THURSDAY, OCTOBER 20, 1881

GEOGRAPHY, NATIONAL AND INTERNATIONAL

IT seems impossible to get any full and authentic account of the doings of the recent International Geographical Congress held at Venice, so that at present it is difficult to say how much it did for the promotion of the subject with which it is connected. Congratulatory addresses seem to have been a prominent feature, and much time was devoted to the subject of interoceanic canals, with special reference to those across the isthmuses of Panama and Corinth. If the Congress itself was disappointing, the Exhibition in connection therewith appears to have been a great success. It was a striking illustration of the dimensions which geographical science has now attained. Maps and charts and globes ancient and modern we should of course expect to find; sextants and compasses also, as well as tents and hammocks, and other paraphernalia of the explorer. But besides the exhibits to which geography can lay special claim, nearly every other science was laid under contribution in one way or another. Geology and meteorology, botany and zoology, and ethnology, and even chemistry and physics, have been placed under levy to help in forming the multifarious departments to which geography now lays claim. This wide extension of a subject, which at one time had little claim to be considered scientific, has its advantages and disadvantages. It has reached its widest limits on the Continent, in Germany, where there are chairs of geography, whose professors, to judge from their programmes and their text-books, would require to be almost omniscient. If a student faithfully follows the course thus chalked out, he ought to end by having a fair knowledge of all the sciences. And it comes to be a question whether the same object might not be attained by beginning at the other end. Why, it may be asked, might not the student begin by acquiring a knowledge of the principles and facts of the sciences concerned, and apply them afterwards to the special subject of geography? At the same time, it must be confessed, to have a complete knowledge of the geography of the world, a little of everything is necessary; and the Continental conception of the subject is certainly preferable to the bald and dry idea entertained of it in this country, as exhibited in most of our text-books. Happily better things may be looked for in the future with the use of such text-books as Green's "Geography of the British Isles," and the late Keith Johnston's Geographical Handbook. While geography thus levies tribute on all the sciences, it must be admitted that in return she largely pays back her debt in the multitude of new data brought home by the best of her pioneers. Unfortunately all explorers do not start with that knowledge of the sciences which would greatly increase their observing capacity. Every explorer is not a Livingstone or a Holub, a Prejevalsky or a Maclay; and for such especially, as also for missionaries, a course of geography similar to that which prevails at the German Universities would be a decided advantage. For practical, and especially for school purposes, it is well that some limit should be defined as to the sphere of geography; the happy medium has, we think, been well struck by M. Elisée Réclus in his magnificent "Géographie Universelle," which, when complete, will no doubt form a mine for compilers of textbooks.

One of the most valuable recent developments of geography is seen in the scheme conceived by the late Lieut. Weyprecht, for the establishment of a ring of Polar observatories. This is now close upon being an accomplished fact, as will be seen from the account we gave of the recent meeting of the International Polar Congress at St. Petersburg. As our readers are no doubt aware, many Arctic authorities are of opinion that the days of great and expensive national Polar expeditions are past, and that the money thus spent would be put to much better use by being devoted to the carrying on of a continuous series of observations. At various points around the Arctic area observatories will be established as near as practicable to the Pole, where a continuous series of observations will be taken, according to a common pre arranged plan. These observations will be connected with meteorology in all its departments, with terrestrial magnetism, the aurora borealis, atmospheric electricity, the movements of the ice, biology, combined with geographical exploration where practicable. After a year or two of such observations we may then be able to compare and co-ordinate Polar conditions with those which prevail in regions further south. A vast array of data must necessarily be accumulated that cannot but be turned to valuable account by science. Our knowledge of the meteorology of the temperate zone can never be complete until we are well acquainted with Arctic conditions, and thus the work to be done at these observatories will have an important practical bearing. Not only so, but it is maintained that it is only when we have the knowledge which will be collected at these stations that we shall be in a condition to send out an expedition for the Pole itself with anything like scientific assurance of success. We cannot but regret, then, that England has no share in the scheme. The countries forming the International Association are Russia, Germany, Norway and Sweden, Denmark, Austria, the United States, and we believe Canada; France and Switzerland lend it their countenance, and Lieut. Bove's Italian Antarctic expedition is to some extent affiliated to the Association. Stations are to be established on the north coast of Siberia, Novaya Zemlya, Spitzbergen, Jan Mayen Island, the west coast of Greenland, Lady Franklin Bay, and the neighbourhood of Behring Straits. The colony for Lady Franklin Bay, sent out by the United States, has already, we believe, reached its destination, and the others will probably be all at work next year.

While speaking of Arctic matters we must express our surprise at a journal like the *Pall Mall Gazette* talking of Polar exploration as a barren work. This of course depends on what one looks for in the way of results; if an immediate return in *£ s. d.* is looked for, the work is barren enough certainly, as barren as all purely scientific research seems at its first undertaking; though even the *Pall Mall Gazette* must admit that all the difference between the present and the past, materially and intellectually, is due to the ultimate results of this same barren work. And we are glad to see that Capt. Adams, the well-known Dundee whaler, again found time to take part in the barren work of Arctic research while doing his best to fill his blubber tanks. He succeeded in sailing up Wellington Channel as far as has hitherto been done; visited the scene of the *Fury* and *Hecla* disaster, and brought home some interesting relics of the Franklin Expedition, as well as some additional information. He fell in with an Eskimo who remembers Crozier and his men, and from whom Capt. Adams seems to have obtained some additional information on the fate of the disastrous expedition. It cannot, however, amount to much after what has been done by the late Capt. Hall, and quite recently by Lieut. Schwatka; still, Capt. Adams deserves the greatest credit for attempting to increase our knowledge of the Arctic area at great risk to himself; he is evidently made of the right stuff. From the United States, we learn, an expedition is to be sent out as early as possible to endeavour to find the records of the Franklin expedition, which Capt. Hall always maintained would be found in the clefts of some rocks near the scene of the disaster. The results will be looked for with interest, and will at least tend to the promotion of knowledge. So also will the international search for the missing *Jeannette*, which it is rumoured may be undertaken next summer. The suggestion of Baron Nordenskjöld, deserving as it must be of every consideration, seems improbable; the bodies and the bottle of whisky found at the mouth of the Lena on September 13, 1879, could hardly have belonged to the *Jeannette*, which was seen steering for Wrangel Land on September 2—*i.e.* 1400 or 1500 miles away. Mr. B. J. Jenkins suggests that the *Jeannette* has been fortunate enough to get into open water not far from the Pole, and may turn up next year. There is no harm in hoping on to the last, as we are justified in doing after the experiences of the Austro-Hungarian Expedition.

What is the conception of geography entertained by our Geographical Society may be learned from the very interesting sketch of its history just published by Mr. Markham in connection with the jubilee of its foundation, which took place upwards of a year ago. The Geographical Society was founded on May 24, 1830. Its original objects were "to collect, digest, and publish interesting and useful geographical facts and discoveries; to accumulate a collection of books on geography, voyages, and travels, and of maps and charts; to keep specimens of such instruments as are most serviceable to a traveller, to afford assistance, instruction, and advice to explorers; and to correspond with other bodies or individuals engaged in geographical pursuits." All highly necessary and useful objects in connection with the advancement of knowledge. The Geographical Society absorbed the old African Association and the Palestine Club, and among its founders or first officers we find the names of Murchison, Robert Brown, Sir John Barrow, Admiral Smyth; and in its first list of Fellows some of the leading scientific men of the time. Mr. Markham complains that the Royal Society did so little for the promotion of geography before the Geographical Society came into existence; but it would have been beyond the functions of that Society to deal with the objects referred to above, and Mr. Markham admits that it really did a great deal to promote all that was most distinctly scientific in connection with geography. It must be admitted that the Geographical Society has very faithfully carried out its programme. It soon became popular, and after it recovered from the results of bad management and extravagant expenditure, it rapidly increased in members and income, until now it is probably the most numerous, if not the most wealthy, learned society in the world. Admiral Smyth established its financial prosperity, and, as every one knows, Sir Roderick Murchison made it fashionable. It has now upwards of 3300 Fellows, and its receipts in 1880 amounted to 8600*l.*, while the Society's funded capital was 18,500*l.*, not to mention the value of its fine premises, library, maps, &c., in Savile Row. Notwithstanding all this material prosperity and its weakness for showing off travelling lions, the Geographical Society has really done much for the promotion of exploration and geography. Directly or indirectly it has been connected with all the expeditions of importance that have gone out from England since it was founded; it has encouraged exploration by grants of money amounting in the aggregate to a considerable sum; it has bestowed its medals and other rewards on explorers and geographers of various nationalities, all of them men who had really earned such honours; it has been of much service in instructing explorers in the technicalities of their business, and recently has established a sort of school for topographical observation; it has accumulated a valuable library and collection of maps, which are freely at the service of all who care to use them; and its *Journal* and *Proceedings* contain a vast amount of information, not simply relating to geographical exploration, but many of the papers relate to the more scientific aspects of geography. The Society has itself initiated or materially supported not a few expeditions of importance, one of the most productive being that which Mr. Joseph Thomson recently brought to so successful a conclusion. One of the most important functions undertaken by the Society is the yearly examinations in geography which it holds in connection with schools; and the papers set at these examinations are both comprehensive and scientific; in this direction the Society is doing really good work in the promotion of scientific geography. It may be remembered that the Council recently instituted an annual course of lectures on the more strictly scientific departments of geography, by men of acknowledged eminence in their subjects. Unfortunately the Council did not feel themselves encouraged to continue these lectures; but we venture to think they were too easily discouraged. Let them by all means have their fortnightly popular meetings during the season; but at the same time there is nothing to hinder them having also more esoteric meetings at stated intervals, at which original papers might be read or lectures given of a kind akin to those found so frequently in the proceedings of Continental geographical societies. In this way the Society would do much to encourage scientific geography, and be justified in claiming the rank of a really scientific society, which many of its well-wishers feel that it can hardly claim at present. Why, moreover, should the Council not at least lend their countenance to the great international scheme of Polar observatories, and take some steps to induce our Government to take an active share in the work? They might easily do this without in any way fettering their action in reference to those great Arctic expeditions to which some of them appear to be so partial.

The Society has shown itself remarkably liberal in the distribution of its medals; out of the 109 which have been awarded since its foundation, 37 have been given to foreign explorers and geographers. Mr. Markham gives a brief and interesting sketch of the great advances in geographical knowledge which have been made since the Society was founded, but shows at the same time how much remains to be done, even when we have obtained a rough knowledge of the whole of the earth's surface, while deep-sea research is yet only in its infancy. The little volume also contains an admirably-arranged list of papers in the *Journals* and *Proceedings* of the Society, covering nearly fifty pages; this, we believe, is the work of the librarian, Mr. Rye, and will be of the greatest value for reference.

Altogether it is evident that in recent years geography not only has made immense advances in the knowledge it has acquired of the "world and they that dwell therein," but has acquired a character which entitles it distinctly to be regarded as a department of science.

THE LATE A. H. GARROD'S SCIENTIFIC PAPERS

In Memoriam. The Collected Scientific Papers of the late Alfred Henry Garrod, M.A., F.R.S. (London: R. H. Porter, 1881.)

FEW customs are gaining greater ground at the present day than that of making the death of any man who, by his energy or talents, has raised his name a little above that of the unknown crowd, a reason for opening a subscription and calling upon all his friends and admirers to tax themselves to found a memorial commemorative of his career. It is first decided that there shall be a memorial, and then the question usually arises as to the form that it shall take. It very often happens that some person or some institution has a need at hand. The prosperity of a school, and indirectly of all connected with it, will be promoted if it has scholarships attached to it which will attract needy students. A window is wanted to complete the ornamentation of a church. Those interested in the church or school eagerly seize upon the opportunity which the hand of death has afforded, and suggest a fitting method of bearing testimony to the memory of the departed. Such memorials generally, after a few years, retain wonderfully little personal connection with him they are supposed originally to honour. The name remains, but the person is forgotten, unless preserved in remembrance for other and more cogent reasons.

Personal memorials of really eminent men, of those who have done good service to mankind, are of inestimable value. True records of their lives, their character, their works, their words, even of their features, afford encouragement and example to all who come after. By such memorials the whole world is enriched and its progress ensured. Among such we scarcely know of any more appropriate to its subject than that which has just been carried out by the Garrod Memorial Committee. It is a handsomely printed large octavo volume of 527 pages, containing an excellent portrait, a memoir, and a reproduction of all the important contributions to science made during the short but fruitful career of the extremely talented biologist whose loss we deplored almost exactly two years ago. The work contains, in a most convenient form for reference, a vast number of facts relating chiefly to the anatomy of birds and mammals, together with all the figures with which the several memoirs were originally illustrated, and a copious index. It has been ably edited, evidently as a labour of love, by Prof. Garrod's successor in the post of prosector to the Zoological Society, Mr. W. A. Forbes, with the assistance for the physiological portion of Prof. E. A. Schäfer. Mr. Garrod was all his life favourably circumstanced to a remarkable degree for pursuing biological research. He had from his earliest age the advantage of scientific associations and the best of educations, and was soon placed in an independent position, which enabled him to make the occupation of his life that which almost all others, even those holding most of the existing scientific appointments, can only do in snatches of time saved from the educational or administrative duties connected with their offices. Of all these advantages he fully availed himself; but considering he was only thirty-three years old at the time of his death, the amount of his already-published work when collected together is surprising, and causes the greater regret that he was not spared to continue what he had so well begun, especially as his editor tells us of the immense amount of material in notes and drawings which he had accumulated, besides that which was in a sufficiently finished state to see the light.

In these days, when so much is being said about the encouragement of scientific research, and so many experiments are being tried, both with public and private money, as to the best means of promoting this end, we cannot help making the reflection, before concluding our notice of this volume, on the great results that may follow a small expenditure judiciously and steadily devoted for a series of years to one object. If the Zoological Society had not in 1865 established its prosectorship, we should have seen little of the really solid advances in our knowledge of the anatomy of the two higher classes of vertebrated animals contained in the valuable memoirs of Dr. Murie, those collected in the present volume, and those now in the course of publication by Mr. Garrod's successor in the office.

THE DIAMONDS, COAL, AND GOLD OF INDIA

The Diamonds, Coal, and Gold of India. By V. Ball, F.G.S. 12mo. (London: Trübner, 1881.)

IN this handy little volume the author presents us with a compendium of the facts known concerning the occurrence and distribution of the three principal mineral products of India. The work being so designed that it may be used as a handbook to the detailed accounts published by the Geological Survey of India and by other authorities in numerous scattered publications to which full references are given. In the first chapter the different localities producing diamonds, including both active and abandoned mines, are noticed in some detail. These are grouped into three areas, the most southerly being that to which the name of Golconda is usually applied, although, as the author points out, that town is not actually in a diamond producing district, but was the staple place where the product of the district was bought and sold.

