhat premature. To a geologist (especially one belonging to the school of Lyell) it is equally difficult to conceive that there should be a broad distinction between the metamorphic rocks of Archæan and post-Archæan age respectively, as that the pre-Tertiary volcanic rocks should be altogether different from those of Tertiary and recent times.

The great object of all our studies—concerning the morphology, the physiology, and the chorology—of the mineral kingdom, ought to be to arrive at definite ideas concerning its ætiology; the causes by which the existing forms, capabilities, and positions of minerals and rocks have been determined.

While the *fossils* contained in rock-masses afford us the means for determining the date of their origin, the careful study of the minerals which they include may enable us to unravel the complicated series of changes through which they have passed since their first formation.

Eighteen years ago, when seeking to show how the origin of a particular rock might be elucidated by a combination of studies in the field, in the chemical laboratory, and by the aid of the microscope, I ventured to offer to this Society some general remarks on this subject. As it has been my constant endeavour since that time to apply the principles then enunciated in the case of rocks of more complicated character and more recondite origin, I may perhaps be forgiven for repeating the words I then used. Every rock since its first formation "has undergone and it still is undergoing a constant series of internal changes, the result of the action of different causes, as heat, pressure, solution, the play of many chemical affinities, and of crystallographic and other molecular forces, causes insignificant perhaps in themselves, but capable under the factor *time* of producing the most wonderful transformations. The geologist is called upon to unravel the complicated results, to pronounce what portion of the phenomena presented by a rock is due to the forces by which it was originally formed, and what must be referred to subsequent change; to discriminate the successive stages of the latter and to detect their various causes; in short, to trace the history of a rock from its deposition to the present moment."

Dr. Wadsworth has well characterised the changes which take place in rock-masses as due to the tendency of unstable mineral combinations to pass into stable ones. It must be remembered, however, that stability is a relative term, and that the arrangement of molecules which is stable under one set of conditions becomes unstable under another set. As by the internal movements and the external denudation of the earth's crust, the conditions under which rock-masses exist are undergoing slow but continual change, new adjustments of the molecular structure of the rocks are at once necessitated and brought about.

In attempting to reason as to the *original* conditions under which a rock-mass must have been formed, it is of great importance to avoid those sources of error which exist in rocks that have undergone much secondary alteration. Such rocks abound in, though they are not necessarily confined to, the older geological formations; and it is among the younger and fresher rocks, therefore, that we may most hopefully seek the key to many petrological problems.

If, for example, we concentrate our attention upon the more recent and less altered igneous rocks, it becomes clear that the degree of crystallisation displayed by them has depended on the slowness with which consolidation has taken place, and that this has in turn been determined by the depth from the surface at which they have been formed. In this way, by the study of igneous rock-masses in Scotland and in Hungary, I was able to show that there is a perfect gradation from highly crystalline rocks—granites, diorites, and gabbros—into the ordinary volcanic types—rhyolites, andesites, and basalts, respectively—and from the latter into the various kinds of volcanic glass. These conclusions have been confirmed by subsequent investigations like those of Hague and Iddings in the Comstock region, and of Lotto in Elba. Further and more recent researches have enabled me to show that certain types of structure have been determined in rocks, according to the more or less perfect absence of all movement within them during their consolidation.

Very remarkable, indeed, are the internal changes which take place in rock-masses when they are submitted to those powerful stresses which result from the movements that occur during mountain-making; and the full explanation of these is perhaps the most difficult problem which still confronts the geologist.

It was long ago asserted by Scrope and Darwin that the solid rock-masses of the globe, under such conditions as these, must have actually *flowed*, like the viscous lavas of the rhyolitic series. These geologists were even able to show that the separation and disposition of the crystalline elements in such lavas present the closest analogy with what is seen in the crystalline schists and gneisses of greatly disturbed areas.

Since these early researches, which were principally based on the study of rocks in the field, aided only by the pocket-lens, three classes of researches have served to deepen our insight into the methods by which the schistose and gneissose rocks must have been produced.

In the first place, the experiments of MM. Tresca and Daubreé have shown that solid matter under enormous pressure behaves like a viscous substance, its whole internal structure exhibiting evidence of the flowing movements to which it has been subjected.

In the second place, the studies of M. Spring have established the fact that both paramorphic change and direct chemical reaction may result from simple pressure. Thus the unstable monoclinic form of sulphur, by a pressure of 5000 atmospheres, was at ordinary temperatures converted instantly into the stable rhombic form, a transformation accompanied by change of density and of many other physical properties. Still more striking is the case of the unstable, yellow, rhombic, mercuric-iodide, which, by simple rubbing with a hard substance, passes into its stable, red, tetragonal allomorph. It is instructive to notice that the same change in both instances appears to take place "spontaneously" after a sufficient interval of time; or, in other words, small variations in temperature, pressure, and other surrounding conditions are capable, if sufficient time be allowed, of bringing about the same result as more intense pressure applied suddenly. That the similar paramorphic change of pyroxene into hornblende, which is so frequently exemplified in the earth's crust, is sometimes the result of intense pressure, and at other times follows from the repeated slight alteration of conditions during long periods of time, we have, I believe, abundant evidence.

But the experiments of M. Spring that prove that chemical reactions can result directly from pressure are of even greater interest to the geologist. By submitting mixed powders to intense pressure, he succeeded in producing metallic alloys and various binary compounds, and also in bringing about double decomposition between many salts. That similar reactions between the complicated silicates which form the minerals of rocks have resulted from the enormous pressures to which they have been subjected, we have the most ample proof. Thus in rocks where such pressure has just begun to act, such as the "flaser-gabbros," wherever the unstable olivine is in contact with the almost equally unstable anorthite, chemical reactions have been set up by the pressure, and these have resulted in the formation of zones of enstatite and anthophyllite, hornblende and biotite, which have been so well described by Törnebohm, Bonney, Adams, and Williams. Provided with the clue supplied by these results, we find little difficulty in going one step further. When the pressure has been still more intense, as in mountain-making movements, reactions are set up among all the minerals of the rock-mass; the elements of which it is composed, set free from their old engagements, enter into new alliances, and the result is the formation of a completely new set of crystallised minerals.

The third class of researches, destined, as I believe, to remove our difficulties in explaining the origin of the schistose and gneissose rocks, are those already alluded to as having been undertaken with the microscope. As yet the details of such changes have only been explained in the case of some of the simpler examples; but I am convinced that the persevering application of the same methods in the field and the laboratory will result in the removal of difficulties that now seem to be absolutely insurmountable.

Some observers in this country have been led to infer that the recrystallisation of rock-masses under pressure has in all cases been preceded by their pulverisation. Of this, I confess that I can find no evidence. That near great faults of all kinds, this reduction of rocks to powder does take place, we find abundant proof; but the evidence also points to the conclusion that such *rock-crushing*, as distinct from *rock-flowing*, is in every case local and exceptional.

There is another and totally different series of changes which takes place in rocks, when, brought near to the surface by denudation, they are exposed to the action of water, oxygen, carbonic acid, and other atmospheric agents. The breaking-up of the alkaline silicates and the deposition of secondary silica, the formation of the zeolites, the epidotes, the chlorites, and serpentine, the resolution of crystallised minerals into the isotropic mixtures, and the recrystallisation of these in new forms, all offer problems of the highest interest to the geologist.

I may venture, in drawing these remarks to a close, to indicate another point of analogy between the three natural-history sciences. It is found in the circumstance that experimental verifications of our conclusions are often difficult, if not actually impossible.

We must be content to reason from the proved variability of the existing forms of plants and animals as to the possibility of the production in time of new species. And in the same way, with our limited command of heat, pressure, and especially of time, we can scarcely hope to originate the exact counterparts of the various minerals and rocks of our earth's crust.

We may nevertheless point with satisfaction to what, in spite of such difficulty, has already been accomplished in this interesting field of research. The honour of having pushed these researches to such successful issues belongs chiefly to the chemists, mineralogists, and geologists of France. To the labours of Senarmont, Daubrée, and a host of other workers, we owe the artificial production of a very large number of the minerals of our globe; while the ingenious experiments of Fouqué and Michel Lévy have resulted in the formation of many rocks differing in no essential particulars from those which have been produced by natural agencies.

In the prosecution of his various researches the importance and value of exact mineralogical knowledge to the geologist is becoming every day more apparent. The temporary estrangement between the cultivators of mineralogy and geology is now, we may hope, for ever at an end; very heartily, indeed, do geologists recognise and welcome the aid of their brethren the mineralogists.

But if it be confessed that the benefits, past and prospective, conferred on geological science by mineralogy are vast and even incalculable, it must also be admitted that the debt is amply repaid by the beneficial influence which is being exercised in turn upon mineralogy by geology.

Some time ago a distinguished mineralogist asked me if I did not find the ordinary text-books of his science but little calculated to arouse the interest or excite the enthusiasm of students. I am sure that the energy of my assent must at least have assured my friend of the strength of my convictions on the subject.

Too long, indeed, has the accumulated mass of mineral lore recalled the grim vision of the seer of Chebar. In that gruesome valley the wail of the student, "the bones are very dry," has mingled with the sigh of the teacher, "Can these bones live?" But now from the four winds of heaven come the constructive ideas of many minds—from Scandinavia and from France, from Germany and from the United States—and in obedience to this influence behold "a great shaking" in the formless mass. Scattered facts, isolated observations, imperfect generalisations, and tentative hypotheses are falling together "bone to his bone," and are building up a sound body of mineralogical knowledge; and into this the spirit of geological thought entering, mineralogy shall stand forth a living science.

DR. WILLIAM TRAILL, OF WOODWICK [1]

THE death of this assiduous student of natural history merits more than a passing notice, since there are few surgeons who did more for the advancement of Eastern conchology than he; while his researches on the antiquities of his native county (Orkney) also claim attention. His whole career, indeed, as in the case of many an Eastern surgeon, illustrates the wisdom of placing both natural history and botany on the curriculum of every medical student.

Dr. Traill was the eldest son of Mr. Traill, of Westness, Rousay, Orkney, and he was born in Kirkwall on September 8, 1818. He proceeded to the University of Edinburgh to study medicine at the age of sixteen, and while there he had the advantage of the direction and advice of his uncle, the late Prof. Traill, who held the Chair of Medical Jurisprudence. Young Traill proved an apt student, and showed from the first a strong liking for natural history. This was fostered by his uncle (whose collection of snakes, now in the Museum of Science and Art, was well known to naturalists), as well as by his pursuits during the holidays at the family seat at Westness, in the Island of Rousay. Amongst his fellow-students were Dr. Cleghorn, of Stranthie, late Conservator of Forests in India, Sir Lyon Playfair, and Dr. Halliday Douglas.

After graduating in 1841, he proceeded to India as a surgeon in the East India Company's service. The splendid field thus opened up to the young naturalist stirred all his energies into activity, and he studied and collected various groups, but especially the land-shells of Madras. His early studies on the shores of Orkney had given him a predilection for this department, and he remained faithful to it throughout life. Thus, when shortly afterwards called to serve in China, he began the collection of those beautiful specimens of Eastern shells now so well known in many collections. His opportunities were further extended by a residence of some years at Singapore, and afterwards at Malacca and other stations. He returned to England in 1854, and his collections were much admired, both as regards the beauty of the specimens and the number of examples of each species. His acquaintance with Dr. Knapp, a retired army surgeon, and also well known as a malacologist, gave a great impetus to his studies, as also did his association with Andrew Murray, Robert Gray, Dr. Howden, Wyville Thomson, Foster Heddle, James Cunningham, Patrick Dalnahoy, and R. Greville.

His return-voyage to India in 1856 gave him an opportunity of examining the pteropods and other pelagic mollusks, and his observations, with four plates and a chart, were communicated by Sir Walter Elliott to the *Madras Journal*, then edited by his friend Dr. Cleghorn. His preparations of the delicate glassy shells of the Thecosomatous forms was remarkable. He also described some rare species, observed certain peculiarities in their structure, and made comparisons between the velum of the young Cypræa and the epipodia of the pteropods. His collection of Eastern mollusks was largely increased during his second period of duty, so that it became celebrated for certain rare types, such as *Rostellaria rectirostris*, *Trochus guilfordii*, *Trochus imperialis*, &c. He also added largely to Prof. Traill's collection of snakes formerly alluded to.