The actual mines are in the southern part of the Madras presidency, in the districts of Kadapah, Karnul, Kistna, and Godaveri. The second great tract, further to the north, lies between the Mahanadi and Godaveri rivers, the chief localities being at Sambalpur and Weiragud, eighty miles south-east from Nagpore, and at a few places in Chota Nagpore. The third great tract is in the vicinity of Panna in Bandelkhand. In addition to these a few small diamonds are reported to have been found near Simla. In all cases the diamonds appear to have been found in sandstones or conglomerates, or in the gravels derived from their alteration. These sandstones are referred in the southern localities to the lowest member of the Karnul formation, which as a whole is considered to be the equivalent of the lower part of the so-called Vindhyan formation of Northern India. An upper group of the latter, the Rewah conglomerate, being the diamond-bearing bed in Bandelkhand. There does not appear to be any authenticated instance of a diamond being found in India in other than sedimentary rocks. One case, however, at p. 49, where the matrix is said to be "a network of strings of calc spar inclosing laminæ and small lumps of green clay," suggests the possibility of the material in question being a decomposed basalt or basaltic tuff, and as such comparable with the South African occurrences. What the present total production of the mines may be we are left to guess; as far as can be gathered from the scattered notices collected by the author, the larger number of the mines are of historical interest only.

The second chapter, that on Coal, is mainly an abstract of the communications on this subject made to the Records of the Geological Survey of India by Mr. Theodore Hughes, and is rather behindhand in point of time. The latest information appears to refer to the year 1878-79. The arguments for and against the supposed Mesozoic age of the Indian coal-bearing rocks are given in abstract with great fairness, and the author's conclusion that "floras alone form an unsafe guide to the correlation" of the ages of rocks in different countries is probably the only safe one that can be drawn from the available evidence. As a mere question of stratigraphical position it is probable that these rocks represent the uppermost coal-measures (Permo-Carboniferous) of Europe. Any one acquainted with the smaller coal-basins in the south of Europe cannot but be struck with the numerous analogies between them and the Indian coal-fields, more particularly in the thickness and irregularity of the seams. The author's statement that the Ramgunj coal "may be described as a non-caking bituminous coal," is rather too general. It is true for the larger seams, but besides these are to be found others in which the caking property is as well developed as in any caking coal in the world. The coke produced is not of particularly good quality, which is however due to the large quantity of ash in the coals, but as to their caking capacity, there can be no doubt whatever. The estimation as to the quantity of coal available seems to be rather wild guesses in some cases, and one of these, for which the data are professedly given, is a good specimen of an arithmetical puzzle. They are as follows (p. 69):—

"The coal occurs in three principal seams . . . average total thickness of 16 feet . . . over an area of 8½ square miles. The amount of coal may therefore be estimated at 1,360,000,000 tons, and the available portion of this at 80,000,000."

How the largest of the above figures is obtained, and what its relation to the smaller quantity may be, is certainly not apparent from the author's statement. An allowance of 94 per cent. for faults, waste, and unworkable coal, which the above figures lead to, seems rather large.

The chapter on Gold contains extracts from most of the published details on the occurrence of precious metals in India down to the Reports of Mr. Brough Smyth, and the latest remarks of Indian newspapers, which latter however are dated as far back as May, 1880. An original investigation of the author's as to the distribution of auriferous detritus in areas occupied by rocks of different characters is of interest. He found that the proportion of gold obtained was larger upon crystalline schists than upon gneiss and granite, a result which agrees with that generally obtained in other parts of the world. As this was predicted to him by his native workmen, it is difficult to see how the author arrives at his belief that gold washing in India affords an example of human degradation.

His evidence seems rather to show that the gold washers have a highly skilled and minute knowledge of the distribution of gold-bearing alluvia, but the value of such knowledge is diminished by the circumstance that the amount of such material available has been practically exhausted by the labours of many generations of workers through a period of 2000-3000 years. The great extent of old workings discovered in some of the Wynaad mines also shows that the "old men" were no contemptible workers as vein miners.

In the earlier part of the volume the work done by "amateurs" in Indian geology is somewhat pointedly contrasted with that of the "professionals," whose whole time is devoted to the subject. This is to be regretted, as is also the assumption of an air of finality for the work of the Indian Survey, which the nature of the work certainly does not allow. For instance, we are told in the same paragraph that the rocks of the Vindhyan formation are absolutely azoic, and that they may be of any age, from Lower Silurian to Carboniferous; the real meaning of this expression being that no fossils have as yet been found in them. In this sense the New Red Sandstone might be said to be azoic over a great part of the central plain of England. The results of the Indian Survey are of great value as furnishing a broad outline of the stratigraphical features of the peninsula, but there will be work enough and to spare for both amateur and professional for many years to come before that outline is moderately filled in detail.

H. B.

OUR BOOK SHELF

The Student's Handbook of Acoustics. By John Broadhouse. (London: William Reeves, 1881.)

We are not quite sure what the title of this work is. The title just given is from the lettering on the back. Within the covers appears a second title, "Musical Acoustics," and on the actual title-page appears the triple announcement, "The Student's Helmholtz," "Musical Acoustics," and "The Phenomena of Sound as connected with

Music." The book itself may without unfairness be described as an "arrangement," or rather as a "pot-pourri," inasmuch as it resembles those musical compositions in which some of the fragmentary themes of one or more great masters are dished up for the public in some new or popularised setting, consisting of commonplaces of a more or less florid type. About 80 per cent. of the pages before us consist of clippings and quotations taken *verbatim et literatim* (and in quotation marks be it added) from the works of Helmholtz, Stone, Pole, Tyndall, and Sedley Taylor, interspersed with a connective-tissue woven from the "author's" own brain. We have found this ingenious fabric very remarkable reading, and have gleaned a number of new facts from it. We have learned, for example, that the transmission of verbal messages, prayers, hymns, and sermons through the telegraph wire by the telephone must be held to "prove that air is not the only medium through which sound-impulses can pass." We find our author declaring on p. 80 that the reason why so romantic a name as the "syren" should be applied to so matter-of-fact an instrument *does not appear;* while on p. 98 he seems to have made the discovery that the name is a misnomer, because "Homer's Σειρήνεος" (*sic*) were not endowed with the power of singing under water as this instrument can. Our author is very unhappy in dealing with equal temperament, and complains that nearly all writers on temperament, with the exception of Mr. Ellis, describe it as dividing the octave into twelve precisely equal semitones, "without explaining that these semitones are not absolutely equal." That the perfect equality of the theoretically equal temperament is never attained *in practice* is indeed true; but why does our author find fault with writers on temperament for stating the exact theory? His accusation against Dr. Stone for palpable misuse of language (on p. 359) is utterly out of place, and only shows that the author has not comprehended the true meaning of a musical interval as defined by a ratio. He appears not to know that if an octave is divided into twelve exactly equal geometrical parts or ratios, the differences between the successive terms of the ratios are not, and cannot be, arithmetically equal to one another. Hence his attack on the perfectly unexceptionable statements of Dr. Pole and Dr. Stone. The diagrams with which the work is interspersed consist principally in pictures of syrens and in copies of wave-forms taken from Mr. Sedley Taylor's "Sound and Music," and spoiled by drawing them as if made up of semicircles pieced together. The wave-form given on p. 266 to illustrate beats does not show the wave-form of the beat *at all:* and though the author gives on p. 102 a wave-form which illustrates a beat admirably, he appears not to know it, as he passes it by as being merely one of a few different forms of tracing which a vibroscope can register. But we have said enough to justify us in having at the outset pronounced "The Student's Helmholtz" to be what we called it—a *pot-pourri*—or, in the plain English tongue, a *hash*.

Afrika im Lichte unserer Tage. Bodengestalt und geologischer Bau. (With a Hypsometrical Map.) By Josef Chavanne. (Vienna: A. Hartleben.)

THE conclusions come to by Herr Chavanne we have already referred to. Africa, he finds, is, on the whole, a high plateau or table-land, crossed here and there by mountain-chains or single elevations. The plateau commences in most places at a remarkably short distance from the sea, the slopes south of the equator being particularly steep. North of the equator the land may be looked upon as a very slightly inclined plane, which, like the southern plateau, is also crossed by separate elevations, some of them being very considerable. The presence of numerous, and for the greater part widely-distributed, lakes is unlike the general physiognomy of the other large continents. By far the most important part of the author's work is the excellent hypsometrical map which accompanies the book, and to which we referred a short time ago. Its scale is 1 : 30,000,000. The elevations are marked in eight different tints of brown, showing so many grades and altitudes from zero upwards. Thus at one glance we see the African continent rising as a rule from 0 to 600 metres in the northern half, while, in the southern half, elevations from 900-1200 metres are the rule. The greatest heights—those of 1500-2000 metres and more—are packed close together on the east side, between the southern end of the Red Sea and the Zambesi River, and only occur again in the extreme south-east (Natal) and far up in the north-west (Atlas). The text of the book is well written; the author's descriptions are always attractive, to the point, and free from all superfluous wordiness.

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 ensure the appearance even of communications containing interesting and novel facts.*]

Struggle of Parts in the Organism

THE review of Dr. Roux's work on the "Struggle of Parts in the Organism" by Mr. Geo. J. Romanes which appears in your number of September 29 (p. 505) contains some passages which, I venture to think, are hardly consistent with the purpose to which the columns of NATURE are devoted. I understand that purpose to be the discussion of scientific facts and scientific laws, properly so called. I should be the last to deny that these facts and these laws may have, and indeed must have, their own ultimate bearing upon theology, whether natural or revealed. But it is not the purpose of a purely scientific journal to enter upon this discussion; it is one which cannot be there pursued without involving controversies alien to the spirit in which physical science ought to be studied and explained.

And if even temperate discussion upon the subject ought to be avoided in a purely scientific journal, still more ought there to be a scrupulous abstention from dogmatic utterances which are hostile to theological opinions, and which are unsupported by even the semblance of argument.

In the passages to which I refer Mr. Romanes asserts that to the whole "argument from design" in nature an "end has come"—as the result of Mr. Darwin's Theory of Evolution—that the "fountains of this great deep have been broken up by the power of one man," and that "never in the history of thought has a change been effected of a comparable magnitude and importance."

As an expression of the opinion of Mr. Romanes that the Darwinian theory ought to put an end to the "argument from design," this assertion may be allowed to pass. But as the assertion of a fact I venture to say that it has no foundation. There are many minds, including some of those most distinguished in science, who not only fail to see any contradiction between evolution and design, but who hold that the doctrine of evolution and the facts on which it is founded have supplied richer illustrations than were ever before accessible of the operations of design in nature.

I should be transgressing my own rule were I to defend this view in your columns. I shall therefore content myself with saying that no possible amount of discovery concerning the physical causes of natural phenomena can affect the argument that the combination and co-ordination of these causes which produce the "apparent" effects of purpose are really and truly what they seem to be—the work of Mind and Will.

Inverary, October 4 ARGYLL

Solar Chemistry

THE researches of Mr. Lockyer, and others, summarised by him in recent numbers of NATURE, have to a great extent complicated the aspect of this grand problem, which appeared so simple to Stokes and Thomson in 1852, and to Stewart and Kirchhoff a few years later.

I wish to consider briefly, what are these new and puzzling complications of the solar problem; and whether we may not still preserve our belief in the existence of *essentially different* elementary atoms, which is the basis of the beautiful Vortex Theory. For it seems that to hazard (however *naturally*) such a step as is involved in assumed dissociation of the (so-called) elements, before we make certain that no less serious hypothesis will account for the observed facts, is contrary to the spirit of Newton's *Regulæ Philosophandi*.

The most prominent of these complications seem to be—

(1). The variations of the relative brightness, width, &c., of the lines in the spectrum of a particular substance, in dependence on the source and circumstances of its incandescence.

(2). The so-called "long" and "short" lines. (These, as will be seen, are probably a case of (1).)

(3). The fact that, in the spectra of sun-spots, *some* lines supposed to be due to a particular element indicate rapid motion of the glowing gas; while others, supposed due to the same element, give no such indication.

(4). The (at least apparent) coincidence of lines in the spectra of two or more elementary substances.

To these may be added:—

(5). The remarkable peculiarities of star-spectra; especially the paucity, and the breadth, of the lines in the spectra of *white* stars.

As regards (1), let us consider a sounding body with a large number of different modes of vibration, exposed to impacts either periodic or at least with an average period. The relative intensities of the various notes which it can give will obviously depend upon the period of the impacts. Now this is precisely the case of a particle (I use the word to avoid misconception) of a glowing gas. The average number of blows it receives will depend on (*a*) the number of particles per cubic inch (and also upon *whether there be another gas present or no*, a point of very great importance) and (*b*) the temperature, which is directly connected with the velocity of the particles.

Change the density, the temperature, the admixture with foreign substances, or any two, or all, of these; and the *average period of the battering* to which a particle is subjected may be so altered as to elicit from it *in any required ratios of relative intensity* the various simple rays it can give out.

It will readily be seen that this may account for all of the phenomena of classes (1) and (2) above.

(3) may be accounted for in many ways. I mention only one, as my object is merely to show that we are *not yet* compelled to accept dissociation of so-called elements even in its mildest form. Other modes of escape, though not quite so simple, present themselves.

What is seen in a sun-spot is the integral, as it were, of all that is taking place (as regards both radiation and absorption) in many thousand miles of solar atmosphere, containing the same substance under the most varied conditions. That portions in which certain lines of that substance are prominent over others may be at rest relatively to the observer along the line of sight; while others, in which (from different density, temperature, or admixture, as above explained) other lines are specially prominent, may have large relative velocities, is certain. This would at once account for these singular observations.

As to (5) we must remember that in a star spectrum we have, as it were, a *triple* integral. For we not only integrate through the depth of the atmosphere, but also over the whole surface of the star; spots, hurricanes, and rotation of the whole, included. This is equivalent to the *superposition* of innumerable separate spectra, no two of which may have *any one* individual line in the same place or of the same breadth, &c. Feeble lines may, in fact, entirely disappear under such treatment.

(4) If not due to want of dispersive power in the apparatus, this may be legitimately attributed to inevitable impurities. It is only in "tall talk" (or in advertisements) that any human preparation, elementary or not, can be spoken of as "*chemisch rein*." And we all know how faint a trace of impurity can be detected by the help of the spectroscope.

Even in the last resort, I see nothing to hinder the existence of exactly equal vibration-periods in two perfectly distinct vortex-atoms:—though their occurrence is extremely improbable.

If we could get an absolutely transparent gas; one, therefore, which could give no radiation under any circumstances; the study of the behaviour of a given quantity of hydrogen mixed with different proportions of it in a vessel of given size, and subjected always to the same conditions of incandescence, would give us invaluable information. G. H.

Replacing Flakes on Palæolithic Implements

THIS wonderful feat was first performed by my friend Mr. F. C. J. Spurrell of Dartford. On first thoughts the thing seems utterly impossible, and it is obvious that no flake can possibly be replaced upon an implement unless one lights on the exact spot where the instrument was made, and finds both implement and flakes in position. Mr. Spurrell so found his material. During the present summer I have discovered another and similar Palæolithic floor, far removed from Mr. Spurrell's, and where implements and flakes are exposed in a stratum perfectly undisturbed since they were gently covered up in Palæolithic times with fine sand containing the shells of such freshwater molluscs as Unio, Cyrenia, and Bythinia. For obvious reasons—the chief one of which is that my work would be totally stopped if I mentioned the locality—I will content myself with stating that the position is nearly a mile from any river, and the *floor* is 41 feet above the level of the nearest stream; above the floor is a thick deposit of fine stratified sand, and above that loam. On this Palæolithic floor I have found several implements and a large number of flakes, and on one of the finest implements, an example 6 inches long, 3½ inches wide, and weighing 1¼ lb. I have been able to replace two flakes, one 2¼ inches long, the other 2 inches in exact position; the flakes slightly overlap each other on the implement, and both have been struck from the edge of the implement at right angles across its face. The implement and flakes were close together, and with them I found a hammer-stone of flint with a distinctly battered and abraded edge. Mr. Spurrell replaced many flakes round his implement, but the implement itself was a spoilt and poor example. My implement, on the contrary, is an unusually fine one, large, heavy, and perfect. Both the implement and flakes show a little of the original grey crust of the flint from which the instrument was made, and this peculiar grey colour led me to attempt the replacement of the flakes with the above-mentioned successful result. One flake has a slightly uneven edge—in some instances considered a proof of use—the second flake is quite sharp. I shall exhibit this implement, with other implements, flakes, &c., from the same place, at an early meeting of the Anthropological Institute. WORTHINGTON G. SMITH

125, Grosvenor Road, Highbury, N.

Integrating Anemometer

PERHAPS the following brief description of the integrator devised by me will suffice to establish its near kinship with Mr. Wilson's (NATURE, vol. xxiv. pp. 467 and 557):—A roller with a spherical edge is made to revolve with a velocity proportional to that of the wind as recorded on an anemogram. This roller presses on a plane table carried by two mutually perpendicular pairs of rails in planes parallel to that of the table. The lowest of the pairs of rails is supported by a frame carried on the extremity of a vertical shaft. The point of contact of the roller with the table lies in the prolongation of the axis of the shaft. The table can rotate with the shaft, but not independently. By a simple arrangement the shaft, and consequently the table, are caused to take up positions corresponding from moment to moment with the direction of the wind record on the anemogram. A style concentric with the shaft presses lightly against a compound sheet of tracing and carbonised paper attached to the under side of the table. Arrangements are also made for obtaining the sum of the movements of the table toward each of the four cardinal points. If the roller be moved with a velocity proportional to that of the wind, whether directly by a cup-anemometer or by a mechanical translation of the trace as given by such an instrument, while the table simultaneously assumes orientations corresponding to the direction of movement of the air, the line drawn by the style will be a miniature copy of the path of an imaginary particle animated by the movements actually belonging to the masses of air which successively affect the anemometer at the given station during the selected period, rigorously in accordance with the principle known as Lambert's. But in order that the trace drawn as described should correctly represent the actual movements of the air, it is evident that the whole mass of the atmosphere must be supposed to move "parallel to itself," *i.e.* in such a manner that the straight line joining any two particles of air shall always be parallel to its original direction, an assumption which is manifestly incorrect. If I rightly understand the description of Mr. Wilson's integrator on p. 467, the trace given by it is precisely that which has just been shown in the case of my own machine to be based on a fallacious assumption. But though the *trace* may be useless, the summation of the movements of the table above described gives results which are representative of physical realities, being in fact the quadrantal components of the wind-movement at the station during the period dealt with by the machine. I trust that the preceding remarks will suffice to justify the statements contained in my last letter. Dr. von Oettingen's remark, referred to in my concluding sentence, related, not to his wind-component-integrator, but to the continual change of form in what may be called the *physical* Lambert's line, and implied the consequent advisability of discarding Lambert's method of treatment.

CHARLES E. BURTON

38, Barclay Road, Walham Green, S.W., October 14

P.S.—On September 21 last I forwarded to Prof. Stokes a description, with drawings, of two forms of wind-component integrator, suitable either for attachment to a cup and vane-anemometer, or for the reduction of existing anemograms of the pattern adopted by the Meteorological Office; and of simpler mechanism than my earlier machine, or Dr. von Oettingen's.

Calabar Bean as a Preservative

As many find such a difficulty in preserving entomological and other natural history specimens it may not be uninteresting to your readers to have a brief note on the use of Calabar Bean as a preservative. About eight years ago, when Aquilla Smith, M.D., Professor of Materia Medica, Trinity College, Dublin, was showing me through the museum that he has rendered so famous, I was struck by the perfect manner in which the specimens were preserved; the little brown beetle that is generally such a pest in similar collections being entirely absent. Dr. Smith told me that he treated the specimens with tincture of Calabar Bean, and very kindly gave me a bottle of the tincture. I used the tincture freely in my cabinet of Lepidoptera, and, although the collection has been wofully neglected since, it has remained quite free from mites. Dr. Smith tells me that the tincture was prepared by Mr. Squire of 277, Oxford Street, London, its strength being one part of the bean to eight of (rectified?) spirit. I might mention that Mr. Fetherstonhaugh used some of the tincture which I gave him in his cabinet, and was delighted with its action. A drop of the tincture is placed on the body of the insect. I found it a good plan to do this whilst the insect was on the drying board, as otherwise, in newly set insects, the damping with spirit caused the wings to spring.

E. MACDOWEL COSGRAVE

A Correction

I FIND that the term "glissette" is not used precisely in the sense which I had supposed. A reference to Mr. Besant's "Notes on Roulettes and Glissettes" (which I had not before me last week) shows that the envelopes of the moving lines, to which the theorem in my last letter refers, would be properly described as *roulettes*. It is obvious, however, that glissettes are in general also roulettes.

GEORGE M. MINCHIN

Royal Indian Engineering College.

Effect of Green in Painted Windows

I NOTICED to-day a curious effect in the east windows of Old Upton Church which may interest artists among your readers, and of which I should be glad to see any explanation. The pattern is in small regular pieces in which a strong red is prevalent, especially in the ribbon round the edge. Green is perhaps the least represented in area. At all events, generally, red largely prevails over green. The latter is not over brilliant. At a distance of ten feet the general effect is red. At that distance I see the pattern sharply, and green is not at all obtrusive. At the length of the church, say fifty feet off, I cannot distinguish the pattern, and the whole window looks a thin watery green haze; the bright red margin is inappreciable.

Richmond, October 12 W. J. HERSCHEL

THE AUTUMN MEETING OF THE IRON AND STEEL INSTITUTE

AT the meeting of the above Institution, which has just taken place, several papers of scientific and practical interest were read and discussed. They may be broadly divided into two classes, viz. 1st, those relating to the production of iron and steel, from the ore, and the qualities of the material when produced; and 2nd, the various applications to which steel has been put in recent times. The latter class of papers, at the recent meeting, dealt principally with the use of steel in the manufacture of ordnance, small arms, projectiles, and gun-carriages, and the papers, some of which were of great interest, will be reserved for consideration in a separate notice. Amongst the papers dealing with the manufacture of steel we may notice specially a memoir by Herr Paul Kupelweiser of Witkowitz, in Austria, on recent progress attained in the use of the basic process at the works with which he is connected. This process, which has been frequently referred to in NATURE, seems—probably on account of the quality of the ores met with—to have been adopted more frequently in Continental steel works than in our own country, for according to Herr Kupelweiser's summary, no less than thirty works in France, Belgium, Germany, Austria, and Russia, have acquired licences under the Thomas patents, the greater number of these being already at work; while the remainder are adapting their old plant, or erecting new works with the view to its immediate introduction. The weak point of the process hitherto has undoubtedly been the want of durability in the refractory linings of the converters, and on this point the author states that, in spite of numerous trials with other materials, the works with which he is acquainted still use the materials originally proposed by Mr. Thomas, viz. either the basic bricks or the shrunk lime and tar mixture. At Witkowitz, however, a new material has been used containing a comparatively small percentage of silica, and the quality of the bricks manufactured from this has been found to be materially improved. Ground brick mixed with 5 to 10 per cent. of tar is also used at many works for lining as well as for repairs. Basic tuyères have been tried in many places, but are not commonly used; but the author states that magnesia obtained by precipitation from chloride of magnesia by milk of lime appears, from experiments made on a small scale, to be a promising material for making tuyères. As regards the quality of the steel he makes the following remarkable statement:—"The basic process, as regards the quality of its products, is not only completely equal to the acid process, but even, in my opinion, superior to the latter." As a specimen of the excellent quality of the mild steel manufactured at Witkowitz the author exhibited a locomotive boiler tube made of this material, which had been expanded cold by means of a tube expander from 9 to 17 millimetres, on an original diameter of 48 millimetres, equal to an extension of from 20 to 36 per cent. on the periphery of the material, without even splitting at the line of weld.

Another paper of great interest to foreign manufacturers was Prof. Tünner's memoir "On the Use of Lignite or Brown Coal in the Blast Furnace." It is well known that the Austro-Hungarian Empire contains immense deposits of this fuel. It would be difficult to over-estimate the benefit which would accrue to the iron industry of Austria if this abundant and inexpensive fuel could be used successfully in the blast-furnace. All the experiments made in this direction till last year were of a more or less isolated and unsatisfactory character. In June, 1880, however, the "Mining and Metallurgical Association of Styria and Carinthia" appointed a committee to investigate the subject afresh. This committee has not yet reported, or indeed concluded its labours, but it is satisfactory to learn that it is fully acknowledged that there is no theoretical difficulty in the way of smelting iron with raw or coked brown coal, and that the practical difficulties have been partly solved; for we learn that at Kalan a blast-furnace was for a time worked with a mixture of from 25 to 75 per cent. of brown coal, and 25 to 75 per cent. of coke. The great difficulty in the utilisation of this fuel lies in the fact that, owing to the high percentage of contained water, the raw coal is liable, when heated, to splinter up into small pieces, somewhat similarly to anthracite, and the coke formed of it is also very small and tender. It is, however, satisfactory to learn from Prof. Tünner that these difficulties may be in a measure obviated by the use of a strong blast, and especially constructed furnaces. The chief difficulty arises in continuing the operation when sponge-iron is produced; but it is suggested that the reduction might be completed from this stage in a small furnace, such as a Siemens furnace with coked fuel.

The results of the further labours of the Committee will be awaited with great interest.

Mr. G. J. Snelus of Workington contributes a paper on the Distribution of the Elements in Steel Ingots. It was till quite lately taken for granted that the steel plates, &c., produced from ingots were not only mechanically, but chemically homogeneous. When the disastrous failure of the boiler plates of the *Livadia* took place, this subject, amongst many others, was minutely investigated, and samples of different portions of the plates were submitted to chemical analysis, with the startling result that the proportions of carbon, manganese, phosphorus, and sulphur were found to vary greatly. At the spring meeting of the Institute Mr. Stubbs announced, during a discussion, that he had discovered that during the solidification of the ingots a redistribution of the elements took place, the carbon, sulphur, and phosphorus going to that part which remained fluid the longest. Mr. Snelus has now by experiment confirmed this statement so far as large ingots are concerned. This fact is brought out most clearly in the following table, which gives the analysis of carbon, sulphur, and phosphorus, of six samples taken from a slice 21 inches below the top of an ingot, measuring 7 feet × 19″ × 19″, and a similar number from a slice 4 inches above the bottom; the number in each case being taken from the outside, number 6 from the centre, and the remaining numbers from intermediate positions:—

No.	Top.			No.	Bottom.		
	C. carb.	Sulphur.	Phosph.		C. carb.	Sulphur.	Phosph.
1.	·44	·032	·044	1.	·44	·048	·060
2.	·54	·048	·060	2.	·42	·056	·062
3.	·57	·080	·086	3.	·41	·048	·054
4.	·61	·096	·097	4.	·40	·048	·054
5.	·68	·120	·111	5.	·38	·048	·058
6.	·77	·187	·142	6.	·37	·044	·052

In examining smaller ingots, however, Mr. Snelus found that the metal was practically homogeneous, and consequently the want of uniformity in the *Livadia's* boiler plates cannot be accounted for in this way, seeing that they were produced from relatively small ingots.

Mr. Edward Richards gave an account of a series of experiments on the strength of samples of mild steel. The specimens were tested both for ordinary tensile strength, and also for the tensile strength after the samples had been submitted to long-continued tensile and compressive strains approaching the elastic limit to torsional strains, and to long-continued strains below the elastic limit. He also made experiments on the strength of samples of plates which had been perforated. The results are of great interest, and will well repay careful study, though they are too voluminous to be reprinted here. We may however notice that in one sense these experiments go to support the much-combated opinion held by Dr. Siemens, that any mechanical treatment to which mild steel is subjected, has invariably the effect of increase of strength.

THE "QUARTERLY REVIEW" ON EARTHQUAKES

THE pages of the *Quarterly Review* constitute perhaps the very last place in which one would look for a new theory on an important scientific question, and the perusal of an article in the July number of that journal on "Earthquakes: their Cause and Origin," has left us in grave doubt as to whether the author of it is writing seriously or is perpetrating a gigantic practical joke.

The article professes to be a review of the well-known and valuable works of Schmidt, Heim, and Mallet on Earthquakes; but added to this list of books for review we have "Scepticism in Geology, and the Reasons for it, by Verifier"! When we find that a considerable portion of the article is occupied with passages quoted from this last-mentioned book, in which the most absurd misconceptions and misconstructions of the writings of Lyell, Darwin, Huxley, and others are embodied, we can scarcely forbear from leaving the task of framing an hypothesis concerning earthquakes, in order to indulge in conjectures as to the relations which may possibly exist between "Verifier" and the author of the article in question.

Ignoring the whole body of facts which have been accumulated by seismologists concerning the amplitude, direction, and velocity of earthquake-waves, the author denies that the earthquake movements are waves at all; and in his reasoning (if such it can be called) he hopelessly confuses the vibration with the shock which has produced it. Dismissing with contempt the views of others on the subject, he proceeds to offer his own conjecture as to the cause of earthquakes. It is no other than our old friend electricity, written with capital letters. Some well-known examples of electrical discharges taking place from portions of the earth's surface are adduced, and it is then naïvely assumed that such discharges of terrestrial electricity would produce the effect of an earthquake. The undulatory movements are supposed to be the result of a struggle of the electricity to break through cushions composed of soft, non-conducting materials, and the cracks and chasms opened in the soil to the power of the "electric jet" to rip asunder the surface.