On retiring from active duty he settled at St. Andrews, and at once took an active interest in the University Museum and Literary and Philosophical Society, of which latter he was a Vice-President at his death. He spent much of his time in arranging the Mollusca in the Museum, and he enriched the collection by many interesting and rare types. In his annual trips to his estate in Orkney he also made researches on the antiquities and geology of the district, and these he embodied in papers communicated to the Edinburgh Antiquarian Society, and to the Society at St. Andrews. Amongst these papers are the following:—"Results of Excavations at the Broch of Burrian, Orkney," two plates and woodcuts; "Notice of Excavations at Stenabeck, Orkney," with woodcuts; "On Submarine Forests in Orkney"; "On the Picts' Houses of Skerra Broc"; "On the Recurrence of Boulder-Clay in Orkney"; "Notice of the Boulders in North Ronaldshay," &c.

His knowledge of botany also enabled him to acclimatise various plants in Orkney, such as *Phormium tenax*, various Veronicas, the Manuka (Capt. Cook's sea-plant), the Japanese *Euonymus*, and others.

Dr. Traill was a man of refined and cultivated mind, genial but unobtrusive, and had a large circle of friends. He enjoyed good health till eighteen months ago, when the first symptoms of the disease which ultimately proved fatal appeared. W. C. M.

[1] Abstract of Paper read at the Literary and Philosophical Society, St. Andrews, January 21, 1887.

THE EARTHQUAKE

A SERIES of shocks of earthquake has caused much havoc in the Riviera during the last week. Although it is too early to attempt to give a complete account of what has happened, the leading facts, so far as they are of scientific interest, are well summed up in the following report, issued by Father Denza, of the Montcalieri Observatory:—

"(1) The earthquake in our region has had nearly the same effect as those on November 28, 1884, and September 5, 1886. In length it extended to the east along a line leaving the plains of Lombardy at Lomellina, and passing by the district of Alessandria to the Riviera di Levanto, and westward over all the Western Alps, proceeding towards Switzerland as far as Geneva and beyond, and to Paris and Corsica. The telluric movement proceeded from the Lepontine Alps on the north to the Gulfs of Lyons and Genoa on the south, extending, but more feebly, through Tuscany to Rome.

"(2) The movement had its greatest intensity in Liguria, in Southern France, and in Piedmont, where it shook the whole of our plain, and penetrated into all the Maritime, Cottian, Graian, Pennine, and Lepontine Alps.

"(3) This time the centre of the strongest intensity was in the Gulf of Genoa, along the line dividing the place where the Apennines join the Alps, and extending from Savona to Mentone. It was within this space that people lost their lives in several localities, such as Savona, Noli, and Mentone, and everywhere as far as Marseilles there were numerous disasters and buildings thrown down. The movement of the soil, not so violent, but equally disastrous, spread over the mountainous country which extends from the Altare Pass to Millesimo, Mondovi, and the neighbouring regions. The shock was severe, but it did no considerable damage, in a portion of the province of Coni, as also in the provinces of Alessandria and Turin, it being very intense on Mont Cenis. It was slighter in the plains and in the valleys of the province of Novara.

"(4) In the places where the earthquake was most intense the principal shocks were three in number, and with a slight difference, depending probably on the difference of clocks, correspond to the times indicated by the seismic instruments of our Observatory—namely, the first at 6.22 a.m., the second at 6.31, and the third at 8.53. In the places near the centre of motion slight shocks occurred at intervals all through the day. The severest and most terrible shock was the first, which was undulatory in several places, oscillatory, and perhaps rotatory. It was several times prolonged and accentuated. Here at Montcalieri, as at Turin and elsewhere, it had three principal repetitions, plainly evidenced by the courses traced by our registering seismograph. These augmentations of intensity were mistakenly regarded by some as so many distinct shocks.

"(5) The dominant direction of the first undulatory shock was from west to east, with slight deviations at intervals from west and north-west to east and south-east, and with oscillatory and very slight vibrations. The two other shocks were also undulatory, and the last was rather more intense than the second, btt without reaching the intensity of the first. The second and third had about the same direction as the first.

"(6) The earthquake in places where it was severe and very severe was accompanied by rumblings. I may add, in conclusion, that about 2 o'clock this (Thursday) morning our most delicate seismic instruments signalled very slight fresh shocks, undulatory, and from north-west to south-west."

The fullest and most accurate details as to the successive shocks have come from the more important towns in the western Riviera. Mr. W. J. Lewis, writing to us from the Hôtel des Iles Britanniques, Mentone, on Saturday, the 26th of February, says that some slight vibrations seem to have been felt there about midnight and 3 a.m. before the great shock. "This last," he continues, "occurred apparently a few minutes before six, just as day was dawning." He was roused from sleep by being violently jolted in bed, which was being shaken with great violence. At the same instant he heard loud noises of apparently cracking walls and ceilings, and the rattle of falling plaster and breaking glasses. "I did not," says Mr. Lewis, "instantly realise my position, but had time to consider what was going on, and to conclude that, if the house collapsed under the shock, escape was hopeless, and that there was nothing to be done. This may possibly have taken ten seconds. Needless to say, that when the motion ceased and I found myself unharmed, I was up, seized my warmest clothing, and was down in the garden in less than a minute. The daily Press will have sufficiently described the scenes which have occurred throughout the Riviera. The second shock, of considerable, but much less, force, occurred about ten minutes later. I observed, within a few minutes of this that the hall clock marked 6.15, local time, corresponding to 5.54 a.m., so that I should be inclined to place the second shock at 6.10. A third shock of about the same intensity as the second occurred between 8.30 and 8.45. This last threw down bricks, tiles, &c., which had been displaced by the first shock, and raised the panic to the greatest height."

According to Mr. Lewis, the early reports of the disaster at Mentone were much exaggerated, but the truth, he says, is bad enough. "The large hotels, especially those in high situations, seem to have suffered least. The whole of the East Bay and the old town have escaped practically unharmed. The greatest damage has occurred to two-storied buildings placed on the alluvial soil in the comparatively level part lying along the sea, and in the valleys of the Carrei and Borrigo, embracing the main portion of the modern town of the West Bay. Here the relation with the foundation is well marked in the case of two equally well-built houses not more than 300 yards apart, viz. St. John's Parsonage and the House of Rest. The former is in the valley, and the foundations were a source of great trouble at the time of building. It is very much shattered. The other is built on a rock, and has escaped uninjured. Within a radius of a quarter of a mile of the station the main destruction has occurred. But the houses most wrecked—some score or more—show most conclusively bad building. The large hotels in this injured area—the Iles Britanniques, National, Orient, Mediterranée, des Colonies, &c.,—most of which are four to five stories high, have suffered injury to lathe and plaster, but in few places are the main walls seriously damaged. In the case of these high buildings the intention of raising them to such a height necessitated a firm and solid foundation. I have noticed that the walls in a part of this hotel at a height of six stories have on the top floor suffered no visible damage. In the same way Monte Carlo, built on rocky ground, has escaped uninjured."

Writing from Nice, a correspondent of the *Times*, signing himself "Commander, R.N.," says that, on Wednesday morning, about six o'clock, he was awakened by an extraordinary commotion so unaccountable that for a moment he thought an escaped lunatic was shaking the bed in a maniacal outburst of fury. Running to the window, he saw that the shock must have been very severe, "for everywhere the streets were strewn with fragments of cornices, mouldings, chimney-pots; while many houses exhibited dangerous-looking cracks and rents in the walls of the upper stories. Another shock as violent as the first must inevitably have been followed by the downfall of many buildings. Fortunately, however, none of the succeeding shocks at all approached the first in violence." Another correspondent of the *Times*—"C. E. de M."—writes from Nice, that he was awakened shortly after 6 a.m. by "a tremendous vibration, which shook the whole house, a large hotel, from top to basement. The bed rocked and swayed violently to and fro like a hammock set swinging, and great masses of plaster fell from the ceiling and walls in every direction, strewing the room with *débris*, while the paper was literally stripped off the walls, and every second the whole hotel appeared as if it must topple over. . . . At 8.30 a.m. another shock, though of less violence, seemed to complete the reign of terror which had now set in."

At Cannes Sir Theodore Martin noted that the first of a series of shocks began at five minutes after six (Cannes time). "No premonitory warning was given, and there was none of that rumbling noise which frequently accompanies earthquakes. The sky was without a cloud, and the first 'rose of dawn' had just begun to show itself in the east. The air was still and fresh, and not a leaf stirred on mimosa or eucalyptus. The trembling, beginning somewhat gently at first, like that produced by the passage of a heavy railway train, grew rapidly more and more marked. . . . The convulsion lasted for fully a minute, and the oscillation was from east to west. A second but slight shock, some minutes afterwards, did not tend to diminish the apprehension caused by the first. So far as I can learn, few of the thousands who fill the hotels remained in their rooms, the great majority finding their way, some in the scantiest of raiment, into the adjoining gardens. The first alarm was beginning to pass off when, about half-past eight, a third shock was felt. This did not last above fifteen seconds, but while it lasted it was very severe, shaking the floors and moving the furniture in the same way, but in a less degree than the first shock. The air continued calm as before, and the whole sky was flooded with sunshine."

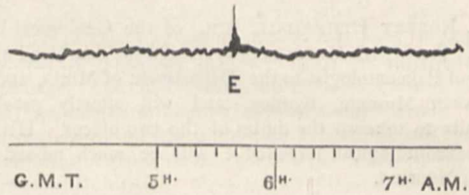
It will be observed that Sir Theodore Martin describes the direction of the oscillation at Cannes as from east to west. Another correspondent of the *Times* says that at Antibes the undulations were "undoubtedly from west to east." At Toulon, where there were two violent shocks about six o'clock, the undulations were also from west to east. On the other hand, at Turin, where there were three shocks in the space of seventeen seconds, the second shock, which was by far the strongest, had a direction from north-east to south-west.

At Marseilles two smart shocks were felt about 6 a.m., and a third at 8.30 a.m. They lasted about fifteen seconds each, and caused fissures in several houses. At Nîmes some windows were shattered, and the clocks stopped; and like results were produced at Grenoble. At Avignon three shocks were felt between 6 and 8 o'clock a.m., and the first shock was violent enough to awake all the inhabitants. Slight shocks were felt at Lyons.

It was in the towns and villages of the Italian Riviera that the earthquake produced its most desolating effects. Diano Marina was utterly destroyed. At the first shock, about 6 o'clock, the inhabitants of this place rushed into the streets half dressed. Then came a more fearful shock. A frightful cracking noise was heard as far as the beach, and the houses fell in, burying the greater number of those who had lived in them. The results at Diano Castello, a mile and a half off, were also very appalling, and at Bajardo more than 200 persons were killed in the church. The full extent of the calamity which so suddenly overtook these and other places in the same district cannot even yet be accurately determined. The following is the official list of dead and wounded:—Alassio, 3 dead, 8 wounded; Albenga, 30 wounded; Albissola, 3 dead, 12 wounded; Bajardo, 230 dead, 30 wounded; Bussano, 80 dead, 27 wounded; Castellaro, 41 dead, 65 wounded; Ceriana, 5 dead, 12 wounded; Diano Castello, 35 dead, 10 wounded; Diano Marina, 180 dead, 65 wounded; Montalto Ligure, 1 dead, 3 wounded; Noli, 16 dead, 12 wounded; Oneglia, 23 dead, about 150 wounded; Pompeiana, 5 dead, 7 wounded; Porto Maurizio, 1 dead, 10 wounded; Savona, 11 dead; Taggia, 8 dead, 14 wounded; Triora, 4 dead, 9 wounded.

All over Switzerland the earthquake was felt, more or less, and the oscillations are said to have been from north to south. Dr. A. Riggenbach, Assistant Astronomer at the Basle Observatory, writes to us that some shocks occurred there. The two clocks of the Basle Observatory, and the two regulators of the public electric dials, the principal astronomical clock of Knoblich, keeping sidereal time, were stopped at 6h. 42m. 50s. a.m. local mean time, or 5h. 34m. 30s. a.m. Greenwich mean time.