The facts on which this extraordinary theory (or "conjecture," as the author very properly terms it) appears to be based are of two kinds. In the first place it is noticed that peculiar atmospheric and electrical disturbances have occurred at the same time as earthquakes. In the second place Dr. Schmidt is quoted to prove that the earthquake shocks which he had studied in Greece had very commonly a course from north-east to south-west. The author adds to this the fact that an earthquake-wave occurring in the United States in the year 1870 took the same direction. He then asks triumphantly, "Is not this the line of path habitually followed by electric currents?"

Excited beyond all bounds by this supposed discovery of the true cause of earthquakes, our author then proceeds to make a number of suggestions which are certainly rather sensational than practical. To the Society of Telegraphic Engineers he appeals to invent a conductor which shall ward off the electric currents and divert earthquakes from their habitual haunts. Medical men are requested to examine the bodies of people killed during earthquakes in order to discover "lightning-scars." And lastly, Sir William Thomson and other eminent electricians are asked to "direct their attention to that storehouse of unlimited energy already filled within the bosom of the earth," and to utilise it for useful purposes.

This curious article may at least serve one useful purpose. Its author is evidently a man of some general knowledge and considerable culture, and the absurd errors into which he has fallen are manifestly the result of his never having received any proper training in the rudiments of science. If the appearance of this article serve to call the attention of the managers of our public schools, and others interested in education, to the painful consequences which may result from the want of a preliminary grounding in the facts of science and the principles of scientific reasoning—then we think it will not have been written in vain.

THE STORM OF FRIDAY, OCTOBER 14

THIS great storm, which appeared so suddenly, sped its course over North-Western Europe so rapidly, and involved so wide a region in its destructive violence, will be long remembered for the well-nigh unparalleled loss of human life which it has occasioned among our fishing population between the Forth and the Tweed. For some days previously atmospheric pressure had been low to the north of the British Isles and high to the south, the difference from north-west to Land's End being about an inch, thus giving steep gradients, and resulting strong west and north-west winds, and stormy seas along the west coast; and as the area of low pressure moved very slowly eastwards the weather conditions continued with some persistence substantially the same. At length on Thursday morning the daily weather charts showed that a change had just begun in the extreme south-west of Ireland, at Valentia, where, and where only, with a barometer beginning to fall, the wind had changed to a southerly direction, but everywhere else in the British Islands it remained north-westerly; whilst at the same time the area of high pressure to the south was advancing from France to Spain, indicating that the path of the coming storm would take a more southerly course. By 2 p.m. the area of a falling barometer had spread eastwards, and the wind changed to south-west as far as Holyhead; and by 6 p.m. observations showed the continued rapid easterly advance of the storm, the wind being now southerly or south-westerly at all the telegraphic stations except Nairn, where it was west-north-west, showing that Nairn was still within the influence of the slow-moving depression to the north.

High winds and very heavy rains occurred during the night over the northern half of Great Britain, and on Friday morning the weather charts showed that North-Western Europe was involved in a storm of great intensity, the centre of which had now advanced as far as Midlothian. Gradients were steep all round the low centre of pressure, and consequently gales and storms of wind prevailed in all parts and in all directions over the British Islands, being west over France and the south of England, south-west and south over the north of England and the North Sea, north-east in the northern half of Scotland, and north-west in Ireland. From the barometric readings published in the *Times* it is seen that the lowest reading occurred in London about 8 a.m., and, in accordance with the isobars on the Weather Chart, the lowest reading occurred in Edinburgh at the same hour. In London, which was some distance from the centre of the storm, the lowest barometer was only 29·086 inches, but in Edinburgh, over which the centre passed, pressure fell to 28·425 inches, which was an inch lower than it was twelve hours before. After 8 a.m. a rapid recovery of pressure set in; the most rapid rise of the barometer in London was 0·214 inch in the two hours from 4 to 6 p.m., and 0·163 inch in the two hours immediately following. In Edinburgh the increase proceeded at a much more rapid rate, beginning with 0·018 inch, from 8 to 9 a.m., and increasing gradually to 0·166 inch from noon to 1 p.m., and 0·150 inch from 1 to 2 p.m., after which it rose less rapidly, and continued to do so at a steady, though greatly diminished, rate for two days till Sunday at 10·30 a.m., when the barometer stood at 30·370 inches, having thus risen nearly two inches in little more than forty-eight hours.

On Saturday morning the centre of the storm had advanced fully 600 miles to eastward, being at the high daily average of 25 miles an hour, and was now near the south-west angle of Lake Wener in Sweden. Here the lowest barometer was about 28·600 inches, whilst at the same time to westward at Valentia pressure had risen to 30·220 inches, thus giving for the southern shores of the North Sea steep gradients for north-west winds, which, with the high seas they raised, proved very destructive to those coasts.

The anticyclone indicated by the high barometer following in the wake of the storm was accompanied with temperatures unusually low for the season during the night of Saturday–Sunday, when temperature fell to 27°·0 at Parsonstown and Nottingham; 29°·0 at Ardrossan; and 32°·0 at Leith, Shields, Cambridge, Oxford, and Mullaghmore. Snowfalls of some depth occurred in many districts, doing no little damage to green crops, and in later districts to grain crops still standing in the fields.

The lamentable destruction to fishing-vessels off the coast of Berwickshire was doubtless to no inconsiderable extent due to the deceptive character of the weather on Friday morning in cases where the barometer either is not consulted, or such a fall as an inch during the twelve hours immediately preceding, is discredited as a precautionary warning. In Midlothian, shortly after eight o'clock, the clouds broke up and the sun shone in a sky rapidly clearing of clouds. Soon, however, a change commenced, and within an hour, behind a low bank of darkish-looking clouds in the northern horizon, a long bank of ashy, leaden-hued, ominous clouds began to appear, and rose higher in the sky. In a brief space of time the whole of the sky was overcast, and a darkness quickly followed so great as to render gas necessary in reading the morning newspaper. It was remarked at the time that the darkness lasted three or four times longer than is usually the case with the darkness which is observed immediately to be followed by a complete change of wind. When it passed away, the wind had changed from south-west to north-north-east and the temperature fallen, and thereafter the wind gradually rose to a gale. On the other hand, off the Berwickshire coast the darkness was denser and more threatening, and almost simultaneously with its approach a hurricane broke out with a devouring energy which bore everything before it, and, explosively as it were, instantly rose to a height which, judging from actual facts related by the fishermen who escaped and the spectators on the shore, can perhaps only be paralleled in this country in recent years by the Edinburgh hurricane of January 24, 1868. On land many lives were lost in London and elsewhere, and in all parts of the country chimney-stacks, roofs, and walls were blown down, telegraph lines were wrecked, and tens of thousands of the finest trees were snapped asunder and levelled with the ground. When there has been time to collect the records of this storm, it will be found to have been one of the most destructive to life and property in these islands in the memory of the present generation.

THE INTERNATIONAL EXHIBITION AND CONGRESS OF ELECTRICITY AT PARIS [1]

IV.

AS we believe our readers will be interested in a fuller description of the arrangements for the telephonic hearing of the Opera than we have yet given, we extract the following from Nos. 50 and 51 of the new and popular French electrical journal, *La Lumière Électrique*, edited by Count Du Moncel. It is from the pen of the Count

[1] Continued from p. 564

himself, and is, we believe, the best account yet published. Our own additions are in square brackets.

One of the greatest successes of the Exhibition of Electricity is certainly the arrangement for the telephonic hearing of theatrical performances which has been organised by the Société Générale des Téléphones. By means of an electrical connection which has been established between the Opera, the Théâtre Français, and the Exhibition Palace, it has become possible to hear in the most complete manner the pieces played on our two principal dramatic stages. The singing of the Opera especially has a fairy-like effect, and all who have been so fortunate as to penetrate into the sanctuaries reserved for these hearings go away astonished and enchanted as if they had come from a dream of the Thousand and One Nights. The effect is in fact captivating; for the singing of the Opera is positively better heard in this way than in the Opera House itself; the words are more distinct, and the delicate turns of sound are better rendered, in consequence doubtless of the fact that the telephonic transmitters, being interposed between the actors and the orchestra, the instrumental music is to some extent sacrificed to the singing. It would scarcely be an exaggeration

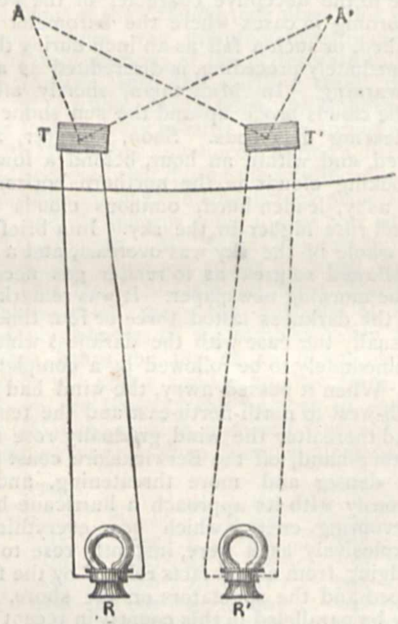

FIG. 1.—Stereoscopic combination of two transmitters.

to say that we hear too well, for the words of the prompter are heard with a distinctness which is somewhat distracting. In short the success is complete, and the Société des Téléphones, as well as M. Ader, who has superintended the arrangements, have a large claim on public gratitude.

The theatrical performances are to be heard not only in the four rooms allotted to the public, but also in a little boudoir off the so-called Salon de l'Impératrice, which is at some distance from the others. Here there are no external noises to distract, and it is possible to enjoy the charming melodies at one's ease.

The four public rooms, one of which is represented in Fig. 3, are covered on all sides with drapery to deaden external sounds, and the telephones are hung in pairs from wooden panels, of which there are twenty in each room. Chandeliers supporting lamps of Swan, Maxim, and Lane-Fox light each of these rooms, and the entrance to each is through a kind of pen which holds twenty persons in single file. The auditor has only to put the two telephones to his ears to hear the theatrical performance. On the table in the centre of the room there is a telephone for the use of the officials.

The connecting wires pass across the northern portion of the galleries of the Exhibition, and thence through sewer pipes to the Opera House and Théâtre Français, where they abut on the stage of each of these theatres, and terminate in transmitters, which are in fact microphones with multiple contacts. Those which are employed are of the Ader system, and are the same as those which are used for the Telephonic Exchange of Paris, but with one slight modification to meet the exigencies of this special purpose. As is well known, the acting portion in these transmitters consists of a sort of gridiron composed of two fixed parallel bars of carbon loosely connected by means of six smaller cross-bars of the same material, whose ends are supported by resting in holes in the sides of the large bars, and are free to rattle about in them. This frame of carbons is attached in a horizontal position to the under side of a thin board of pine, which is the vibrating plate. [Sometimes the gridiron is doubled, so as to consist of three fixed bars, the middle one being connected to each of the others by five small bars (ten small bars in all). The terminals of the battery are in both cases connected with the two outside bars, and the current divides itself between the five small bars as it passes from each large bar to the next. An ordinary

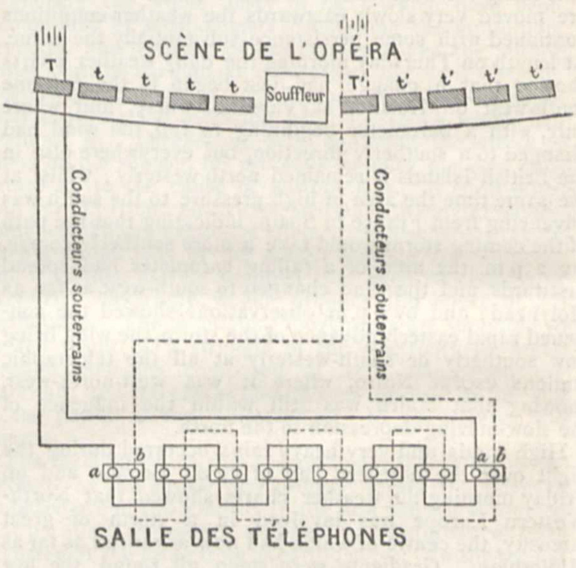

FIG. 2.—Connections between Opera and hearing-room.

five-barred gate, without the sloping tie, gives a good idea of the general form. It is one of the many forms which have been given to Crossley's microphonic transmitter, and is believed to be about on a par with many other forms.]

On account of the multiplicity and variety of sounds which it is capable of transmitting, it has been fixed on a leaden socket standing on four india-rubber feet, to deaden the effect of the vibrations of the floor of the stage. The necessity for such an arrangement is obvious in a theatre where the floor is continually being shaken by dancing.

At the Opera House there are ten transmitters of this kind disposed on both sides of the prompter's box along the edge of the stage. The arrangements suitable for any theatre vary according to the position and magnitude of its stage; and M. Ader informs us that he intends to double the number of transmitters at the Opera House, so as to render the sounds still more intense.

The receivers in the telephonic rooms of the Exhibition are the *téléphones à surexcitation* of M. Ader, which we have described more than once in this journal, and the arrangement of the batteries which work these multiple systems possesses no special feature. The batteries are placed wherever there is room for them, generally underneath the stage; but as they would become too highly polarised if left in circuit during a whole representation, it is necessary to renew them every quarter of an hour, and for that purpose a commutator has been provided which allows the change to be made in a moment. This commutator consists of a board furnished with as many spring-plates as there are transmitters, and serves to keep up the connection between the transmitters and the batteries.

The greatest difficulty that has been met with has been how to render the transmitter more sensitive to the voices of singers than to the loud sounds emitted from the instruments of the orchestra, which would otherwise predominate. M. Ader has had to make a number of acoustic studies and trials on this point, which we cannot explain without going too much into detail, and has completely vanquished the difficulty; we will, however, explain the means which M. Ader has employed to enable the auditor to follow to some extent the movements of the actors on the stage.

Everybody knows the stereoscope, which enables a person, by means of the superposed visual impressions of the two eyes, to see the stereoscopic images with their natural relief. M. Ader applies the same principle to the perception of sounds.