Mr. G. M. Whipple, Superintendent of the Kew Observatory, has been good enough to send us a careful tracing, which we reproduce, of the curve given by the bifilar magnetograph at the Kew Observatory, showing that the instrument was affected by the earthquake about 5.40 a.m. Indications of the later shocks were shown on the original photograph, but not with sufficient clearness to enable them to be satisfactorily



Copy of trace of bifilar magnetograph at the Kew Observatory, Richmond, Surrey, 1887, February 23, 5–7 a.m. Movement produced by earthquake marked E.

identified. In the Signal Office at Washington, the Government seismoscope was, on Wednesday morning, disturbed by accurately recorded shocks at 7.33 a.m. This is equivalent to 7.50 a.m. by the standard time of the 75th meridian. If, therefore, these shocks were connected with the earthquakes in Southern Europe, the velocity of their transmission from the Riviera was about 500 miles an hour.

The problems connected with the earthquake were discussed at the meeting of the French Academy of Sciences on Monday. M. Mascart stated the contents of a note from M. Fines, of Perpignan, who possesses a magnetometer. A little before the shock his magnetic instruments were shaken by a peculiar jolting motion. At 5.45 a.m. the magnetic registering instruments at the Observatory in the Parc de St. Maur, near Paris, exhibited the same motions. At the Lyons Observatory similar vibrations were observed at 5.55. M. Mascart remarked that these movements were simultaneous. It was not, therefore, an oscillatory movement passing from one point to another with which they had to deal, but a phenomenon which affected a large space simultaneously. He supposed there had been an electric current which had acted on all the instruments placed within its sphere of action. The form of the curves recorded was very distinct from those given by magnetic instruments when affected by storms or auroras. M. Mascart suggested that means might yet be found of predicting the approach of a seismic storm. He added that if the cause of the effects that had been observed was an electric flux, it was easy to understand why their intensity was everywhere nearly the same. A commission was appointed to examine documents which may be transmitted with reference to the earthquakes.

NOTES

A CIRCULAR to Great Britain and the other European States, and to the United States, has been forwarded by the Executive Commissioners of the Melbourne Centennial International Exhibition. The Exhibition will be opened on August 1, 1888, in order to celebrate the centenary of the founding of the colony of New South Wales, and will remain open for six months. The Commission invites the British, foreign, and colonial Governments to participate in the undertaking, and trusts that steps will promptly be taken by them for the completest possible representative display. It is pointed out that the population of Australasia is 3,500,000, that the imports of British goods annually amount in value to 32,000,000*l.*, and that 7700 miles of railway are open for traffic, while over 2000 miles of line are in course of construction. Applications for space must be made before the end of August this year. The Commission desires to make the Exhibition specially interesting in manufacturing processes, machinery, &c., in motion, and objects of manual labour. There will also be a picture gallery lighted by electricity. Further information may be obtained from the Agent-General in London, or from the Executive Commissioners in Melbourne.

MR. ROBERT ETHERIDGE, JUN., of the Geological Department of the British Museum, has received the combined appointments of Palæontologist to the Department of Mines, and to the Australian Museum, Sydney, and will shortly proceed to Australia to take up the duties of the two offices. His extensive palæontological knowledge will be much missed in the British Museum.

SOME days ago the Medical School of Paris elected M. Brouardel as Dean, in the place of M. Béclard, recently deceased. M. Brouardel is Professor of Forensic Medicine.

ON Saturday last Mr. John Morley delivered, in the Egyptian Hall of the Mansion House, the annual address to the students of the London Society for the Extension of University Teaching. His subject was "The Study of Literature," and we need scarcely say that he set forth his ideas with his usual vigour and lucidity. But what did Mr. Morley mean by the following sentence: "I, for one, am not prepared to accept the rather enormous pretensions that are nowadays made sometimes for physical science as the be-all and end-all of education"? By whom are these "rather enormous pretensions" made? Men of science, no doubt, claim for the study of physical science a high place in education; but we have never heard that they feel disposed, on that account, to exclude the study of art and literature.

THE University of St. Petersburg lately celebrated its sixty-eighth anniversary. It has 64 professors, 47 fellows, 8 lecturers, and 39 laboratory assistants. There are 2627 students, who are grouped as follows:—For Oriental languages, 87; for law, 1170; for natural science, 426; for mathematics, 618; for history and philology, 224.

WE have received the four February sections of "Studies in Microscopical Science," edited by Mr. Arthur C. Cole. The text, which is finely illustrated, relates to Haustoria, the ovary and ova in birds, fatty degeneration of the kidney, and microbes.

PROF. OTTO STRUVE'S jubilee was celebrated some days ago at the Pulkowa Observatory. A great number of delegates from learned societies and scientific institutions were present.

THE new journal edited by Prof. Grancher is called the *Bulletin Médical*. It appears in Paris twice a week, on Thursdays and Sundays.

IN the February number of the Journal of the Anthropological Institute there is an interesting paper by Mr. Bloxam, describing eight specimens of Aroko or symbolic letters, which have actually been used by the tribe of Jebu in West Africa. These Aroko were sent to Mr. R. N. Cust by Mr. J. A. Otonba Payne, Registrar of the Supreme Court at Lagos, who himself belongs to the tribe of Jebu. The paper is carefully illustrated. One of the figures represents a message from a native prince of Jebu, Ode, to his brother residing abroad. It consists of six cowries, all turned in the same direction. The quill of a feather is passed through them from front to back, and the shaft is turned towards the end of the quill and fixed to the side of the cowries. The significance of this symbolic group of objects depends upon the facts that, in the Jebu language, six is "E-fà," from the verb "fà," to draw, and that Africans are in the habit of cleansing their ears with a feather, and look upon it as the only instrument by which this can be effectually done. The meaning is: "By these six cowries I do draw you to myself, and you should also draw closely to me; as by the feather only I can reach to your ears, so I am expecting you to come to me, and hoping to see you immediately."

IN the *Rendiconti* of the Reale Istituto Lombardo for January, Count Trevisan de Saint-Léon describes some experiments recently carried out by Dr. Bareggi in Milan, for the purpose of showing that it is possible to ascertain, from the state of the blood, whether persons bitten by animals suspected of rabies, or even undoubtedly mad, have really been infected.

THE Reports of the Botanist to the New York Agricultural Experiment Station, Geneva, N.Y., Mr. J. C. Arthur, for 1885 and 1886, furnish an admirable illustration of the value of such State appointments. A large portion of both Reports is occupied with an exhaustive history of the pear-blight (*Micrococcus amylovorus*), which is exceedingly destructive to pear-trees in the Northern United States; proofs that the mischief is caused by the specific Bacterium; and suggestions for a remedy. In addition to this, much information is given with regard to the following diseases, among others: the strawberry-mildew (*Sphærotheca Castagnei*), the plum-leaf fungus (*Septoria cerasina*), the lettuce-rust (*Septoria Lactucæ*), and the lettuce-mildew (*Peronospora gangliformis*). Woodcuts are given of these various fungoid parasites, and a very useful summary is appended of the literature of the pear-blight.

AN admirable lecture on "Wrought Iron" was delivered by Mr. J. Starkie Gardner at the Society of Arts on Tuesday, February 22. It is printed in the current number of the Journal of the Society of Arts, with illustrations of the exquisite ironwork in the cathedrals of York, Durham, and Winchester. The general artistic superiority of mediæval ironwork to that of later times Mr. Gardner attributes in part to the fact that in the Middle Ages important work of this kind was intrusted only to smiths who had a special aptitude for it. If such a workman was not forthcoming, the work was either not executed, or was made in the simplest form; whilst, if he were forthcoming, the details at least of the design were left to his own fancy. Mediæval smiths were not fettered by estimate or bound by time, but Mr. Gardner is of opinion that they did their work much more quickly than men do now. Otherwise, he thinks, the intricate designs used in Germany, Spain, and Portugal, for ordinary domestic purposes, could not have been produced at any price which would have suited the occupiers.

AT a durbar held at Shillong in connection with the Jubilee rejoicings, Mr. Ward, Chief Commissioner of Assam, reviewed the history of the province during the last fifty years. In that time, he said, its population and settled area had been nearly trebled. The first tea plantation had been started about fifty years ago. There were now nearly 200,000 acres under tea, while the land taken up by planters, although not yet actually planted, amounted to about 400,000 acres. Again, fifty years ago the land revenue of five districts, comprising Assam proper, had been about four and a half lakhs of rupees; it had grown to twenty-six lakhs. Then the journey from Gowhatty to Debroughur had occupied a month or six weeks; now it took three days.

MUCH interest has been excited by the announcement that Capt. Conder, of the Palestine Exploration Expedition, has succeeded in deciphering and translating the Hittite inscriptions. Ten principal texts are known, and Capt. Conder claims to have intepreted all of them. Three of his translations, which were published in the *Times* of Saturday last, are invocations to the sun and water gods, and, apparently, to the divinity of the moon. Capt. Conder says that not only the words, but the grammar of the inscriptions, can be shown to belong to a well-known tongue. What this tongue is, we are not to learn for some time.

WE regret to announce the death of Dr. Grothe, Professor at the Polytechnical School at Delft, author of "Mechanical Technology," and an excellent monograph on iron. He was born in Westphalia in 1806, and died on February 10 last.

PROF. HAECKEL, of Jena, has just started on a journey to the East, which will be of some months' duration. He will visit the coast of Asia Minor to continue his investigations of lower marine animals.

LIEUT. QUEDENFELDT has just returned from Morocco to Berlin, bringing with him some valuable collections: an ethnological one, which he has presented to the Anthropological Society, a collection of insects, and a large collection of the implements, tools, and instruments of torture of the Hamadjas tribe.

MESSRS. G. PHILIP AND SON have in the press a revised and enlarged edition of "The Geology of England and Wales," by Horace B. Woodward, F.G.S., of the Geological Survey of England. They will also have ready shortly "Philips' Planisphere of the Stars visible from the Countries situated about 35° south of the Equator" (uniform with "Philips' Planisphere for England"); "Rustic Walking Routes within the Twelve-mile Radius from Charing Cross," containing a field-path map of the district, with geographical description, charts, and directions, by W. R. Evans; and "Philips' Handy Volume Atlas of the World," consisting of sixty-four plates, containing upwards of one hundred maps, printed in colours, with statistical notes on each map.

MESSRS. WHITTAKER AND CO. will publish shortly a second and much enlarged edition of "Magnets and Dynamo-Electric Machines," being the first volume of their "Specialist's Series." For the new edition some revisions in the text have been made, and a preface and a chapter on the latest types of generators have been written by Mr. W. B. Esson.

A FRENCH translation has been published of Cæsar Lumbroso's "Uomo Delinquanti," with a fine series of figures to illustrate the learned author's lectures concerning the anthropological features of the professional criminal.

ADMIRAL TEISSERENC DE BORT has just published a map, showing the distribution of fog on the various parts of the earth. It is based upon observations made at 1600 land stations, and 112,000 marine ones.

IN a Report just issued, Mr. S. W. North, Medical Officer of Health, calls attention to the prevalence of typhoid fever in York during the year 1886. For many years York has been liable to outbreaks of this disease, and the fact will not surprise anyone who reads Mr. North's account of the sanitary conditions of the city.

IN a paper entitled "Ueber die Allgemeine Beugungsfigur in Fernröhren" (Mémoires de l'Académie Impériale des Sciences de St. Pétersbourg, viie. série, tome xxxiv., No. 5), Hermann Struve remarks that the old problem of the diffraction of light through a circular aperture, the source being in the axis, has been considered by Airy and others, who have given approximate solutions in special cases; but the general solution has only been made feasible by the discovery of Bessel's functions. He accordingly proceeds to develop it by the straightforward methods with which readers of modern analysis are familiar; showing how his solution accords with those previously given for the axis and for the edge of the geometrical shadow. In this latter case he remarks that the illumination is less than one-fourth that which would be obtained by removing the screen. His results are put into a useful numerical form in tables at the end of the paper.

THE last number of the *Bulletin* of the Belgian Natural History Museum contains a summary of ornithological observations made at various stations throughout Belgium during the year 1885. This is quite a novel feature, which, if carried out systematically, promises excellent results, especially as regards the many obscure questions connected with the migrations of birds of passage. The chief stations are Brussels, Hasselt, Carlsburg, and the Ostend and other lighthouses along the coast. The names of the naturalists who undertake to send in reports are given in all cases. These reports contain the name of the bird in three languages—Latin, French, and Flemish or Walloon according to the locality—followed by the dates of arrival and departure, and any other remarks tending to throw light on the habits and movements of the bird. Thus, under *Ciconia alba*, Bechst., *Cicogne blanche*, *Ooievaar* (white stork), we have, from the Nieuport Lighthouse: "Seven seen, June 18, flying westwards; rare on this coast, where they never nest.—Signed, A. Vermorke." The present summary contains 171 such entries, the value of which, when made by competent observers from year to year, ornithologists will not fail to appreciate.

THE latest advices from Honolulu report that the volcano of Mauna Loa is again in eruption, and that all the craters in the vicinity have become active.

IN the December number of the *Mineralogical Magazine*, Prof. Macadam gives the analysis of a sample of talc used in paper-making. This mineral is obtained from New Jersey. It is very largely employed for paper-making in place of China clay (kaolin), and gives, amongst other advantages, a much more pure effluent, fully 90 per cent. being retained in the paper. From its fibrous nature it appears to attach itself to the smaller paper particles, and retain these also. The very high and beautifully smooth glaze of the American papers is largely due to the use of this substance.

IN the *Mittheilungen* of the Zürich Antiquarian Society (Band xxii. Heft 1) will be found a detailed account of the recently-discovered lake-dwelling at Wallishafen, on the Lake of Zürich. The articles found were mainly bronze, but underneath the existing remains appear to be the charred fragments of an earlier dwelling, the remains of which clearly belong to the Stone Age.

A LARGE canoe, belonging to prehistoric times, was lately dragged from the bottom of the River Cher, near Vierzon, and is now in the Museum of the Society of Antiquaries at Bourges. A part of it had been visible for many years at low water, but no one understood what it was until it happened to be seen by M. Beauchard, who at once perceived its real character. When it was brought to land, fragments which had been torn or cut off by peasants were recovered and pieced together. The canoe is in the form of a trough, and is said to have a general resemblance to the ancient boat found some time ago at Brigg, in Lincolnshire. The present specimen has the special characteristic of being closed at both ends by pieces of wood fixed in vertical grooves. This device seems to have been adopted in consequence of the boat having been injured by some accident.

M. GUILMETH, the French traveller, while on a journey in Australia, discovered some bee-hives in a gigantic eucalyptus-tree, of 120 metres in height. The honey was strongly scented with the perfume of the flowers of the tree. Prof. Thomas Karaman has examined it, and believes it to have beneficial medicinal properties.

Like the authorities of the National Museum, Washington, the Curators of the Museum of the Academy of Natural Sciences, Philadelphia, complain that they have not nearly room enough for the display of the collections intrusted to their charge. "It is well within the truth," they state in their Report for 1886, "to say that the existing collections, if properly displayed, would completely fill a building of twice the dimensions of the present one. The large and very valuable collections of the Pennsylvania Geological Survey, contained in upwards of 200 cases, still remain in the cellar, boxed, for want of exhibition space. The types of the greater number of the fossil plants described by Lesquereux in his 'Coal Flora of the United States,' probably one of the most valuable collections of fossil plants in the world, have been added to this collection during the year, but, for similar reasons, still remain boxed. The report of the Professor of Ethnology and Archæology indicates that accessions to this department of the Academy's Museum could readily be had were proper exhibition space provided, but that under present conditions the same is impossible. In view of these facts the necessity for an extension to the Academy's building cannot be too strongly insisted upon." The Curators also urge that a fund should be raised for zoogeographical exploration. The interest derived from 50,000 dollars would, they think, fairly equip an annual expedition to any of the largely-unexplored regions lying about the dominions of the United States, such as Mexico, Central America, the Bahamas, and Labrador.

Mr. Arthur J. Bethell has reprinted, with additions and corrections, three articles which lately appeared in the *Field*, on a ride to the Falls of Zambesi. He has added a number of notes which may be of considerable service to men who think of spending some time in hunting in South Africa.

It was decided some time ago that a number of the Crown diamonds of France should be sold. Others were put aside for the collections of the Paris School of Mines and Museum of Natural History; and these gems were recently given to the delegates appointed by the two Schools. The Regent diamond, a very fine one, will be kept in the Louvre Gallery.

The additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*), a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Miss E. James; a Three-striped Paradoxure (*Paradoxurus trivirgatus*) from India, presented by Mr. Gerald Callinder; a Common Squirrel (*Sciurus vulgaris*), British, presented by Miss May Honrott; a Scop's Owl (*Scops qui*), captured at sea near Aden, presented by Mr. W. M. Holland; a White-fronted Heron (*Ardea novæ-hollandiæ*) from Australia, presented by Mr. J. B. Dyas; a Stanley Parrakeet (*Platycercus icterotis*) from West Australia, a Burmeister's Cariama (*Chunga burmeisteri*) from South-East Brazil, a Black Sternothere (*Sternothærus niger*) from West Africa, received in exchange; two Smews (*Mergus albellus* ♂ ♀), European, purchased.

OUR ASTRONOMICAL COLUMN

Comet 1887 *b* (Brooks, January 22).—The following ephemeris for this object is by Dr. R. Spitaler (*Astr. Nach.* No. 2773).

1887 Berlin midnight	R.A. h. m. s.	Decl. ° ′	Brightness
March 4	3 37 51	51 48·5 N.	1·19
6	3 43 32	49 39·6	1·15
8	3 46 11	47 35·1	1·12
10	3 53 33	45 35·2	1·08
12	3 58 3	43 39·9	1·04
14	4 2 17	41 49·3 N.	1·00

The brightness on January 25 is taken as unity.

Comet 1887 *c* (Barnard, January 23).—Dr. H. Oppenheim gives (*Astr. Nach.* No. 2773) the following ephemeris for Berlin midnight for this comet:—

1887	R.A. h. m. s.	Decl. ° ′	log *r*	log Δ	Brightness
March 10	21 36 44	51 59·4 N.	0·3182	0·3700	0·6
14	21 52 56	53 51·0	0·3259	0·3775	0·6
18	22 9 39	55 34·6	0·3335	0·3855	0·5
22	22 26 51	57 10·3	0.3411	0·3938	0·5
26	22 44 30	58 37·8	0·3486	0·4025	0·4
30	23 2 32	59 57·2 N.	0·3560	0·4113	0·4

The brightness at discovery is taken as unity.

Comet 1887 *d* (Barnard, February 15).—Prof. Boss supplies the following elements and ephemeris for this object from observations made on February 16, 18, and 20:—

T = 1887 April 6·77 G.M.T.

$$\left.\begin{aligned} \pi &= 203° \ 13' \\ \Omega &= 139 \ \ 16 \\ \iota &= 126 \ \ \ 2 \end{aligned}\right\} \text{Mean Eq. } 1887{\cdot}0$$

$\log q = 9{\cdot}8892$

Ephemeris for Greenwich Midnight

1887	R.A. h. m.	Decl. ° ′	Brightness
March 2	3 56·7	29 21 N.	0·38
4	3 40·0	31 18	
6	3 26·5	32 48 N.	0·32

The brightness at discovery is taken as unity.

A Method for the Determination of the Constant of Aberration.—M. Lœwy, in reply to M. Houzeau's claim to be considered the originator of the method for determination of aberration by measurement of the relative positions of two stars situated in distant parts of the sky (Nature, vol. xxxv. p. 377) points out, in the *Comptes rendus*, tome civ. No. 7, that the invention of a new method for the determination of the constant of aberration does not consist in a general indication of the effect of aberration on a certain observation or combination of observations, but in furnishing definite rules the following out of which will lead to results of the accuracy demanded by the exigencies of modern science. M. Lœwy maintains that M. Houzeau's researches on the subject come under the former category, whilst his own are entitled to be ranked under the latter.

The same number of the *Comptes rendus* contains a note by M. Trépied pointing out how photography can be applied for the purpose of practically carrying out M. Lœwy's method.

The Harvard College Observatory.—From Prof. Pickering's Report, presented on December 7, 1886, we learn that during the past year the east equatorial has been used for the photometric observation of the eclipses of Jupiter's satellites upon the system adopted in 1878. The total number of eclipses thus observed is 358, of which 39 have occurred since the end of October 1885. With the same equatorial the observation of comparison stars for variables with the wedge photometer has been continued, and has formed the principal work of the instrument. The "new" stars in Orion and Andromeda, and comets, have also been observed with the east equatorial throughout the year. The reduction and publication of work already done with the meridian-circle is at present, in Prof. Pickering's opinion, more desirable than the prosecution of new series of observations. This department of the Observatory has sustained a heavy loss in the resignation of Prof. Rogers, who has devoted many years to laborious astronomical work at Harvard College. During the year ending November 1, 1886, 209 series of measures have been made with the meridian-photometer. The total number of separate photometric comparisons is 59,800. The instrument continues to give entire satisfaction as a means of measuring the brightness of stars of the ninth magnitude or brighter. The average deviation of 100 circumpolar stars used as standards, which, with the smaller instrument of the same kind employed in the Harvard photometry, was 0·16 of a magnitude, has been reduced to 0·12 with the present instrument; whilst the average deviation of stars from the fifth to the ninth magnitude but little exceeds 0·1 of a magnitude. And a comparison between the results obtained by Dr. Lindemann, at Pulkowa, with a Zöllner photometer, and at Harvard College, with the meridian-photometer, shows that the average deviation of a measurement of the difference in brightness between two stars observed at both places does not exceed 0·1 of a magnitude. For an account of the interesting and important researches in stellar photography which have recently been carried out at the Harvard College Observatory, see NATURE, vol. xxxv. p. 37.

NEW MINOR PLANET.—A new minor planet, No. 265, was discovered on February 27, by Herr Palisa, at Vienna. This is the fifty-eighth that Herr Palisa has discovered.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 *MARCH* 6-12

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on March 6

Sun rises, 6h. 37m.; souths, 12h. 11m. 28·1s.; sets, 17h. 46m.; decl. on meridian, 5° 40′ S.: Sidereal Time at Sunset, 4h. 43m.

Moon (Full on March 9) rises, 13h. 39m.; souths, 21h. 29m.; sets, 5h. 10m.*; decl. on meridian, 17° 4′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 54	13 15	19 36	3 22 N.
Venus	7 20	13 35	19 50	2 16 N.
Mars	7 0	12 54	18 48	1 58 S.
Jupiter	22 19*	3 21	8 23	12 2 S.
Saturn	12 2	20 11	4 20*	22 28 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

March	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
6	*f* Geminorum	6	0 41	1 40	131 289
8	18 Leonis	6	4 1	4 39	67 337
8	45 Leonis	6	18 24	19 14	68 185
8	ρ Leonis	4	20 50	21 54	61 111
8	49 Leonis	6	22 53	near approach	332 —
11	γ Virginis	2½	3 7	3 40	145 210
11	B.A.C. 4277	6	4 22	near approach	186 —

March	h.	
12	3	Mercury stationary.
12	20	Jupiter in conjunction with and 3° 34′ south of the Moon.

Saturn, March 6.—Outer major axis of outer ring = 44″·0; outer minor axis of outer ring = 18″·3; southern surface visible.

Variable Stars

Star	R.A. h. m.	Decl. ° ′			h. m.	
U Cephei	0 52·3	81 16 N.	Mar.	7,	19 36	*m*
S Arietis	1 58·6	11 59 N.	,,	6,		*M*
T Cancri	8 50·2	20 17 N.	,,	9,		*m*
R Ursæ Majoris	10 36·7	69 22 N.	,,	11,		*M*
T Virginis	12 8·8	5 24 S.	,,	7,		*M*
S Ursæ Majoris	12 39·0	61 43 N.	,,	10,		*M*
W Virginis	13 20·2	2 48 S.	,,	12,	5 0	*M*
δ Libræ	14 54·9	8 4 S.	,,	9,	23 39	*m*
U Coronæ	15 13·6	32 4 N.	,,	6,	18 46	*m*
R Scorpii	16 10·9	22 40 S.	,,	11,		*M*
U Ophiuchi	17 10·8	1 20 N.	,,	7,	5 46	*m*
		and at intervals of			20 8	
U Sagittarii	18 25·2	19 12 S.	Mar.	9,	3 0	*m*
β Lyræ	18 45·9	33 14 N.	,,	9,	1 0	*m*
S Vulpeculæ	19 43·8	27 0 N.	,,	12,		*M*
η Aquilæ	19 46·7	0 43 N.	,,	9,	5 0	*m*
δ Cephei	22 25·0	57 50 N.	,,	12,	0 0	*m*

M signifies maximum; *m* minimum.