Suppose two microphonic transmitters, placed on the

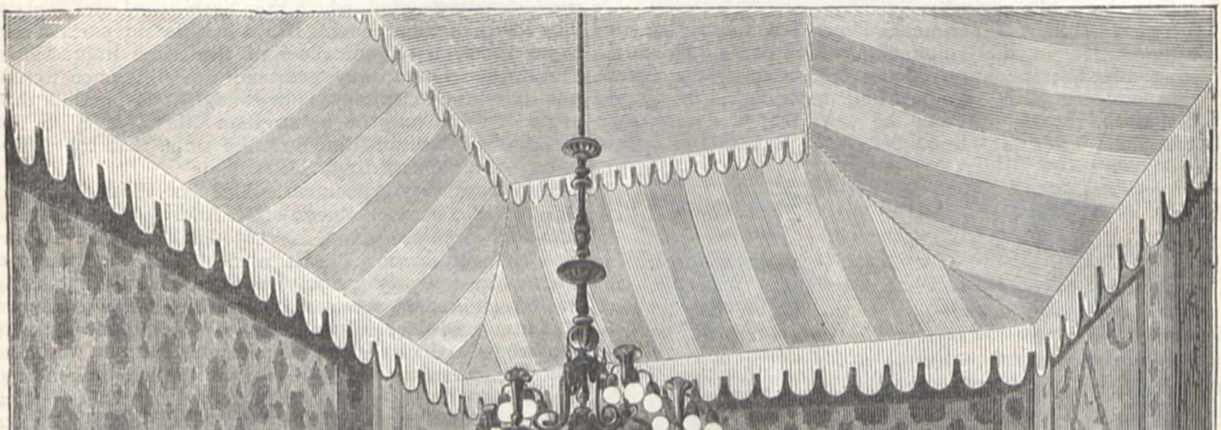

FIG. 3.—One of the hearing-rooms in the Exhibition.

stage at T and T′ (Fig. 1). Let one of them be connected by wires with the receiver R, and the other with the receiver R′, these receivers being applied to the two ears of the auditor, and suppose an actor to stand first at A and then at A′. In the former position, as he is nearer to the transmitter T than to T′, his singing will be heard loudest with the left ear; but when he is at A′ he is nearer to T′ than to T, and the right ear will receive the strongest impression. Thus as he goes from A to A′ the definite sensation which the auditor will receive will be that of a diminution of loudness in the left and an increase of loudness in the right ear, which is the same as the sensation which we experience when a person who is speaking walks from our left to our right. The same principle will apply to a number of actors crossing one another on the stage. Fig. 2 explains how this idea has been carried out at the Opera House.

We have already stated that there are five transmitters on each side of the prompter's box [marked *souffleur* in the figure] along the edge of the stage. Each of these transmitters has its own separate circuit, and consequently its own separate underground cable. On arriving at the hearing room, the cables terminate each in eight receivers, but always in such a manner that to each auditor the effects are very different for his two ears. Fig. 2 shows the course of the circuits for two transmitters, and the circuits for the others are arranged on the same plan. A little study of this figure is enough to show that in each pair of telephones in the receiving room the left one corresponds to the transmitters on the left side of the stage, and the right one to the transmitters on the right side. All the left-hand telephones are in one circuit, and all the right-hand ones in the other. This arrangement, which is clearly shown in the figure, is very ingenious, and though a simpler arrangement with a smaller number of circuits could have been employed, the additional expense involved in having so many circuits was not allowed to stand in the way, as it was necessary in order to make forty-two pairs of telephones work properly; and even this number is not sufficient to satisfy the public curiosity.

These brilliant experiments show that there was no exaggeration in the statements which were published soon after the invention of the telephone, to the effect that concerts and sermons had been heard at great distances. It cannot now be said that we were too credulous when we announced in 1878 that the opera

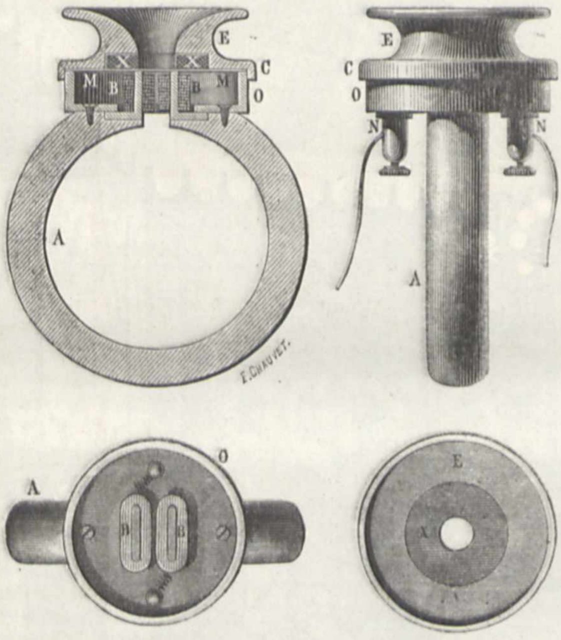

Fig. 4.—Ader's telephone *à surexcitation.*

"Don Pasquale" had been very well heard in the telephone at Bellinzona, and that none of the fine turns of this charming music had been lost. We believe indeed that the results then obtained were far inferior to those which we have now the opportunity of enjoying; and still more marvellous results in telephony have, we are informed, been quite recently obtained.

Fig. 3 represents one of the hearing rooms, namely, that which is lighted with Lane-Fox lamps. A mahogany wainscotting is carried round the walls at about the height of the ear, and on it are fixed twenty small wooden panels furnished with hooks to hang the telephones on. The telephones are connected with the underground conductors by means of flexible wire cords which come out of the wainscotting, so that nothing is easier than for the auditors to put the telephones to their ears. As the telephones are connected, eight in each series, with one and the same pair of microphonic transmitters, and the different pairs of transmitters occupy different positions on the stage, the effects are not the same for all the telephones. Those which are in connection with transmitters at the extreme right or left are more affected by the sounds of the loud instruments in the orchestra than those which are connected with the transmitters nearest the prompter; but these latter, on the other hand, are more affected by the prompter's voice.

To make the effects as equal as possible, M. Ader has so arranged the connections that the two transmitters which form one pair are in precisely opposite conditions; for instance, the transmitter at the extreme left is paired with the first to the right hand of the prompter, the second from the extreme left with the second to the right of the prompter, and so on. The best effect is obtained from the pair which occupy the middle places in the two sets. These differences give an obvious explanation of the different accounts given by different persons of the predominating sounds which they have heard, and explain why many of them, having heard in different parts of the same room, have not received the same impressions. Naturally enough they attribute the difference to the quality of the telephones, but though it is possible that some of these may be better than others, it is to the positions of the transmitters on the stage that the differences are chiefly attributable.

[The receiving instrument, which, as above stated, is the *telephone à surexcitation* of M. Ader (pronounced like the English name Adair), is very similar to the Gower-Bell receiver, having like it a steel horseshoe magnet, which forms nearly a complete ring, and which, being coated with nickel, serves as the handle. Round the two soft iron pole-pieces of this magnet coils of very fine wire are wound, which are in circuit with the line wires, so that the currents from the transmitter at the sending-station pass through them. A thin circular plate of iron, fastened by its edges, is fixed at a very small distance from the pole-pieces, and serves as the vibrating diaphragm. The peculiarity of the Ader telephone is that a flat ring of soft iron is fixed at a little distance behind this vibrating plate; that is to say, on the side remote from the magnet, its office being to concentrate and intensify the force of the magnet upon the diaphragm. This is what is meant by *surexcitation.* The plate, in fact, is more strongly attracted by the magnet than it would be if this ring were absent. In Fig. 4 (which consists of three sections and one elevation of this telephone) A is the steel magnet, B B are the coils, M M is the vibrating diaphragm, X X the flat ring for intensifying the force of the magnet upon the diaphragm, O the resonance chamber, and E the trumpet-shaped opening which is applied to the ear.]

The following account of Rysselberghe's meteorograph was accidentally omitted from a previous article:—

One of the neatest specimens of electrical mechanism is the meteorograph of M. Van Rysselberghe, exhibited by the Royal Observatory of Brussels. It gives its records not only at the place of observation, but at one or more distant stations, and is now giving every night at Paris a record of the indications of the instruments at Brussels. Once every ten minutes it comes into action and registers one after the other the six following elements:—(1) temperature; (2) humidity; (3) water in rain-gauge: (4) direction of wind; (5) barometer; (6) velocity of wind. It also makes a mark about every half second due to the action of clockwork at the sending-station.

The registration is made by a diamond point on a thin plate of zinc which is bent round the surface of a revolving cylinder, and which is covered with lamp-black to make the marks more visible. This plate serves afterwards for printing any number of copies. There may be several of these cylinders at as many different stations, all receiving simultaneously the indications furnished by any one station. The mode of action is as follows:—

Let us take for example the case of one of the thermometers. The thermometer-tube is vertical and open at the top. A long metallic probe smaller than the tube of the thermometer descends once in ten minutes with a slow motion produced by clockwork. The probe, by touching the mercury, completes a circuit, through which a current is instantly transmitted from a local battery. The line-wire is included in this circuit, and a corresponding movement is produced in the diamond point of the receiving instrument. A local electro-magnet is also made by this current, and the arrangements are such that the current is thus diverted from the mercury at the instant after the probe has touched it, and there is consequently no spark when the probe leaves the mercury. The instantaneous current which thus passes is always from the probe to the mercury; in other words the mercury is the negative and the probe the positive terminal. If any moisture be present its oxygen goes to the probe (which is of platinum) and the hydrogen to the mercury, which thus, instead of oxidising, is kept always bright. Evidently the higher the mercury stands in the tube, the sooner will the contact be made, and thus the scale of equal parts before-mentioned gives the height of the mercury.

The diamond point makes a succession of short marks which (in virtue of a mechanical interruption) form a regular series up to the moment when the probe touches the mercury, after which they cease for several seconds. The cylinder revolves once in ten minutes, and the diamond point has at the same time a slow longitudinal motion (being mounted on a screw axle), so that the successive indications of the same thermometer form a nearly continuous curve (traced by points).

Thus by one line wire and one diamond point the curves for all the six instruments are drawn at a station which may be 200 or 300 miles distant. The value of such an instrument for furnishing the director of a central station with accurate data on which to base his weather-predictions speaks for itself; and as regards expense, all the expenses of photography and of reducing and engraving photographic traces are saved. It has been worked in Belgium over a wire of the length of 750 miles.

(To be continued.)

NOTES

THE Royal Institution Session will commence with a course of six lectures on astronomy, adapted to a juvenile audience, by Prof. R. S. Ball, F.R.S., Astronomer-Royal in Ireland. Dr. W. Huggins will give a discourse on Comets at the first Friday evening meeting, January 20, 1882.

THE International Commission for the next transit of Venus, established in Paris under the presidency of M. Dumas, has accomplished its work and published a series of instructions, which will appear in the next number of the *Comptes rendus* of the Academy of Sciences, and be sent to all astronomers and observatories. A complete scheme for international co-operation has been adopted.

AS No. 12 of the Bibliographical Contributions, edited by Mr. Justin Winsor of the Harvard University Library, we have a List of the Publications of Harvard University and its Officers, 1870–80. It contains, for example, the publications of the Astronomical Observatory, the Bussey Institution, the Museum of Comparative Zoology, &c., followed by an alphabetical list of the officers (professors, &c.) of the University with their publications, and including such names as those of Agassiz, father and son, J. A. Allen, the ornithologist, J. P. Cooke, professor of chemistry, Asa Gray, H. A. Hagen, professor of entomology, E. C. Pickering, professor of astronomy, the late Benjamin Peirce, S. H. Scudder, N. S. Shaler, J. Trowbridge, professor of physics, and others.

THE experiments made at the Paris Opera in electric lighting have been successful for regulators. Not less than thirty-six Brush lamps illuminated the celebrated monumental staircase, with Werdermann in the circular gallery, and Jaspar in the buffet. Sixty-four Jablockhoff lights were disposed on the ceiling round the chandelier with success in spite of the numerous changes of colour. The incandescent light exhibitors—Swan, Maxim, and Edison—were not ready to act their part, and the opportunity was lost for them; a second will be given to-day.

A RUMOUR has been spread by the *Journal Officiel* that the Electrical Exhibition will be closed on the 1st of November. The impending resignation of M. Cochéry is stated to be at the bottom of this semi-official attempt. But it is certain no alteration will be made in the original date of closing, except to extend the time granted up to December 1.

THE death is announced, at the age of eighty-four years, of M. Dubrunfaut, a well-known French industrial chemist.

IT is stated that M. Hervé-Mangon, director of the Paris Conservatoire des Arts et Métiers, has decided to resign his post in order to devote himself more entirely to politics, he having been elected recently as *deputé* for the department of La Manche. Probably he will be succeeded by Col. Laussedat of the Polytechnic School.

PROF. HAECKEL has arrived at Vienna on his way to Ceylon.

IN connection with the Museum and Library, Queen's Road, Bristol, the following syllabus of a course of nine lectures, on literary and scientific subjects, to be delivered during the winter, 1881–82, has been issued:—October 31, 1881, Clements R. Markham, C.B., F.R.S., Sec. R.G.S., the Basque Provinces of Spain; November 14, Prof. W. J. Solas, M.A., F.R.S.E., F.G.S., the Natural History of Volcanoes; November 28, Prof. S. P. Thompson, B.A., D.Sc., F.R.A.S., Electric Storage and Lighting; December 12, Prof. William Ramsay, Ph.D., F.C.S., Improvements in Iron and Steel Manufacture; January 23, 1882, Prof. Bentley, F.L.S., Epiphytic and Parasitic Plants, with some observations on the Life of other Plants; February 6, Ven. Archdeacon Norris, B.D., Canon of Bristol, Redcliffe Church: its Architecture and History; February 20, J. E. H. Gordon, B.A., the Leyden Jar; March 6, W. Saville Kent, Infusoria; March 20, Rev. A. H. Sayce, M.A., the Land of the Phœnicians.

LIEUT. FRIEDRICH WILL will shortly undertake a thorough zoological-entomological investigation of the provinces of Bahia, Pernambuco, and Piauhy; he is sent by the Entomological Society of Stettin, the president of which is Dr. C. A. Dohrn.

WE have received parts 1 and 2 of the first volume of the *Transactions* of the Seismological Society of Japan, containing an address on Seismic Science by Prof. Milne, together with papers by Messrs. Ewing, Wagner, and Gray, on various seismometric and seismographic instruments, and by Mr. Mendenhall on a determination of the Acceleration of Gravity at Tokio. The Society is to be congratulated on the numerous proofs of activity which it has already shown, and on the very valuable scientific work it is doing in this rather neglected branch of study.

A USEFUL paper by Mr. W. J. Harrison, Science Demonstrator for the Birmingham School Board, on the Teaching of Science in Public Elementary Schools, has been issued by him in a separate form. He resumes all the reasons for science-teaching in schools in a clear and forcible manner, and gives some hints that might be of service to science teachers. In Birmingham, we believe, they are now endeavouring to obtain money for science scholarships, by which boys of merit will pass from the Board Schools to the great Foundation School there (King Edward's Grammar School), then to the Mason College, and perhaps subsequently to some university. There are now 2000 children and 200 pupil teachers under science instruction in Birmingham, and the results so far have been most encouraging.