ON RADIANT-MATTER SPECTROSCOPY:—EXAMINATION OF THE RESIDUAL GLOW[1]

I.

THE duration of phosphorescence after cessation of the exciting cause is known to vary within wide limits of time, from several hours in the case of the phosphorescent sulphides to a minute fraction of a second with uranium glass and sulphate of quinine. In my examinations of the phosphorescent earths glowing under the excitement of the induction discharge *in vacuo*, I have found very great differences in the duration of the residual glow. Some earths continue to phosphoresce for an hour or more after the current is turned off, while others cease to give out the light the moment the current stops. Having succeeded in splitting up yttria into several simpler forms of matter differing in basic power (Roy. Soc. Proc. vol. xl. pp. 502-509, June 10, 1886), and always seeking for further evidence of the separate identity of these bodies, I noticed occasionally that the residual glow was of a somewhat different colour to that it exhibited while the current was passing, and also that the spectrum of this residual glow seemed to show, as far as the faint light enabled me to make out, that some of the lines were missing. This pointed to another difference between the yttrium components, and with a view to examine the question more closely I devised an instrument similar to Becquerel's phosphoroscope, but acting electrically instead of by means of direct light.

The instrument, shown in Fig. 1, A and B, consists of an opaque disk, *a b c*, 20 inches in diameter, and pierced with twelve openings near the edge as shown. By means of a multiplying wheel, *d*, and band, *e f*, the disk can be set in rapid rotation. At each revolution a stationary object behind one of the apertures is alternately exposed and hidden twelve times. A commutator, *g* (shown enlarged at Fig. 1, B), forms part of the axis of the disk. The commutator is formed of a hollow cylinder of brass round a solid wooden cylinder. The brass is cut into two halves by a saw cut running diagonally to and fro round it, so as to form on each half of the cylinder twelve deeply cut teeth interlocking, and insulated from those on the opposing half cylinder by an air space about 2 mm. across. Only one half, *h h h*, of the cylinder is used, the other, *i i i*, being idle; it might have been cut away altogether were it not for some little use that it is in saving the rubbing-spring, *j*, from too great friction when passing rapidly over the serrated edge. To a block beneath the commutator are attached two springs, one, *k*, rubbing permanently against the continuous base of the serrated hemicylinder *h h*, and the other, *j*, rubbing over the points of the teeth of *h h*. By connecting these springs with the wires from a battery it will be seen that rotation of the commutator produces alternate makes and breaks in the current. The spring, *j*, rubbing against the teeth is made with a little adjustment sideways, so that it can be said to touch the points of the teeth only, when the breaks will be much longer than the makes, or it can be set to rub near the base of the teeth, when the current will remain on for a much longer time and the intervals of no current will be very short. By means of a screw, *l l*, attached to the spring, any desired ratio between the makes and the breaks can be obtained. The intermittent primary current is then carried to an induction coil, *m*, the secondary current from which passes through the vacuum tube, *n*, containing the earth under examination. When the commutator, the coil-break, and the position of the vacuum tube are in proper adjustment, no light is seen when looked at from the front if the wheel is turned slowly (supposing a substance like yttria is being examined), as the current does not begin till the tube is obscured by an intercepting segment, and it ends before the earth comes into view. When, however, the wheel is turned more quickly, the residual phosphorescence lasts long enough to bridge over the brief interval of time elapsing between the cessation of the spark and the entry of the earth into the field of view, and the yttria is seen to glow with a faint light, which becomes brighter as the speed of the wheel increases.

To count the revolutions, a projecting stud, *o*, is fastened to the rotating axis, and a piece of quill, *p*, is attached to the fixed support, so that at every revolution a click is produced. With a chronograph watch it is easy in this way to tell the time, to the tenth of a second, occupied in ten revolutions of the wheel.

Under ordinary circumstances it is almost impossible to detect any phosphorescence in an earth until the vacuum is so high that the line spectrum of the residual gas begins to get faint; otherwise the feeble glow of the phosphorescence is drowned by the greater brightness of the glowing gas. In this phosphoroscope, however, the light of glowing gas does not last an appreciable time, whilst that from the phosphorescent earth endures long enough for it to be caught in the instrument. By this means, therefore, I have been able to see the phosphorescence of yttria, for example, when the barometer gauge was 5 or 6 mm. below the barometer.

When the earth under examination in the phosphoroscope is yttria free from samaria, and the residual emitted light is ex-

[1] Paper read before the Royal Society by Mr. William Crookes, F.R.S., on Feb. 17.

amined in the spectroscope, not all the bands appear at the same speed of rotation. At a slow speed the double greenish-blue band of Gβ (545) first comes into view, closely followed by the deep blue band of Gα (482). This is followed, on increasing the speed, by the bright citron band of Gδ (574), and at the highest speed the red band of Gζ (619) is with difficulty seen.

The following are measurements of the time of duration of the phosphorescences of the different constituents of yttrium. The wheel was first rotated slowly, until the first line visible in the spectroscope attached to the phosphoroscope appeared; the speed was counted, and it was then increased until the line next visible was seen. In this way the minimum speed of revolution necessary to bring each line into view was obtained, and from these data the duration of phosphorescence for each constituent

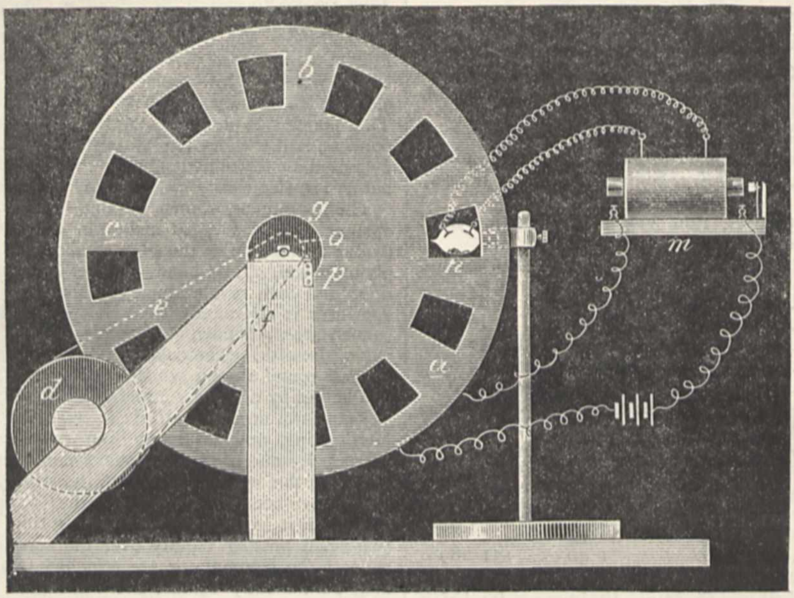


Fig. 1, A.

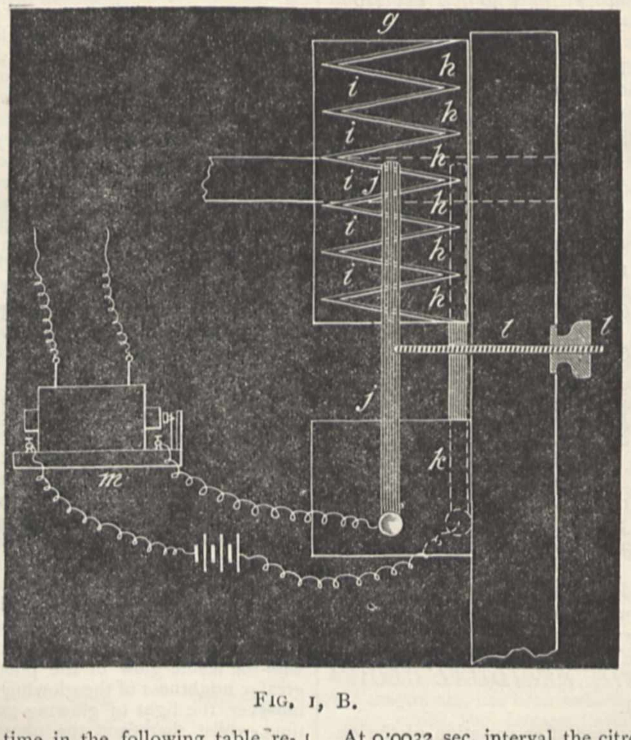


Fig. 1, B.

of yttria was calculated. The time in the following table represents in decimals of a second the time elapsing between the cessation of the induction discharge and the visibility of the residual glow of the earth:—

At 0·0035 sec. interval the green and blue lines of Gβ and Gα begin to be visible.

At 0·0032 sec. interval the citron line of Gδ begins to be visible.

At 0·00175 ,, the deep red line of Gζ (647) is just visible.

At 0·00125 ,, the line of Gδ is almost as bright as that of Gβ, and the red line of Gη is visible.

At 0·000875 sec. interval the highest speed the instrument could be revolved with accuracy, the whole of the lines usually seen in the yttria spectrum could be seen of nearly their usual brightness.

I have already recorded (Phil. Trans., 1883, Part III. pp. 914–16), that phosphate of yttria, when phosphoresced *in vacuo*, gives the green lines very strongly whilst the citron band is hazy and faint. The same tube of yttric phosphate was now examined in the phosphoroscope. The green lines of Gβ soon showed themselves on setting the wheel into rapid rotation, but I was unable to detect the citron band of Gδ even at a very high speed.

The effect of calcium on the phosphorescence of yttria and samaria has been frequently referred to in my previous papers. It may save time if I summarise the results here. About 1 per cent. of lime added to a badly phosphorescing body containing yttrium or samarium always causes it to phosphoresce well. It diminishes the sharpness of the citron line of Gδ but increases in brightness. It also renders the deep blue line of Gα extremely bright. The green lines of Gβ are diminished in brightness. Lime also brings out the phosphorescence of samarium, although by itself, or in the presence of a small quantity of yttrium, samarium scarcely phosphoresces at all.

In the phosphoroscope the action of lime on yttrium is seen to entirely alter the order of visibility of the constituents of yttrium. In a mixture of equal parts yttrium and calcium, the citron Gδ line is the first to be seen, then comes the Gα blue line, then the Gβ green line, and finally the Gη red line. This may, I think, be explained somewhat as follows:—Calcium sulphate has a long residual phosphorescence, whilst yttrium sulphate has a comparatively short residual phosphorescence. Now with yttrium, although the green phosphorescence of Gβ lasts longest, it does not last nearly so long as that of calcium sulphate. The long residual vibrations of the calcium compound induce, in a mixture of calcium and yttrium, phosphorescence in those yttric molecules (Gδ) whose vibrations it can assist, in advance of those (Gβ) to which it is antagonistic; the line of Gδ therefore appears earlier in the phosphoroscope than that of Gβ, although were calcium not present the line of Gβ would appear first.

Experiments were now tried with different mixtures of yttria and lime as ignited sulphates, to see where the special influence of lime on Gδ ceased.

Yttrium	Calcium	
Per cent.	Per cent.	
97½	2½	Order of appearance in the phosphoroscope.—Gβ, Gα, Gδ, and Gη. The citron line of Gδ is only to be seen at a high speed, and is then very faint.
95	5	Order of appearance in the phosphoroscope.—Gα, Gβ, and Gδ (citron and blue) together, and lastly Gη (red). At a very high speed the green lines of Gβ become far more luminous than any other line.
90	10	Order of appearance.—Gδ and Gα together, then Gβ, and lastly Gη.
80	20	Order of appearance.—Gδ and Gα simultaneously, then Gβ, and lastly Gη. The residual phosphorescence lasts for 30 seconds after the current stops. The light of this residual glow is entirely that of Gδ. The line of Gβ comes into view at an interval of 0·0045 second. At 0·00175 second the line of Gη is just visible.
60 50 40	40 50 60	Order of appearance.—Gδ and Gα together, then Gβ and Gη together.
30 10 5	70 90 95	Order of appearance.—Gδ, Gα, Gβ.
1	99	Order of appearance – Gδ, Gα. The green lines of Gβ could not be seen in the phosphoroscope; they would probably be obliterated by the stronger green of the continuous spectrum given by the calcium.