MAJOR-GENERAL MAITLAND, writing to the *Times* in connection with the Bordeaux Phylloxera Congress, makes a suggestion which appears quite worthy of attention. He believes that all the remedies hitherto applied or proposed are open to the reproach to which all empiric treatment of disease is obnoxious—viz. the attacking of a symptom instead of the essential root of the disease, and thus betraying a want of right apprehension of its true origin. "This, in my humble view," General Maitland says, "is to be attributed to exhaustion of the vitality of the plant, induced by unduly and unnaturally overtasking its productive powers. In this respect the phylloxera of the French vineyards bears a close analogy to the red spider of the Indian tea garden, to the leaf-worm of the Indian, American, and other cotton fields, and, in short, to parasitic growth wherever proving fatally destructive throughout the vegetable kingdom. The mode in which this law of nature, as it may be termed, operates, may be understood by reference to the physiological paradox, 'Life dies; death lives.' Wherever the vitality of a plant is abnormally diminished by over-plucking, over-pruning, and unceasing inexorable demands to produce more, more, when nature demands rest and repose to recruit exhaustion, the sap, the plant's life-blood, becomes poor, sluggish, and enfeebled. Parasitic life is then evolved, and preys upon the little remaining life that injudicious culture has left the plant. If the above view in regard to the origin of phylloxera be accepted as an approximation to the truth, the remedy would seem to be self-indicated—repose. Give the vineyards rest."

AN extraordinary report of four large expeditions for Africa being organised in Brussels, was lately given in the *Pall Mall Gazette*, and has this week been reproduced by the *Daily News*. There is, however, absolutely no foundation for the statement.

THE *Colonies and India* states that the unusual spectacle of snow was seen on Table Mountain on August 16. Such an occurrence has been recorded only once since 1813, viz. in 1878.

THE first list of the honorary council of the International Electric Exhibition which is to be held at the Crystal Palace, comprises the following names of well-known men of science:—Mr. James Abernethy, President Institute Civil Engineers; Prof. W. G. Adams, F.R.S., Sir James Anderson, Prof. Ayrton, F.R.S., Sir Henry Cole, K.C.B., Mr. William Crookes, F.R.S., Capt. Douglas Galton, C.B., F.R.S., Dr. Gladstone, F.R.S., Col. Gouraud, Sir John Hawkshaw, C.E., F.R.S., Dr. J. Hopkinson, F.R.S., Prof. Fleeming Jenkin, F.R.S., Sir E. J. Reed, C.B., M.P., Mr. B. Samuelson, M.P., Dr. C. W. Siemens, F.R.S., Mr. W. Spottiswoode, President Royal Society. The following gentlemen will be the chief officers for the Exhibition: Manager, Major S. Flood Page; secretary, Mr. W. Gardiner; superintendent, Mr. P. L. Simmonds; assistant engineer for Exhibition, Mr. R. Applegarth, C.E.; clerk of works, Mr. W. Carr.

THE Programme of the Technological Examinations of the City and Guilds Institute for 1881-2 contains several new subjects and arrangements—improvements on previous programmes. The examination papers set for 1881 are interesting.

WE notice in the Russian journal, *Old and New Russia*, an interesting paper on M. Tyaghin's wintering at Novaya Zemlya, on hunting in that land, together with a good sketch of the bird life in the neighbourhood of the wintering place.

DR. GOBI, who has investigated during many years the flora of the White Sea, has published his researches in a separate work in Russian.

WE notice in a paper published in the *Annals* of the Spanish Society of Natural History (vol. x. 1881), that Don Fr. Quiroga observes that the numerous implements in Spanish museums which are usually described as nephrite are mostly made of fibrolite, this name having been given by Count de Bournon to a variety of sillimanite. Out of 115 hatchets which were considered as nephrite, and were found mostly during the geological survey of the provinces of Guadalajara and Cuenca, only one was of nephrite, whilst 111 were of fibrolite and three of jadite. The fibrolite is often found among the mica-slates of the provinces of Madrid and Guadalajara.

THE same volume of the *Annals* contains a paper, by Don S. Calderon of Arana, on the evolution of the earth.

A STRIKING instance of the activity of man in destroying forests may be shown by the following figures, which we find in M. Olshevsky's paper in the last issue of the *Izvestia* of the Russian Geographical Society. After having taken into consideration the surveys which were made in the province of Ufa before 1841, and the recent distribution of forests in that province, M. Olshevsky shows that the area of forests, which formerly was about 17,577,000 acres, has now diminished by at least 3,500,000 acres; although the population is still very sparse, that is, less than three souls per square mile, and it was yet less some time ago.

THE well-known publishing firm of A. Hartleben (Vienna, Pesth, and Leipzig) have recently published a little work by Heinrich von Littrow, "Carl Weyprecht, der österreichische Nordpolfahrer." It contains many characteristic reminiscences as well as letters of the late discoverer of Franz-Josef Land. It is a fitting and touching literary monument to a brave, energetic, highly-cultivated, kind, and modest man of science, whose useful career was unfortunately cut short so prematurely.

Auf der Höhe is the title of a new international review, edited by Leopold v. Sacher-Masoch, and published at Leipzig by Gressner and Schramm (London: Dulau). The first number (October) contains several interesting articles, though none of them scientific; among the list of contributors, however, we notice the names of several Continental men of science.

DR. KING's report on the Government Cinchona Plantation in British Sikkim for the year ending March last, shows a continued and highly satisfactory progress—a progress that has been made not only in the extended cultivation of well-known and established species, but also in the propagation of valuable and rarer kinds. Most satisfactory results are recorded of the species known as *Cinchona Ledgeriana*, one of the varieties of *Calisaya* which, as Dr. King says, is surpassingly rich in quinine, and which has derived its name from Mr. Ledger, a collector who brought the seed from South America. Regarding another valuable kind, namely, the plant yielding the Carthagena or Columbian bark, which is largely imported to this country from the northern part of South America, and of which four plants were sent to the Government Plantations from Kew in January, 1880, Dr. King says, "They arrived in good condition and during the year they were increased largely by cuttings. Propagation went on most favourably for some time, but later on in the year the young plants were severely attacked by the pest only too well known to gardeners as 'thrips.' The usual treatment was applied with vigour, but in spite of this, when the year ended the six original plants had been increased only to sixty rooted plants and ninety partially rooted cuttings." Dr. King, however, further says that "every effort will continue to be made to increase the stock of this interesting species." Both the general condition of the plantation and the financial results are reported as satisfactory, and the results as gathered from the quinologist's report, which is appended, are also satisfactory, inasmuch as they show an increased manufacture of febrifuge and also an increased demand. Dr. King and his co-workers are to be congratulated on the continued successful results of their labours.

Dr. Obst, the director of the Ethnographical Museum at Leipzig, after attending the Archæological Congress at Tiflis, intended to make an exploring tour in the Caucasus, Armenia, and Asia Minor, and then to return to Saxony *viâ* Constantinople and Athens.

A strange phenomenon was recently observed at Emerson, near Lake Winnipeg. A dark cloud formed of myriads of winged black ants passed over the place from east to west. When it descended the ground over a large area was covered an inch deep with the insects.

Mauna Loa (Hawaii) is again active, and the lava threatens the port of Hilo, situated on the east side of the island.

In a letter which we have received from Mr. G. H. Kinahan he disavows the suggestion imputed to him (Nature, vol. xxiv. p. 471) that Laurentian rocks occur in Co. Tyrone.

The additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♀), a Bonnet Monkey (*Macacus radiatus* ♀) from India, presented by Mr. G. E. Jarvis; a Vervet Monkey (*Cercopithecus lalandii* ♂) from South Africa, presented by Mrs. Brassey; two Leopards (*Felis pardus*) from Ceylon, presented by Lieut.-Col. J. S. Armitage, F.Z.S.; a Mesopotamian Fallow Deer (*Cervus mesopotamicus* ♀), two Beatrix Antelopes (*Oryx beatrix* ♀ ♀), two Arabian Gazelles (*Gazella arabica* ♂ ♀) from Muscat, presented by the Lord Lilford, F.Z.S.; a Naked-footed Owlet (*Athene noctua*), European, presented by Mr. R. J. Marlton; a Common Kestrel (*Tinnunculus alaudarius*), a Common Hare (*Lepus europæus*), European, presented by Mr. W. K. Stanley; a Paradise Whydah Bird (*Vidua paradisea*) from West Africa, presented by Mr. Bowyer Bower; two Bonnet Monkeys (*Macacus radiatus*) from India, a Bell's Cinixys (*Cinixys belliana*) from East Africa, deposited; an Osprey (*Pandion haliaetus*), European, purchased; a Hardwicke's Hemigale (*Hemigalea hardwickii*) from Borneo, received on approval.

OUR ASTRONOMICAL COLUMN

The Satellite of Neptune.—We subjoin such a table as was suggested by Prof. Newcomb for indicating with little trouble the approximate position of the satellite of Neptune, at any time about the approaching opposition. The argument *u* has the same significance as in Newcomb's Tables:—

Argument *u*.		Angle of Position.		Distance.
°	°	°	°	″
0	180	73·3	253·3	11·4
10	190	65·7	245·7	13·1
20	200	59·7	239·7	14·6
30	210	54·8	234·8	15·8
40	220	50·4	230·4	16·6
50	230	46·3	226·3	16·9
60	240	42·3	222·3	16·9
70	250	38·2	218·2	16·4
80	260	33·8	213·8	15·5
90	270	28·6	208·6	14·3
100	280	22·2	202·2	12·7
110	290	14·0	194·0	11·0
120	300	2·7	182·7	9·2
130	310	346·4	166·4	7·7
140	320	324·2	144·2	6·8
150	330	299·4	119·4	7·0
160	340	278·6	98·6	8·0
170	350	263·7	83·7	9·6
180	360	253·3	73·3	11·4

Values of *u* at Greenwich noon

Oct. 28	187·55	Nov. 27	225·26	Dec. 27	262·95
Nov. 7	80·12	Dec. 7	117·83	Jan. 6	155·51
17	332·69	17	10·39		

Motion of *u* in

Days.	°	Hours.	°
1	61·26	1	2·55
2	122·51	2	5·11
3	183·77	3	7·66
4	245·03	4	10·21
5	306·28	5	12·76
		6	15·31
		12	30·63

From which figures *u* may be interpolated for any hour required. When *u* is found in the second column of the table, the angle of position is to be taken from the second column.

Comet 1881 *f* (Denning, October 3).—The comet discovered by Mr. W. F. Denning of Bristol during the night of the 3rd inst. has been observed at Marseilles by M. Coggia, and at Lord Crawford's Observatory at Dunecht. Elements calculated by Dr. Copeland and Mr. Lohse upon Dunecht observations on October 9, 10, and 12, are as follows:—

Perihelion passage 1881, September 12·0943, Greenwich M.T.

Longitude of perihelion	22° 6′ 9″	M. Eq. 1881·0
Ascending node	72 47 45	
Inclination	7 45 12	
Log. perihelion distance	9·859822	

Motion—direct.

Hence it is found that this comet, like that discovered by Mr. Barnard on September 19, is receding both from the sun and the earth. As remarked in Lord Crawford's Circular, No. 33, the elements bear some resemblance to those of the fourth comet of 1819, detected by Blanpain at Marseilles, which was certainly moving in an elliptical orbit of very limited dimensions. This circumstance alone attaches a particular interest to Mr. Denning's comet, and makes it of importance that it should be accurately observed for position as long as practicable.

Ceraski's Variable—U Cephei.—The following Greenwich times of minima depend upon Mr. Knott's observation on the 2nd inst. with the period $2^d \cdot 49280$:—

	h. m.		h. m.		h. m.
Oct. 22	10 24	Nov. 11	9 1	Dec. 1	7 39
27	10 4	16	8 41	6	7 18
Nov. 1	9 43	21	8 20	11	6 57
6	9 22	26	7 59	16	6 37

BIOLOGICAL NOTES

The Hypophysis in Ascidians.—In a second paper to the Belgian Academy on this subject (*Bull.* No. 6) M. Julin describes the quite special arrangement of the "hypophysary gland" in *Phallusia mamillata.* Besides the principal excretory duct existing in all Ascidians, and here considerably reduced, there are a large number of orifices by which the glandular tubes pour their product of secretion into the peribranchial cavity, of which the cloaca forms the median part, which receives all the products and residues of the organism, to be cast out. Hence the products of the hypophysis in this species are probably also excrementitial, and the gland is physiologically the kidney of the animal. If it be so with *P. mamillata* it is likely to be the same with the other Tunicata; and though, in most, the hypophysis opens into the mouth, one cannot infer that the product is to be utilised in the alimentary canal. From the morphological point of view it is noteworthy that in glands properly so-called, arising from an epidermic or epithelial invagination, the product of secretion is generally eliminated by a single orifice, and that the only exceptions occur in the category of urinary apparatus (Cestodes, Trematodes, &c.).

The Corals of Singapore.—We learn from a paper (*Proc.* of Berne Nat. History Society) by Prof. Studer, on the Corals of Singapore, that there are no less than 122 species known from this locality. Of these fifty-one species are special to the locality, whilst the others inhabit the seas of New Guinea, of the New Britannic Archipelago, of the Solomon Islands, and reach as far as Fiji, some few extending as far as Tahiti. At the same time the Singapore corals yield very few species in common with the Red Sea, the Seychelles, and Mauritius, and these are Fungidæ, but no Madreporaceæ. Thus it may be established that the coral fauna of the Indian Ocean must be divided into two distinct regions—a western and an eastern, the latter extending far to the east into the Pacific. These two regions are divided by deep sea and by coast-lines, which, as the eastern and southern coasts of India, do not afford the necessary conditions for the development of corals, whilst the extension to the east is much facilitated by low grounds and favourable coast-lines. Nevertheless, however different as to the species which inhabit them, both regions have a close likeness as to certain species, and both might be considered as having formed a single region, probably at the time when the great plateau of the Sunda Islands was a continuation of the continent, and when Madagascar and Ceylon were in close connection. As to the inhabitants of greater depths and of colder water—as the Gorgonids, the Anthozoæ, and the Primnoids—the same species are widely spread throughout the Pacific and the Indian Ocean, showing thus that the differentiation of shallow-water forms goes on more rapidly than that of the deep-water ones.

A CHEMICAL DIFFERENCE BETWEEN LIVING AND DEAD PROTOPLASM.—From various experiments (chiefly with protoplasm of plants, also with Infusoria) Herren Loew and Bokorny find (*Pflüger's Arch.*) that living protoplasm possesses in an eminent degree the property of reducing the noble metals from solutions, and that this property is lost when death occurs. "It may well be inferred," say the authors, "that the mysterious phenomenon denoted by the name of 'Life' depends essentially on these reducing atom-groups. In the present state of science we explain these 'groups in motion,' these springs of life phenomena, as aldehyde groups, but would by no means exclude some different and better mode of explanation."

RATTLESNAKE POISON.—Dr. Lacerda Filho has published the results of his experiments on the poison of the rattlesnake (*Crotalus horridus*) in the *Archivos do Museu nacional do Rio de Janeiro*, iii. 1. The poison of *Crotalus horridus* acts upon the blood by destroying the red-blood corpuscles, and by changing the physical and chemical quality of the plasma. 2. The poison contains some mobile bodies similar to the micrococcus of putrefaction. 3. The blood of an animal killed by the snake's bite, when inoculated to another animal of the same size and species, causes the death of the latter within a few hours, under the same symptoms and the same changes of the blood. 4. The poison can be dried and preserved for a long time without losing its specific quality. 5. Alcohol is the best antidote to the poison of *Crotalus horridus* known until now.