The action of barium on yttrium was now tried. The following mixtures (as ignited sulphates) were made:—

Yttrium	Barium	
Per cent.	Per cent.	
95 90 80	5 10 20	In the phosphoroscope the Gβ line appears earliest, but the blue Gα line is the next to be seen, whilst the red line of Gη is the latest in appearing. As the percentage of yttrium increases the blue line more and more overtakes the red and increases in brightness.
70 60 50 40 30 25	30 40 50 60 70 75	Spectrum similar to the above. As the percentage of yttrium increases the spectrum grows brighter. In the phosphoroscope the earliest line to appear is the Gβ green, then the Gη red, and next closely following it the Gα blue.
20 15 10 5	80 85 90 95	In the radiant-matter tube all these mixtures give similar spectra. The Gβ green is a little brighter and the Gδ citron is a little fainter than in the corresponding mixtures of yttrium and calcium, but the whole of the yttrium lines are seen. In the phosphoroscope the Gβ green is the first to appear, then the Gη red. The Gδ citron is not visible at any speed.
1	99	Red line of Gη is much brighter; Gδ is very faint, and the green of Gβ is stronger. In the phosphoroscope the order of appearance is,—first the line of Gβ, then the red line of Gη.
0·5	99·5	Phosphoresces with difficulty, of a light blue colour, but turns brick-red in the focus of the pole. Spectrum very faint. Order of appearance to phosphoroscope,—Gβ first, the others too faint to be seen.

The next experiments were tried with strontium, to see what modification the addition of this body to yttrium would produce. The following mixtures of ignited sulphates were experimented with:—

Yttrium	Strontium	
Per cent.	Per cent.	
95	5	A very good yttrium spectrum. In the phosphoroscope the order of appearance is,—first the green of Gβ, then the Gα blue, lastly the Gη red. No Gδ citron line could be seen.
80	20	In the phosphoroscope the green of Gβ is very prominent at a low speed, standing out sharply against a black background. With a higher velocity the Gα and Gη lines come into view.
60 40	40 60	The ordinary spectrum of this and the neighbouring mixtures is very rich in the citron line of Gδ, but I entirely fail to see a trace of this line in the phosphoroscope at any speed. The line of Gβ is the first to come, then the blue line of Gα.
35	65	At about this point a change comes over the appearance in the phosphoroscope. The blue line of Gα is now the earliest to appear, and it is followed by the Gη red and Gβ green. No Gδ line is seen.
25 15 5 0·5	75 85 95 99·5	These mixtures are very similar to each other in the phosphoroscope. The line of Gα comes first, next the Gη line, then Gβ line. No Gδ citron line has been seen in any of these mixtures.

In a paper read before the Royal Society, June 18, 1885 (Phil. Trans., 1885, Part II., p. 716), I described the phosphorescence spectrum given by a mixture of 61 parts yttrium and 39 parts of samarium, and illustrated it by a coloured lithograph. Also in a paper read before the Royal Society, February 25, 1886 (Roy. Soc. Proc. vol. xl. p. 236), I described and figured the phosphorescent spectrum of an earth obtained in the fractionation of yttria which was identical, chemically and spectroscopically, with an earth discovered by M. de Marignac, and provisionally called by him Yα. I repeat here these spectra, and the spectrum of yttrium added for comparison. Omitting minor details, it is seen that the Yα spectrum is identical with

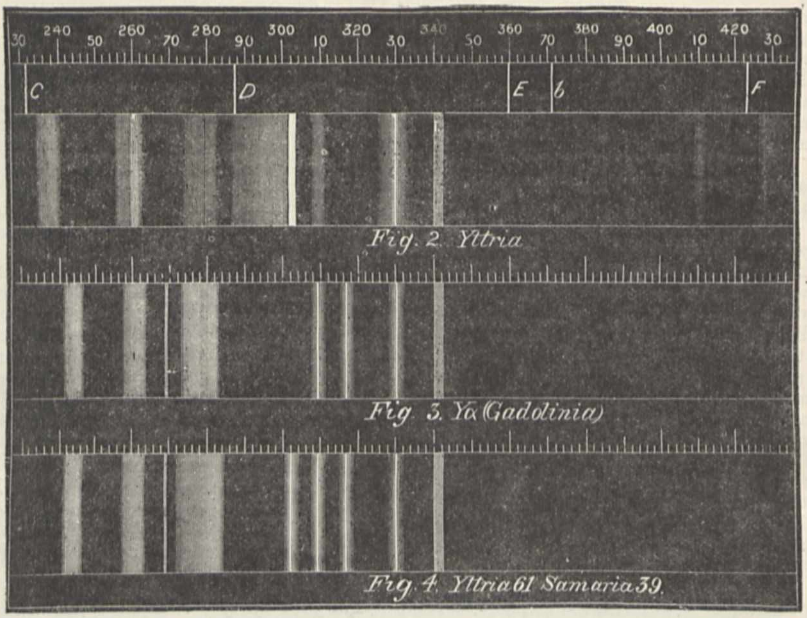


Fig. 2. *Yttria.*

Fig. 3. *Yα (Gadolinia).*

Fig. 4. *Yttria 61 Samaria 39.*

that of the mixture yttrium 61, samarium 39, with one important exception—the citron line of Gδ in the former spectrum is absent in the latter. Could I by any means remove Gδ from the mixture of yttrium and samarium the residue would be Yα. I have little doubt that this will soon be accomplished, but in the meantime the phosphoroscope enables us to remove the line of Gδ from the mixture. It is only necessary to add strontium to a suitable mixture of yitrium and samarium and view the phosphorescing mixture in the instrument when the wheel is rotating rapidly, to obtain a spectrum which is indistinguishable from that of Yα.

(*To be continued.*)

PRE-SCIENTIFIC THEORIES OF THE CAUSES OF EARTHQUAKES

IN the course of a lecture delivered recently before the Rigaku Kyôkai, or Science Society of Tokio, on the causes of earthquakes, Prof. Milne classified the theories as to the cause of these phenomena into three kinds—unscientific, *quasi*-scientific, and scientific. In the former class he included the explanations of the Negro preachers at Charleston after the late earthquakes there, that they occurred in consequence of the wickedness of the population. The Mussulmans in Java recently prayed to the volcanoes there to cease their shakings, at the same time promising reformation of life. That earthquakes are the direct result of man's wickedness is an idea that has always been common. About 1750 earthquakes were felt in many parts of Europe, which were widely attributed to this cause, and innumerable sermons were preached inculcating the lesson that if mankind would live better lives there would be no more earthquakes. In 1786, after a shock at Palermo, the people are recorded to have gone about scourging themselves, and looking extremely humble and penitent. An English poem called "The Earthquake," published in 1750, alleged, in somewhat halting verse, that the disturbances were not due to an unknown force, nor to the groanings of the imprisoned vapours, nor yet to the shaking of the shores with fabled Tridents:—

"Ah no! the tread of impious feet
The conscious earth impatient bears
And shuddering with the guilty weight,
One common grave for her bad race prepares."

From this theory, which can scarcely have satisfied the poet himself, Prof. Milne passed on to the myths which attribute earthquakes to a creature living underground. In Japan it is an "earthquake-insect" covered with scales, and having eight legs, or a great fish having a certain rock on his head which helped to keep him quiet. In Mongolia the animal was said to be a frog, in India the world-bearing elephant, in the Celebes a world-supporting hog, in North America a tortoise. In Siberia there was a myth, connected with the great bones found there, that these were the remains of animals that lived underground, the trampling of which made the ground shake. In Kamchatka the legend was connected with a god, Tuil, who went out hunting with his dogs. When these latter stopped to scratch themselves, their movements produced earthquakes. In Scandinavian mythology, Loki, having killed his brother Baldwin, was bound to a rock face upwards, so that the poison of a serpent should drop on his face. Loki's wife, however, intercepted the poison in a vessel, and it was only when she had to go away to empty the dish that a few drops reached him and caused him to writhe and shake the earth. The lecturer had no means of collecting the fables of the southern hemisphere; but they would obviously be worth knowing for purposes of comparison. As to *quasi*-scientific theories, these endeavoured to account for earthquakes as parts of the ordinary operations of Nature. It was supposed, for instance, that they were produced by the action of wind confined inside the earth. The Chinese philosophers said that Yang, the male element, entered the earth and caused it to expand, and to shake the ground in its efforts to escape. Its effects would be more violent beneath the mountains than in the plains, and therefore earthquakes in the north of China, which was mountainous, were said to be more violent than those in the south. It was supposed that when the wind was blowing strongly on the surface of the earth, there was calm beneath, and *vice versâ*. Aristotle and many other classical writers attributed earthquakes to wind in the earth. Shakespeare, in "Henry IV.," speaks of the teeming earth being pinched and vexed with a kind of colic by the imprisoning of unruly wind within her womb. Then came the theory of electrical discharges, which was advocated in 1760 by Dr. Stukely, as well as by Percival and Priestley. They are strongly held in California at the present day, where it was believed that the network of rails protected the State against any dangerous accumulation of electricity. But Prof. Milne showed that the laying down of rails in Japan had no such effect. He thought the electric phenomena which sometimes attended earthquakes were their consequences, not their causes. He had himself experimented with dynamite placed in a hole; an earth-plate was fixed about thirty yards away from the dynamite, and from it a wire was carried some distance to another earth-plate. When the dynamite charge was exploded there was certainly a current produced, as was indicated by a strong deflection of a galvanometer-needle at the end of the wire. He attributed this to chemical action. When the ground was shaken there was always a greater or less action by increase or decrease of pressure in connection with the earth-plate. Earth currents unquestionably accompany earthquakes, but, as has been said, they appear to be the consequences, not the causes, of the latter. Next came the chemical theories, which were very strong in Europe up to the beginning of the present century. It was imagined that underground there were various substances, such as sulphur, nitre, vitriol, which, by their action on each other, resulted in violent changes, giving rise to vapour, the sudden production of which, in certain cases, would shake the ground. It was only in 1760 that Dr. Mitchell, who wrote a good deal on the subject, first threw out the theory that earthquakes were connected in some way with volcanoes, because they were most frequent in volcanic countries. He observed that large quantities of steam were given off from volcanoes, and came to the conclusion that an earthquake was produced at the time that an attempt was made to form a volcano, that steam got in between certain strata, and, as it ran between them, caused pulsations. Prof. Rogers, about the same time, in North America, endeavoured to show that it was not steam, but really lava, that ran along underneath the ground, causing it to rise and fall, thus producing an earthquake. Prof. Milne having thus dealt with unscientific and *quasi*-scientific theories, passed on to those of modern science. It is unnecessary here to follow him into this portion of his subject, although it occupied the main part of the lecture.

ON THE EFFECT OF CERTAIN STIMULI ON VEGETABLE TISSUES[1]

THE object of our paper is to describe the behaviour of turgescent pith when placed in water and treated with certain reagents. If from a growing shoot the external tissues be removed, a well-known result is seen: the pith suddenly lengthens, becoming longer than the specimen was at first. This experiment shows that turgescent pith is normally in a compressed condition—it is always trying to get longer—and when it is freed from the coercion of the unyielding external tissues, it at once does become longer. This tendency to become longer is further manifested by allowing turgescent pith to remain in damp air, or in water, for some time, when a great increase in length takes place. In such a piece of pith we have the essential, active factor in growth, freed from interference, and at liberty to perform its function rapidly and freely. The tendency in turgescent pith to get longer is the very power which calls forth that increase in length which we call growth; so that in studying turgescent pith we are studying the active agent in the production of growth. We do not suppose that our results are necessarily directly applicable to normal growth,[2] but we think that they have a bearing on normal growth sufficiently close to give interest to our experiments.

The pith,[3] after being cut into pieces about 6 inches in length and ⅓ inch in thickness, was ready for use. The lower end of the pith was fixed to a hook at the bottom of a narrow jar, the upper end was attached by a silk thread to the short arm of an auxanometer lever. The jar was then filled with water, and as the pith elongates the short arm of the lever ascends and the long arm rapidly descends. Its movement, read off on a millimetre scale, gives an index of the rate of "growth" of the pith. The lengthening of the pith is, in fact, observed like the normal growth of a plant, the only difference being that the "growth" of the pith is so rapid that the descent of the long arm is clearly visible to the naked eye and is correspondingly easy to measure. It is most striking to see the index travelling down thus quickly

[1] Abstract of a Paper by Anna Bateson (Newnham College) and Francis Darwin (Cambridge), read before the Linnean Society, January 20, 1887.

[2] For the sake of convenience we shall nevertheless use the word "growth" to mean the elongation of the pith under observation.

[3] Sunflower and Jerusalem Artichoke.

and traversing (it may be) 10 mm. (⅜ inch) in a minute. We used a stop-watch to determine the time in which the point of the long arm of the lever travelled over a certain distance, and we could thus estimate the changes in the rate of growth from minute to minute.

The first thing needful to know is the ordinary course of growth of the pith in water. It was found that an interesting phenomenon—an apparent *grand period*—takes place. That is to say, the growth is at first slow, then more rapid, and ultimately becomes slow again, the whole period taking perhaps twenty minutes to complete. This is precisely the series of changes which a growing organ exhibits in the course of days instead of minutes. We do not suppose that our grand period is necessarily of a kindred nature to the grand period of normal growth. For we are aware that purely mechanical processes, such as the moistening of a hygroscopic awn, exhibit the same thing—the awn at first untwists slowly, then more quickly, and then again slowly. But the knowledge of the fact is of great importance to us, since unless we know the normal course of growth we cannot study the effect of reagents.

Warmth.—Before going on to consider the action of reagents, we will say a few words as to the stimulation caused by an increase in the surrounding temperature. If the water in the jar is gradually warmed, the growth of the pith increases in speed in the most striking manner. The increase is fairly steady from, say, 17° C. to about 35°, the rate at this latter temperature being perhaps four times as high as it was at first. It then usually becomes irregular, with some diminution; and, just before a temperature is reached which kills the tissues, a sudden and rapid fall in the rate of growth sets in. This we found usually to occur at about 55° C. This is, no doubt, an unusually high temperature, but not higher than plants are known to be able to survive.

The chief interest in these temperature experiments is this: they show that the phenomena we are considering is a truly vital one. We have always been on our guard in this matter, and have wished to make certain that the observed phenomena are not in some mysterious way mechanical, instead of, as we believe, the response of living tissues *as* living tissues. Therefore, when we find that heat has a normal effect on our material, we are encouraged to believe that our other results—to which we now pass on—are also vital phenomena.

Alcohol.—The pith was attached to the auxanometer, and the jar filled with water. As soon as the rate of growth was found to be steadily diminishing, a small quantity of alcohol was added. The result was an immediate and striking increase in the rate of growth. For instance, when 2 per cent. of spirit was added, the growth was accelerated within two minutes by 50 per cent.

The result is temporary, so that in the course of another two minutes the rate of growth sinks to what it was before stimulation. Similar results were obtained with ether, and here the pith was allowed to grow in damp air, and was subjected to ether in the form of vapour. When the vapour was present in the proportion of 0·27 per cent., the acceleration was 56 per cent.; with 0·4 per cent., the acceleration was 100 per cent. Here, as in the case of alcohol, the result was temporary, the rate falling in a few minutes to what it was before stimulation.

When the ether amounts to 3 per cent. of the atmosphere, the pith is killed, and shows no increase, but, on the contrary, a decrease[1] in length. Elfving has shown that ether has a stimulating effect on respiration, and on the sensitiveness of swarm-spores to light. He also tested its effect on the growth of phycomyces. His results differ from ours, inasmuch as he found no stimulating effect: the ether produced either no effect whatever, or else it retarded, or even stopped, growth.

Ammonia.—We employed the *Liquor Ammoniæ fortior* of the "British Pharmacopœia" for the preparation of our solutions, and we found that various strengths ranging between 0·5 and 2·4 per cent. produced acceleration of growth. Here again, as with ether and alcohol, the acceleration was very temporary.

Acids.—As a rule, acids produced no acceleration, but caused either retardation, or flaccidity and death. Thus, for instance, acetic acid (0·5 and 1 per cent.) produced retardation; 5·4 per cent. produced death.

Hydrocyanic Acid did not cause flaccidity such as we have described in the case of acetic acid. The action of this reagent is comparable rather to that of alcohol, but is not

[1] This contraction is simply a symptom of flaccidity, and usually of death.

identically the same. It produces either a temporary acceleration, such as is due to alcohol, or else a remarkably steady and high rate of growth. On the action of this reagent we hope to make further observations.

Quinine Chloride.—Extremely dilute solutions acted poisonously, and produced a shortening of the tissues. When contraction took place it was manifested within a remarkably short time. In one case contraction seemed to begin simultaneously with the exposure to the poison, and was certainly well marked in less than one minute.

Conclusion.—The most interesting fact which we have established is the possibility of stimulating turgescent tissues to increased elongation by such reagents as alcohol, ether, and hydrocyanic acid. And we incline to think that our results may help to direct attention to a factor in the problem of cell-mechanism—namely, the protoplasmic element, rather than the purely osmotic side of the question.

SOCIETIES AND ACADEMIES

London

Royal Society, February 24.—"On the Relation between Tropical and Extra-Tropical Cyclones." By the Hon. Ralph Abercromby. Communicated by Mr. R. H. Scott, F.R.S.

All cyclones have a tendency to assume an oval form; the longer diameter may lie in any direction, but has a decided tendency to range itself nearly in a line with the direction of propagation. Tropical cyclones have less tendency to split into two, or to develop secondaries than those in higher latitudes. A typhoon which has come from the tropics can combine with a cyclone that has been formed outside the tropics, and form a single new, and perhaps more intense, depression. There is much less difference in the temperature and humidity before and after a tropical cyclone than in higher latitudes. The quality of the heat in front is always distressing in every part of the world.

The wind rotates counter-clockwise round every cyclone in the northern hemisphere, and everywhere as an ingoing spiral. The amount of incurvature for the same quadrant may vary during the course of the same cyclone; but in most tropical hurricanes the incurvature is least in front, and greatest in rear; whereas in England the greatest incurvature is usually found in the right front. Some observers think that broadly speaking the incurvature of the wind decreases as we recede from the equator. The velocity of the wind always increases as we approach the centre in a tropical cyclone; whereas in higher latitudes the strongest winds and steepest gradients are often some way from the centre. In this peculiarity tropical cyclones approximate more to the type of a tornado; but the author does not think that a cyclone is only a highly developed whirlwind, as there are no transitional forms of rotating air.

The general circulation of a cyclone, as shown by the motion of the clouds, appears to be the same everywhere. All over the world, unusual coloration of the sky at sunrise and sunset is observed, not only before the barometer has begun to fall at any place, but before the existence of any depression can be traced in the neighbourhood. Cirrus appears all round the cloud area of a tropical cyclone, instead of only round the front semicircle, as in higher latitudes. The alignments of the stripes of cirrus appear to be more radial from the centre in the tropics, than tangential, as indicated by the researches of Ley and Hildebrandsson in England and Sweden respectively. Everywhere the rain of a cyclone extends farther in front than in rear. Cyclone rain has a specific character, quite different from that of showers or thunderstorms; and this character is more pronounced in tropical than in extra-tropical cyclones.

Squalls are one of the most characteristic features of a tropical cyclone, where they surround the centre on all sides; whereas in Great Britain, squalls are almost exclusively formed along that portion of the line of the trough which is south of the centre, and in the right rear of the depression. As, however, we find that the front of a British cyclone tends to form squalls when the intensity is very great, the inference seems justifiable that this feature of tropical hurricanes is simply due to their exceptional intensity.

A patch of blue sky, commonly known as the "bull's-eye," is almost universal in the tropics, and apparently unknown in higher latitudes. The author's researches show that in middle latitudes the formation of a "bull's-eye" does not take place when the motion of translation is rapid; but as this blue space is not observed in British cyclones when they are moving slowly, it would appear that a certain intensity of rotation is necessary to develop this phenomenon.

The trough phenomena,—such as a squall, a sudden shift of wind, and change of cloud character and temperature, just as the barometer turns to rise, even far from the centre—which are such a prominent feature in British cyclones,—have not been even noticed by many meteorologists in the tropics. The author, however, shows that there are slight indications of these phenomena everywhere; and he has collated their existence and intensity with the velocity of propagation of the whole mass of the cyclone.

Every cyclone has a double symmetry. One set of phenomena, such as the oval shape, the general rotation of the wind, the cloud ring, rain area, and central blue space, are more or less related to a central point. Another set, such as temperature, humidity, the general character of the clouds, certain shifts of wind, and a particular line of squalls, are more or less related to the front and rear of the line of the trough of a cyclone. The author's researches show that the first set are strongly marked in the tropics, where the circulating energy of the air is great, and the velocity of propagation small; while the second set are most prominent in extra-tropical cyclones, where the rotational energy is moderate, and the translational velocity great. The first set of characteristics may conveniently be classed together as the rotational, the second set as the translational, phenomena of a cyclone.

Tropical and extra-tropical cyclones are identical in general character, but differ in certain details, due to latitude, surrounding pressure, and to the relative intensity of rotation or translation.

Linnean Society, February 17.—Mr. W. Carruthers, F.R.S., President, in the chair.—The Rev. A. Johnson exhibited drawings of an abnormal *Begonia Veitchii* grown by him the preceding autumn. The peculiarity consisted in the flower having a single, large, flask-shaped, ovarian-like organ (?) placed centrally, and surmounted by a single, simple, straight style; thus, though doubtless a male, indicating an hermaphrodite condition, while presenting resemblances to the normal female organs of *Laurus nobilis*.—Mr. E. M. Holmes exhibited some irregularly-developed lemons, in which the carpels were more or less separated at the apex; the arrest of the normal union of the carpel being attributed to the bite of an insect in the early stage of the growth of the fruit.—There were exhibited, for Mr. J. G. Otto Tepper, a new *Stylidium* (*S. Tepperiana*, F. Muell.), collected in November 1886 on Mount Taylor, Kangaroo Island, Victoria, Australia. It was found in the interstices of a Tertiary limestone. Other trees which grew in the neighbourhood were stunted Eucalypts, Hawkeas, and an Acacia somewhat resembling *A. pycnantha*.—Sir J. Lubbock drew attention to examples of *Peziza coccinea* from Ilfracombe.—A dried specimen of *Primula imperialis*, Jungh., collected by Dr. Sydney Hickson in Java, was exhibited from the Royal Gardens, Kew. This species is a giant form of *Primula*, being over 3 feet in height. Plants of this Himalayan and Malayan species are now under cultivation at Kew, and form an interesting addition to this popular group of garden plants.—Mr. G. Maw showed two rare Narcissi, both known under the name of *N. cernuus*. The daffodil discovered by Mr. Buxton in the Pyrenees at 7000 feet altitude is interesting as the only white form known in a wild habitat. A diminutive, orange-coloured species, flowered by the Rev. C. Wolley Dod from bulbs collected by Dr. Henriques, of Coimbra, appears to be allied to *N. triandrus*.—Sir J. Lubbock read the second part of his paper on phytobiological observations, and on the leaf of *Liriodendron*. In *Œnothera bistorta* the seed-leaves are linear, terminating in a large round expansion. There is nothing to account for it in the seed, nor does it appear to be of any advantage to the young plant. On watching the growth, however, and comparing it with that of other allied species, the explanation appears to be as follows: the cotyledons are at first round, but a growth takes place at the base of the cotyledon, which closely resembles that of the subsequent leaves, hence their peculiar figure in this species. In allied species the seed-leaves consist of two parts, a terminal portion—the true or original cotyledon—and a subsequent growth resembling in each species their true leaves. With reference to seed-leaves in which the stalks are connate, *e.g. Smyrnium*, the union seems clearly advantageous as giving additional strength. Other characters in various species, *Plantago*, *Tilia*, *Heliophila*, *Cardamine*, &c., were instanced. As to the tulip-tree (*Lirio-*

dendron), for long a puzzle by the peculiar saddle shape of the leaves, after testing various other suggestions which had proved untenable, Sir John described the structure of the bud and the manner in which the young leaves were packed in it, and showed that the peculiar manner in which the young leaves are arranged, satisfactorily accounts for the well-known and very remarkable form of the leaf.—A paper was read on *Dichelaspis pellucida*, by Dr. Hoek, of Leyden. The cirripede in question was got from the scales of a water-snake in the Mergui Archipelago by Dr. J. Anderson, and this is believed to be the first record of the species since Charles Darwin wrote his classic monograph on the group thirty-five years ago.