THE SPERMOGONIA OF AECIDIOMYCETES.—According to recent observations by Prof. Rathay (Vienna Acad. *Anz.*) the spermogonia of Uredineæ or Aecidiomycetes may discharge their contents without the action of external moisture, of rain or dew (the only way, as apparently supposed by A. de Bary). The process may occur in dry and hot sunny weather, and as follows:—These spermogonia produce in their interior not only mucilage and spermatia, but also sugar. In virtue of the latter they separate water by "osmotic action," and this water causes the inclosed mucilage to swell, and thereby afford exit from the cavity. The author's observations were made upon the spermogonia of *Gymnosporangium conicum* and *Puccinia suaveolens*.

PELAGIC FAUNA OF GULF STREAM.—Alexander Agassiz gives an interesting account of his explorations of the floating fauna of the Gulf Stream in the vicinity of the Tortugas. The party remained at this station for some five weeks, being allowed to select quarters at Fort Jefferson. Unfortunately during the greater part of their stay the strong northerly winds interfered greatly with the surface fauna. Had the south-easterly winds prevailed the fauna would have been driven against the Tortugas. The few favourable days showed, however, a wealth of pelagic animals which had been hardly anticipated, and which proved how excellent a station this would be to investigate the fauna from. It also has the immense advantage of supplying the naturalist, and at his very door, with not only the common species of reef-building corals, but with the varied invertebrate fauna to be found in such places. Leaving a full enumeration of the species for another occasion, in the letter we now notice (*Bulletin* of the Mus. Comp. Zoology, vol. ix. No. 3) A. Agassiz mentions in a general way the presence of a couple of species of Firoloidea, of Phyllirhöe, of several Appendiculariæ, of a small Pyrosoma, of a Doliolum, two species of Salpa, and half a dozen species of Pteropods. The number of pelagic foraminifera was greatly disappointing; not once was a species of Globigerina met with, and the Radiolarians appear to have also been scanty. A list of the Ctenophoræ, Discophoræ, Siphonophoræ, and Hydroids met with is appended by Mr. Fewkes. Many of the species are indicated as new.

RETARDED DEVELOPMENT IN INSECTS.—In a paper by Prof. C. V. Riley, at the recent meeting of the American Association, the author records several interesting cases of retarded development in insects, whether as summer coma or dormancy of a certain portion of a given brood of caterpillars, the belated issuing of certain imagines from the pupa, or the deferred hatching of eggs. One of the most remarkable cases of this last to which he calls attention is the hatching this year of the eggs of the Rocky Mountain Locust or Western Grasshopper (*Caloptenus spretus*) that were laid in 1876 around the Agricultural College at Manhattan, Kans. These eggs were buried some ten inches below the surface in the fall of 1876 in grading the ground around the chemical laboratory, the superincumbent material being clay, old mortar, and bits of stone, and a plank side-walk being laid above this. In removing and regrading the soil last spring Mr. J. D. Graham noticed that the eggs looked sound and fresh, and they readily hatched upon exposure to normal influences, the species being determined by Prof. Riley from specimens submitted by Mr. Graham. Remarkable as the facts are, there can be no question as to their accuracy, so that the eggs actually remained unhatched during nearly four years and a half, or four years longer than is their wont; and this suggests the significant question, How much longer the eggs of this species could, under favouring conditions of dryness and reduced temperature, retain their vitality and power of hatching? Putting all the facts together, Prof. Riley concludes that we are as yet absolutely incapable of offering any satisfactory explanation of the causes which induce exceptional retardation in development among insects. The eggs of Crustaceans, as those of *Apus* and *Cypris*, are known to have the power of resisting drouth for six, ten, or more years without losing vitality, while in some cases they seem actually to require a certain amount of desiccation before they will hatch. Yet the fact remains that different species act differently in this respect. In short, nothing is more patent to the observing naturalist than that species, and even individuals of the same species, or the progeny of one and the same individual, act very differently under like external conditions of existence: in other words, that temperature, moisture, food, &c., influence them differently. Hence, as has been shown by Semper to be the case with other animals, so it is with insects, changes in the external conditions of existence will not affect the fauna as a whole equally, but will act on individuals. We can understand how this great latitude in susceptibility to like conditions may and does, in the case of exceptional seasons, prove beneficial to the species by preserving the exceptional individuals that display the power to resist the unusual change; but we shall find ourselves baffled when we come to seek an explanation of the cause or causes of such retardation, unless we accept certain principles of evolution. In the innate property of organisms to vary, and in the complex phenomena of heredity, we may find a partial explanation of the facts, for the exceptional tendency in the present may be looked upon as a manifestation through atavism of traits which in the past had been more commonly possessed and more essential to the species.

PHYSICAL NOTES

A SINGULAR case of the production of sound by natural causes is recorded by M. Reuleaux (*Proc.* of the Nat. Hist. Soc. of Prussian Rhineland and Westphalia). He observed it while hunting in the Röderbacherthal, near the highest point of the Rhine province. The ground is, in the main, gently undulating and densely wooded. The valley, spacious on the eastern side, narrows rapidly at one part to a sort of pass, through which, for about one kilometre, the Röderbach flows westwards. A sout-west wind was blowing, and M. Reuleaux, coming along the hillside from the east, heard what appeared to be the strokes of a fine deep-toned bell in rapid succession. There was no such bell in the neighbourhood, and some other sounds soon heard satisfied him that the effects were of natural origin. Tones were heard growing in force to a maximum, then dying away; they were like those of organ pipes at first, but their "clang" came to resemble that of a harp or violin. At the mouth of the pass, whence the sounds seemed to radiate, there was a strange agitation in the air, and mixture of sounds, some of which abruptly stopped. M. Reuleaux supposes bodies of air in vortical motion (*trombes*) to have been carried along from the pass, and the sound to have been due to conflict between the outer and the inner air at the mouth of such *trombes*, producing oscillations. There was a marked difference of temperature between the higher and the lower parts of the valley, and this is regarded as an important factor in the case; the cold air above pressing on the warm below, and closing the pass to a sort of tube. The wind seemed to be active only in the lower parts.

WITH the aid of delicate apparatus of recent invention Herr Grunmach (*Wied. Ann.* No. 9) has investigated the electro-magnetic rotation of the plane of polarisation of radiant heat in solid and liquid substances (flint glass, plate glass, sulphide of carbon, oil of turpentine, distilled water, and alcohol). His finding is as follows:—1. In solid as well as in liquid diathermanous bodies there is such rotation, and always in the direction in which the current flows through the spiral or circulates round the magnetic core. 2. The amount of this rotation is, *cæteris paribus*, very different for different substances; the rotation is greater the greater the index of refraction of the substance. 3. With direct action of a galvanic current conducted round the diathermanous body, the amount of the rotation is proportional to the intensity of the current. 4. In a diathermanous body placed between the poles of an electromagnet, the amount of rotation is proportional to the magnetic force acting on the body. 5. The amount of rotation increases with the length of the substance traversed by the rays; but the relation between these two quantities could not be numerically determined.

EXPERIMENTS on heat-conduction have been lately made by M. Christiansen of Copenhagen (*Wied. Ann.* No. 9), by the following simple method:—Three round copper plates are placed one above another, separated by small pieces of glass. A hole is bored radially into each plate, and a thermometer bulb inserted in each hole. The lowest plate rests on a brass vessel, through which cold water is conducted, and on the top plate rests a brass vessel with circulation of warm water. Through holes in the two upper plates (supplied with copper stoppers) the intervals between the plates may be filled with liquid. M. Christiansen experimented first with air, and he proves that its heat-conduction increases with the temperature. The ratio of the conductivity of air to those of several liquids was next studied, the liquid being placed in the lower interval. The results agree well with Weber's figures for absolute conductivity. Some experiments were also made with plate glass (dry and wet) and marble. The method may be adapted (the author points out) to measurement of electric resistances, the potential being measured instead of the temperature.

AMONG some interesting experiments with liquid films, described by M. Plateau to the Belgian Academy, is one in which fine iron wire is first bent to represent a six-petalled flower in outline; the circular centre being supported on a small fork stuck in a piece of wood. The wire is slightly oxidised with nitric acid. The flower is dipped in glyceric solution, and is then put under a bell jar near a window, so that the sky is reflected in the films. A pretty play of bright colours is soon observed, and it continues for hours. Again, with regard to explosion of soap bubbles, one is apt to think the whole of the film is converted simultaneously into minute spherules. M. Plateau has formerly shown that it is not so, and has analysed the course of the phenomenon. An experiment proving the contraction of the bubble during its quick destruction is as follows:—A bubble of glyceric liquid about 11 centimetres in diameter is blown with tobacco smoke, and placed on a ring. Having waited till the top appears blue, you break it there with a metallic wire, whereupon the mass of smoke is shot vertically upwards a dozen centimetres, and then spreads out horizontally, in umbrella shape. It then rises more slowly, and is diffused.

PROF. EXNER of Vienna has lately proved that galvanic elements formed of three elementary substances, one of which is bromine or iodine, give perfectly constant action, and that the electromotive forces exactly correspond to the heat values of the chemical processes. There is no trace of polarisation. Bromine and iodine are also shown to be the worst conductors of electricity at present known. Both bromine and iodine conduct entirely without polarisation, (the latter in solid as well as in liquid condition.) The conductivity rises rapidly with the temperature.

CAREFUL experiments by Herr v. Wroblewski on diffusion of liquids (three chloride of sodium solutions and water) are described in *Wied. Ann.* (No. 8), and yield the result that the constant of diffusion (so far as those experiments go) decreases with decrease of the amount of salt, according to a law of simple proportion. The author further tried a photometric method of measuring diffusion, where the proportion of salt is extremely small; using Hüfner's spectrophotometer and (as colouring-matter in water) nigrosin. He cannot claim great exactness for the results, but the constant is at least one place of decimals smaller than the smallest constant of a salt hitherto known.

DR. KALISCHER, who has been experimenting on selenium cells for the photophone, confirms the observations of Adams and Day that light may in certain cases set up in these cells a photo-electromotive force; the cell becoming its own battery. The same experimenter draws attention to a curious point, namely, that the sensitiveness of selenium cells to light is often greater in cells of high resistance than in those in which, by annealing, the resistance has been greatly reduced. A single cell kept for some months gradually lessened in resistance, while becoming less sensitive to light. These anomalies Dr. Kalischer attributes to the allotropic modifications through which the substance passes, the want of homogeneity accounting also for the photo-electromotive forces observed.

AN excellent paper by M. Gariel has appeared in our contemporary, *L'Électricien*, in which the formulæ for the grouping of cells in a voltaic battery, as deducible from Ohm's law, are discussed and represented in graphic diagrams. M. Gariel has thus arrived at a kind of abacus by which the various problems that arise may be geometrically solved by simple inspection.

PROF. LOVERING of Harvard has lately unearthed from the *Memoirs* of the American Academy a paper by Dr. Nathaniel Bowditch of Salem, Mass., communicated in 1815, in which he investigates the figures made by a double pendulum which compounded two vibrations at right angles to one another. This research, which was illustrated by several plates of figures, therefore antedates that of Lissajous, to whom the discovery of these figures is usually accredited, which was published in 1857. Bowditch investigated the cases of the ratios representing unison, the octave, the twelfth, and the double octave. Bowditch was himself inspired to this investigation by a paper written by Prof. Dean of Burlington, Vermont, in which a compound pendulum, identical with that known as Blackburn's pendulum, was used to illustrate the motions of the earth as viewed from the moon. Blackburn's pendulum dates from 1844. Sang, in 1832, used vibrating wires to compound rectangular vibrations; and Wheatstone's kaleidophone dates from 1827.

SELF-LUMINOUS photographs capable of shining in the dark can be made, as Eder has shown, by laying a transparent "positive" upon a sheet of Balmain's luminous paint, and then exposing the latter to sunlight. The photograph thus produced is a "positive" also. It lasts, of course, only for a limited time.

DR. MÜLLER-ERZBACH, who has just made an exhaustive examination of the desiccating powers of different substances, states that there is no perceptible difference between the power of concentrated oil of vitriol, glacial phosphoric acid, and solid caustic potash in this respect, and that caustic soda and chloride of calcium are only slightly inferior, the difference in tension of aqueous vapour between phosphoric anhydride and anhydrous chloride of calcium being a fraction of a millimetre in the barometric column. He also states that caustic soda is absolutely dehydrated by being shut up in a desiccator with caustic potash.

SOLAR PHYSICS[1]

LIEUT.-COL. DONNELLY, R.E., made the following introductory remarks to Prof. Stokes' first Lecture, which was the first of the series:—

I greatly regret both for your sake and my own that I should have to detain you for a few minutes from the lecture which we have all come to hear. It has, however, been considered desirable that some explanation should be given of what has led to the formation of this Committee on Solar Physics, and what has led to the giving of these Lectures. I am glad to say that in engaging your attention for a few minutes I shall not seriously curtail the time that Prof. Stokes will have at his disposal, for he has been good enough to undertake to lecture on Friday in place of General Strachey, who unfortunately cannot give the lecture which has been announced for him.

[1] Introductory Lecture by Prof. Stokes, Sec.R.S., in the South Kensington Museum Theatre on Wednesday, April 6, 1881.

Our history commences in the year 1875, when the Royal Commission on Scientific Instruction and the Advancement of Science made their eighth and final Report, strongly recommending the establishment, by the State, of an Observatory for Solar Physics. They say that their opinion is confirmed by the action which has been taken by foreign countries in this matter, observatories for astronomical physics having been already established in various parts of Italy, while their immediate erection had been determined on at Berlin and in Paris. The Royal Commission further hoped that similar institutions might be established in various parts of the British Empire, and they particularly called attention to the great advantages that India, at certain high-level stations, affords for continuous observations, which are so important in this matter. In 1876 a very large and influential deputation from the British Association had an interview with the then Lord President of the Council, the Duke of Richmond and Gordon, with the view of urging on the Government the necessity of taking action on this and other recommendations of the Royal Commission. In replying to that deputation the Duke of Richmond pointed out that in a certain small way he had already done something in the matter, for Mr. Lockyer had been transferred from the War Office to the Science and Art Department, and facilities were being afforded him for carrying forward that portion of the researches upon this subject which he had been engaged on for several years.