Zoological Society, February 15.—Prof. W. H. Flower, F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of January 1887, and called special attention to two Blakiston's Owls (*Bubo blackistoni*) from Japan, presented by Mr. J. H. Leech; three Hooker's Sea-Lions (*Otaria hookeri*), presented by the Hon. W. J. M. Larnach, Minister of Marine of New Zealand; and a Blue Penguin (*Eudyptu'a minor*) from Cook's Straits, New Zealand, presented by Mr. Bernard Lawson.—Prof. F. Jeffrey Bell read a report on a collection of Echinodermata made in the Andaman Islands by Colonel Cadell. The collection was stated to contain 100 examples referable to 50 species.—Mr. G. A. Boulenger read a paper on a collection of Reptiles and Batrachians made by Mr. H. Pryer in the Loo Choo Islands. The author observed that exceptional interest attached to this collection, seeing that it was the first herpetological collection that had reached Europe from that group of islands. Two new species were described, viz. *Tachydromus smaragdinus* and *Tropidonotus pryeri*.—Mr. Oldfield Thomas read a paper on the small Mammals collected in British Guiana by Mr. W. L. Sclater. The collection contained thirteen specimens belonging to eight species, of which one was new; this the author proposed to describe as *Hesperomys* (*Rhipidomys*) *sclateri*.—Mr. G. A. Boulenger pointed out the characters of a new Geckoid Lizard from British Guiana. The specimen in question was contained in a small collection of Reptiles made by Mr. W. L. Sclater on the Pomeroon River. The author described it as *Gonatodes annularis*.—A communication was read from Mr. Charles O. Waterhouse, containing an account of a new parasitic Dipterous Insect of the family Hipposcidæ. The author stated that this insect had been found on a species of Swift (*Cypselus melanoleucus*), by Dr. R. W. Shufeldt, at Fort Wingate, New Mexico. It was closely allied to *Anapera pallida*, a European dipterous parasite found on *C. apus*, and was proposed to be named *Anapera fimbriata*.—Mr. John H. Ponsonby communicated, on behalf of Mr. Andrew Garrett, the first part of a paper on the Terrestrial Mollusks of the Viti or Fiji Islands.—Mr. F. E. Beddard read a paper on the structure of a new genus of Lumbricidæ (*Thamnodrilus*) discovered by Mr. W. L. Sclater in British Guiana, which he proposed to characterise as *Thamnodrilus gulielmi*.

Anthropological Institute, Feb. 8.—Mr. Francis Galton, F.R.S., President, in the chair.—A paper was read by Sir Charles Wilson on the tribes of the Nile Valley north of Khartoum. Sir Charles Wilson opened his paper by remarking on the extraordinary way in which the various races inhabiting the Nile Valley—with many of whom he had come in contact in the course of the Nile Expedition—had become mixed up, and how completely the indigenous population had in certain cases lost its nationality while absorbing its Arab conquerors. The tribes of the Nile Valley north of Khartoum might be divided into three groups, the Hamitic, the Semitic, and the Nuba, all alike claiming descent from the Koreish of Mecca. Sir C. Wilson then proceeded to give briefly a history of the different tribes from the earliest times, describing in detail the peculiarities and physical characteristics of each race. A number of Soudanese weapons, lent by Sir Allen Young, were exhibited.

Paris

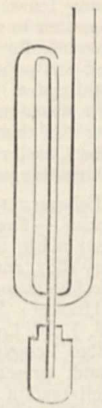
Academy of Sciences, February 21.—M. Gosselin, President, in the chair.—Determination of the constant of aberration: first method of observation, by M. Lœwy. In this paper the author proceeds to explain successively the geometrical properties on which depend the various methods of estimating the constant of aberration. The first of the two processes is here dealt with, which, although somewhat less rigorous than the general method, practically yield results of the greatest precision, while also enabling the observer to determine two other physical constants—the variation of refraction caused by change either of temperature or of atmospheric pressure.—Note on M. Faye's recent communication regarding waterspouts, by M. Mascart. M. Faye having again raised this question in connection with M. Weyher's experiments, the author returns to his original contention that the great body of observed phenomena are directly opposed to M. Faye's theory of cyclones.—On the development of the Pennatulæ (*Pennatula grisea*), and on the favourable biological conditions presented by the Arago Laboratory for zoological studies, by M. H. de Lacaze-Duthiers. A visit paid to the Arago station last October suggests some remarks on the flourishing condition of the Alcyonaria and Pennatulæ, which have become thoroughly acclimatised in this district. A general description is given of the laboratory and reservoir at the Fontaulé headland, which has been enlarged to a capacity of 130 cubic metres, offering every facility for the study of sponges, star-fish, tritons, and many other lower forms of marine life.—On the Alpine flora surviving in the Paris district, by M. A. Chatin. The author discusses the various hypotheses which trace this already described flora either to the Scandinavian or Swiss Alps or to the Pyrenees, and concludes generally that the Parisian highland flora is independent of all, and truly aboriginal. It is also contended that most of the present European vegetation goes no further back than the Quaternary formations, and that for plants there has been independent succession and plurality of centres of creation rather than widespread diffusion from a single centre.—On the orthobutyrate and isobutyrate of lime, by MM. G. Chancel and F. Parmentier. An exhaustive study of these substances shows that M. le Chatelier's approximate relation—

$$\frac{dx}{x} : \frac{k}{\delta} Q \frac{dt}{T^2},$$

giving the variation of solubility of different bodies, with their heat of solution at saturation, cannot be regarded as the expression of a general law from which fresh deductions may be safely drawn.—On the red fluorescence of alumina (second notice), by M. Lecoq de Boisbaudran. Here are treated two highly calcined aluminas + Cr_2O_2 and + Bi_2O_3, and a moderately calcined alumina + Bi_2O_3.—On the incubation of Phylloxera during the winter season, by M. A. L. Donnadieu. In reply to M. Balbiani, who holds that the Phylloxera of the oak completes the entire cycle of its evolution in a single year, the fertilised eggs hibernating during the ensuing winter, the author's researches lead to the conclusion that the activity of this organism is not interrupted during the period of suspended vegetation of the plant on which it lives. A like conclusion is arrived at as regards the Phylloxera of the vine, which on this plant continues without interruption, but with a somewhat diminished intensity, the biological evolutions of its summer life throughout the winter season.—Observations of Brooks's comet made at the Observatory of Toulouse, by M. Baillaud.—On Gauss's quadrature formula, and on Hermite's formula of interpolation, by M. P. Mansion.—On the orthogonal systems formed by the θ functions, by M. F. Caspary.—On the movements of the air, by M. Ch. Weyher. A series of experiments are described which have been carried out by means of a jet of air or vapour a demi-millimetre in diameter and inclined 45° to the horizon, holding in suspense two spheres, one of cork with a diameter of 20 mm., the other of caoutchouc inflated with air. The centre of gravity of the spheres is below the axis of the jet, which thus causes them to revolve round each other, while their weight is balanced by the attraction produced by the series of little eddies developed along the sides of the jet.—On a method of determining the induction flux traversing an electro-magnetic system, by M. R. Arnoux. A simple method is described, by means of which this quantity may be accurately determined without the aid of the ballistic galvanometer, which is not available for practical purposes.—On the causes determining the phosphorescence of the sulphuret of calcium, by M. A. Verneuil. From the author's researches, which are still in progress, it appears that the violet sulphuret of calcium prepared from shells owes its bright phosphorescence to the salt of bismuth, the carbonate of soda, the sea-salt, and the sulphate of lime formed during the reaction.—Action of some metals on weak solutions of the nitrate of silver, by M. J. B. Senderens. It is shown that by acting on such solutions lead reduces the nitric acid while the silver is precipitated; also that analogous phenomena are presented by zinc, iron, tin, cadmium, antimony, and aluminium.—Action of sulphuric acid on the solubility of the sulphates, by M. R. Engel. Sulphuric acid, acting on solutions of sulphates incapable of combining with it to form acid sulphates, determines a diminution of the solubility of the salt. But this is shown to take place according to a law different from that observed for the chlorides in presence of hydrochloric acid.—On the reproduction of the micas, by MM. P. Hautefeuille and L. Péan de Saint-Gilles. In this preliminary paper the authors confine themselves to some of their researches on the fusion of the elements of the micas with the fluosilicate of potassa.—Remarks on M. Boutroux's note regarding the action of nitric acid on sugar, by M. E. Maumené. M. Boutroux's statement that by the action of sugar and nitric acid he obtained saccharic acid and oxalic acid, but not hexepic acid, is shown to be erroneous.—On the treatment of new wines with sugar, by MM. D. Klein and E. Fréchou. The authors' experiments show the possibility of obtaining with alcohol of about the theoretic quantity right fermentations by means of which poor vintages may henceforth be converted into good wines capable of preservation.—A contribution to the study of the alkaloids, by M. Oechsner de Coninck.—Researches on the mode of action of colchicine taken as a therapeutic, and on the mechanism of this action, by MM. A. Mairet and Combemale. The authors' experiments show that this substance has the same diuretic or purgative action on men as on animals, but the former are three times more sensitive to its action than the latter.—Fresh studies on the embryogeny of the Nematodes, by M. Paul Hallez.—On the development of the Nematodes of the beetroot during the years 1885 and 1886, and on their modes of propagation, by M. Aimé Girard.—On the oscillations produced during the Eocene period in the Laval basin, by M. D. Œhlert.—On the geological constitution of la Montagne-Noire, Castelnaudary district, by M. J. Bergeron.

BERLIN

Physical Society, January 21.—Prof. von Bezold in the chair.—Dr. König spoke of the disadvantages of the hydro-oxygen lamps, and demonstrated a new lamp constructed by Herr Linnemann, in which the unsteadiness in the light, arising from the fact that in the common lamp the flame burned now in the burning tube and now outside of it, was avoided. In the new lamp the coal-gas or the hydrogen issued from a ring-shaped opening in the burner, while the oxygen in the centre was admitted through a capillary tube and did not come into contact with the burning gas till outside of the burner. In the middle of the blue flame was seen a bright point which gave the heat-maximum. Instead of the lime cylinder, Herr Linnemann used in his lamp zircon plates, which, at the place of the bright point, gave a highly intense constant light. The speaker made use of this light in order, with the aid of the optical bench of Prof. Paalzow, to demonstrate by projection a long series of phenomena in connection with the doctrine of the polarisation of light. For all teaching purposes and demonstrations this method of representing the most important optical phenomena could not be surpassed by any other.—Dr. Lummer described the experiments of M. Macé de Lepinay, who by a new method had determined the wave-length of the ray of light D_2, ascertaining, as he had done, by weighing, the volume of a quartz cube, the size of which was determined in units of the wave-lengths, and from the volume of the cube finding the length of the light-wave. The speaker showed a series of inaccuracies in the measurements of M. de Lepinay, and, in view of the fact that the wave-lengths of the rays of light were now measured with a precision of 1/60,000, whereas the determination of the centimetre was affected with an uncertainty of 1/4000, he purposed inversely ascertaining the length of the centimetre from the wave-length. The mode of procedure should be the same as that made use of by M. de Lepinay, yet several improvements in the measuring and weighing were stated, such as the speaker hoped to be able to effect later on.—Dr. Dieterici showed an apparatus designed by Prof. Köppen which enabled one to fill a barometer free of air very rapidly. An upright standing communicating-tube open at one end for the admission of the quicksilver issued at the other end in a capillary tube passing at the bottom into a vessel. The open leg of the siphon was longer than the other. On pouring in the quicksilver it rose uniformly in both legs, forced up the air in the closed leg and through the capillary outwards. When the closed leg was entirely filled with quicksilver, and yet more continued to be poured in, it drained itself off through the capillary, bearing along with it all the air, in the same manner as did the Sprengel pump. The quicksilver became collected in the lower vessel and closed the lower opening of the capillary. The vacuum was thus established, and in the closed leg of the com-



municating-tube the quicksilver sank to barometer height.—Prof. H. W. Vogel presented photographs of coloured objects which in the distinctness of their *nuances* perfectly corresponded with the impression conveyed by the objects themselves to the eye. The speaker had, in conjunction with Herr Oberneth, succeeded in finding in eosin-silver a substance rendering the photographic plates most highly sensitive for the yellow-green rays, corresponding with the utmost sensitiveness of the retina for those rays. The photographs of solar spectra and different landscapes attested the excellence of this "sensibilisator."

CONTENTS