The representation by the Council of the British Association was followed by a memorial from a number of eminent men of science. I need only mention, among others, the names of Adams, Andrews, Broun, Joule, Clerk Maxwell, Roscoe, and William Thomson, to show you how influential a memorial it was. They based their appeal for the formation of an observatory for astronomical physics on the fact that in the opinion of a considerable number of scientific men there was a more or less intimate connection between the state of the sun's surface and the meteorology of the earth, and they called attention to the fact that recent investigations on the part of several independent men had led them to the conclusion that there was a similarity between the sun-spot period, periods of famine in India, and cyclones in the Indian Ocean. They conclude by saying, "We remind your Lordships that this important and practical scientific question cannot be set definitely at rest without the aid of some such institution as that the establishment of which we now urge." It was under those circumstances that the Lords of the Committee of the Council of Education referred the question to Prof. Stokes, Prof. Balfour Stewart, and General Strachey for their opinion as to whether a start could not be made, and most of what is required by the memorialists in the way of daily accurate observation be accomplished by utilising the advantages offered by the chemical and physical laboratories at South Kensington, with the aid of the detachment of Royal Engineers stationed there. I need not trouble you with the terms of the reference. They are given in Lord Sandon's letter of August 13, 1877, which is printed in a Parliamentary paper as a return to an address of the House of Commons moved by Lord Lindsay on March 20, 1879. I may, however, quote one sentence from it: "Although we are not at present in a position to consider the establishment of an official observatory on a comprehensive scale, we believe that some advantage can be gained if a new class of observations can be made with the means at command; since the best method of conducting a physical laboratory may thus be worked out experimentally, and an outlay eventually avoided which, without such experience, might have been considered necessary." I should also mention that Lord Sandon in his letter suggested that the Astronomer-Royal should be consulted on the subject, and he stated that "We propose to ask General Strachey to act with you especially with a view to advising us as to how far any arrangements made at South Kensington may be worked with, or form part of the system of observations which, we are informed, are in contemplation for India." Just at that particular time the Indian Government had made arrangements for having daily photographs taken of the sun's disk at Dehra-Doon in the North-West Provinces, by Mr. Meins, who, while he was a sapper in the Royal Engineers, had been trained by Mr. Lockyer. The Committee to which I have already referred reported at the end of 1877, and they state what in their opinion may be done at once and without entailing any serious cost. This report is also given in the Parliamentary paper to which I have alluded. Nothing however was done at that time, and in November, 1878, the Duke of Devonshire, as Chairman of the Royal Commission on Scientific Instruction and the Advancement of Science, wrote again calling attention to the subject, and strongly urging that the Report of this Committee should be acted upon. In 1879 a small sum, 500*l*., was taken in the estimates for the expenses of the Committee on Solar Physics. And this has been continued ever since. As soon as that vote had been put into the estimates with the sanction of the Treasury, a Committee was formed consisting of the gentlemen whom I have already mentioned, namely: Prof. Stokes, Prof. Balfour Stewart, and General Strachey, to whom were added Mr. Norman Lockyer, Capt. Abney, and myself. The object of this Committee is to make trial of methods of observation, to collect observed results, to find out what is being done in foreign countries, and so far as possible to collect and bring together all information on this subject, and finally to reduce the Indian observations which have been made since the time that Mr. Meins was sent to India. The Committee made a preliminary report last year, which was presented to both Houses of Parliament, and has been published. I therefore need not trouble you with any of the information contained in it. You will there see what the Committee has been doing, and what arrangements have been made for carrying on the Indian observations since Mr. Meins' death.

While the Committee has been thus acting in its corporate capacity, certain of its members have been carrying on independent researches of their own on different branches of the subject. The results of those researches have been published in the *Proceedings* of the Royal Society, but from the necessarily fragmentary manner of publication, it has no doubt been very difficult, even for men of science, to follow what was being done. Acting, therefore, on a suggestion made by the President of the Royal Society, the Lords of the Council asked the Members of the Committee to give a course of lectures which should bring in a more or less popular manner the results of their researches before the public. It is to that suggestion that this course of lectures is due. So much for the Committee. But I trust you will excuse me if I touch upon one other subject. It is now just within ten days of eighty years since Dr. William Herschel read a paper before the Royal Society which was headed "Observations tending to Investigate the Nature of the Sun in order to find the Causes or Symptoms of its Varying Emission of Light and Heat," and so on. But for the time I have already occupied, I should like to have read to you some portions of this paper, which are very striking even at the present moment. I will however only say now that he followed this paper by another one on May 14, 1801, on "Additional Observations tending to Investigate the Nature of the Sun in order to find the Causes or Symptoms . . . . and a Few Remarks to remove Objections that might be made against some of the Arguments contained in the former Paper." In those papers Dr., or, as he was afterwards, Sir William, Herschel very strongly and forcibly urges the importance of a continued observation of the sun's surface and of the sun-spots. He investigates the connection of sun-spots as far as the periods were then known, with cyclones, with the prices of wheat, and other terrestrial phenomena, and he points out of what great advantage continuous observations upon this subject were likely to be. My colleagues can tell you better than I can, and no doubt will in their lectures, what has been done in this matter since the days of Sir William Herschel. I am afraid it is not very much—I mean of course in the way of continuous observations—and yet during the interval a step has been made in the instruments of research almost, if not altogether, as great as that made in astronomy by the discovery of the telescope. I refer to the use of the spectroscope. Now, the use of this instrument, the spectroscope, so far as solar and stellar chemistry is concerned, is no doubt due to a magnificent research by Kirchhoff published in 1859. But I think I may be allowed to call your attention to a statement made by Sir William Thomson in his address to the British Association in 1871. He there says that some time prior to the summer of 1852 he had been taught by a certain distinguished professor at Cambridge the fundamental principles upon which this process of investigation proceeded. I need scarcely, I hope, tell you that I am not endeavouring to introduce parochialism into what should be the cosmopolitan regions of science; still less am I claiming priority for one who I am sure would be the first to repudiate such a claim. But I think you will agree with me that it is rather a striking example of the fitness of things that it is the distinguished physicist to whom Sir William Thomson referred who will give the introductory lecture of this course.

PROF. G. G. STOKES, F.R.S., then delivered the following lecture:—

Some of my colleagues have applied themselves with industry and with remarkable success to various questions connected with the physics of the sun. I am not in that happy condition. I have however been requested to open this course of lectures on Solar Physics. In doing so I will touch but lightly on the labours of my colleagues, because they are going to lecture themselves, and they will be far better able than I should be to expound their own researches. As to the subject of the lecture I have pretty nearly a *carte blanche* before me, and I may choose my own ground. I propose to refer briefly to what is known on the subject and what speculations were made respecting the physical constitution of the sun some considerable time ago, and then to indicate how our notions gradually came to be changed.

Now I need not dwell on the importance of the sun to man. The savage knows how important it is, how man is dependent upon the sun for light and heat; but the man of science knows that, to a far greater extent than the savage can imagine, man is dependent upon that great central body of our system for almost his whole supply of light and heat. For if we want light at night, what do we do but light a candle, or whatever else it may be? If we want more heat than we get directly from the sun we light a fire; but whence comes that fire? In England we commonly use coal; and whence came this coal? An examination of the products of the coal-fields shows that they are the remains of extinct vegetation; and if we may assume that vegetation went on in past geological ages according to the same laws that we observe at the present day, the supply of the carbon, upon which we are mainly dependent for the heat given out in the combustion of the coal, was derived from the air. But in the air it existed in the state of carbonic acid, to which we reduce it in the process of burning; and it was under the influence of light that, by some process the details of which we cannot explain, the carbonic acid was decomposed and the carbon appropriated. So again as regards our supply of light: if we light a candle we make use of what is derived from the fat of animals; they are unable to decompose carbonic acid, and are dependent on vegetables for their food; so that directly or indirectly we come to the agency of the sun. We see therefore how important the sun is to man. But independently of its great importance, it presents us with features of extreme interest, which are calculated to excite the liveliest curiosity in the man of science.

The question arises, first, Is the sun always in precisely the same condition? For more than two centuries it has been known that there is a change in its appearance which has been observed from time to time. I allude to the dark spots which appear on its surface. Those spots are seen to move over the disk of the sun, not with a uniform angular motion, as if there were some body interposed between us and the sun, and circulating around it, but nearly as if they belonged to a solid globe rotating on its axis. I say nearly, but not quite in the same way, because it is now well established by the labours of the late Mr. Carrington, that if we attempt to determine the time of rotation of that body on the supposition that the spots were stuck to it, we obtain different results according to the place of the spot on the sun's disk. As I have said, taken as a whole the spots move nearly as they would do if they belonged to a solid globe to which they were stuck, and in that way we may determine approximately at least the direction of the sun's axis of revolution, or equator. Now Mr. Carrington found that the spots which are situated a short distance north and south of the equator, taken by themselves alone, would indicate a more rapid period of rotation of this body than those which are situated nearer the poles. (They are never found for some considerable distance round either pole.) Associated with those spots there is another appearance called faculæ, which are ridges of extra brightness on the surface of the sun, and which have an evident relation to the spots. They are ordinarily in the neighbourhood of the spots, and moreover—and this is a point worthy of consideration with reference to any theory as to the formation of the spots—it is found that sometimes faculæ will break out at the surface of the sun where there is no spot, but there is certain to be an outbreak of a spot or spots not long later. Besides this outward appearance, which can be seen with even moderately good telescopes, fine telescopes show that the whole of the surface of the sun has a mottled appearance, consisting of portions, some more, some less, bright. It is dotted over with small specks, having the general character of minute specks of bright light. [Photographs of the sun's surface, including a large-scale one, by Janssen, of a small portion, were here exhibited.]

These dark spots are constantly in a state of change, which goes on from day to day, and the finer mottlings change with very great rapidity indeed, so that M. Janssen found that two consecutive photographs taken quickly one after the other did not show the mottling identical; two photographs taken at the same instant did.

Now what notion can we form as to the nature of these spots? One important matter to know with respect to any speculation about their nature is, whether they are elevations or depressions. Mr. Wilson showed even in the last century, by observations of them as they changed their position on the sun's disk by the sun's rotation, that they were below, and not above, the general surface; and to the telescope they give the idea of a hole in a luminous envelope, through which you look down upon something dark beneath; and so the older astronomers adopted the notion that the sun was surrounded with a luminous envelope which they called a photosphere, and that the body of the sun itself was, not absolutely, it may be, but at any rate comparatively speaking, dark. Indeed, Sir William Herschel went so far as to speculate on the possibility of the sun being a habitable globe. How this great luminosity could possibly be kept up around a vast globe like the sun, generally dark and accordingly at a comparatively low temperature, they did not explain, and in fact you must suppose, on this hypothesis, that the true state of things at the surface of the sun is quite unlike what we have at the surface of the earth. Now we must endeavour to make our theories as to the nature of the phenomena which present themselves rest upon known laws as far as we can. Sir John Herschel, indeed, conjectured that possibly the body of the sun might be defended from the heat of the envelope which, as we know on earth, radiates so fiercely into space, by a perfectly reflective canopy. But where are we to get a perfectly reflective canopy? The only example we know of perfect reflection is that of total internal reflection, where rays of light or heat, as it may be, fall with sufficient obliquity on the surface of separation between a denser and a rarer medium, the rays being in the denser medium.

The nearest approach we know to total reflection, leaving that case out of consideration, is that of polished silver; but polished silver, although it reflects by far the largest quantity of the light falling incident upon it, by no means reflects the whole. If a globe like the sun with an envelope of polished silver were surrounded by an intensely glowing body, the globe would not remain cold, at least if we are to rest upon the experiments which we can make in the laboratory. Yet this idea of a dark solid body remained in the mind of astronomers for a long time. I will read a passage from Sir John Herschel's "Outlines of Astronomy" about what the spots are:—"Many fanciful notions have been broached on this subject, but only one seems to have any degree of physical probability, viz. that they are the dark, or at least comparatively dark, solid body of the sun itself, laid bare to our view by those immense fluctuations in the luminous regions of its atmosphere, to which it appears to be subject." This sentence remained unaltered even in the edition of Sir John Herschel's work published as late as 1858.

It was, I think, in 1854, that Sir William Thomson—whom I am happy to see before me—threw out another speculation as to the nature of the heat of the sun. First I should say, perhaps, what it was not supposed to be. If we abandon the idea of a body remaining cool within an intensely glowing envelope surrounding it on all sides, and suppose that the sun is really exceedingly hot, where are we to suppose the source of that heat to be; in fact, what origin are we to attribute to the source of the heat which we know as a fact to radiate from the sun, wherever it may come from? The most natural supposition would be that of primitive heat. Take the sun, that is to say, existing as it was ages ago; starting from that point, then, you may imagine it to be sending out heat all these ages and gradually cooling itself down. Now there would be one very strong objection to that theory if you supposed that the sun was a solid body. It might be glowing, but unless the conducting power were enormously greater than anything we have reason to suspect from experiments we can make on earth, the surface would very quickly cool down and become comparatively dark. The notion of a solid body must be given up if we suppose that primitive heat is the source. It must be at least liquid, and that liquid must be in a state of constant agitation.

Objections, however, occurred to Sir William Thomson's mind to such a view, and they led him to adopt another, that the heat was due to the impact of meteoric bodies falling into the sun. The surroundings of the sun may be considered to consist of a vast number of meteoric bodies similar to the shooting stars which we see when they come across the earth's atmosphere. An assemblage of such bodies reflecting in a measure the light of the sun may possibly constitute the zodiacal light. Now if these bodies are continually falling into the sun their impact will produce an enormous quantity of heat. I should mention that this idea had been thrown out previously by Waterton, but Sir William Thomson made an important change in it by supposing that instead of being dependent on meteoric bodies casually falling into the sun from the stellar spaces, there is a supply of such bodies circulating round the sun and gradually falling into it. He showed that the heat produced by such impacts would enormously surpass the heat of combustion of the most combustible substances we know on earth. This theory attributes the heat of the sun to something outside itself; what I may call, in contradistinction to that, primitive heat, attributes it to what is inside the sun, to the body itself. According to the meteoric theory the seat of the most intense action is at the surface of the sun itself. The old theory of a comparatively cool nucleus is here given up, and the sun is allowed to be a glowing body, molten, doubtless; but still the most intense action is supposed to take place on the surface of the sun. With regard to the spots I think the idea of Sir William Thomson at that time was that there were great whirlwinds at the surface of the sun from time to time which blew away these meteors, and consequently caused, where they existed, a less intense succession of impacts, and consequently less heat, and that a portion became comparatively dark. I just mention this historically. I will not at present say anything about the very important information which the spectroscope gives us respecting the sun, but will reserve that to a later period.

A different theory was thrown out by M. Faye in 1865. According to this the interior of the sun is intensely hot, and for that very reason, as M. Faye supposed, comparatively speaking non-luminous. He conceived, in fact, that the interior was so hot that bodies were there in a state of dissociation; and as we know that many a glowing gas gives out plenty of heat, but comparatively little light, so it was supposed that the interior of the sun, by virtue of its intense heat, radiated only comparatively little light, and that it was not until the substances of which the sun was composed came to the outside that they became cool enough to enter into chemical combinations, and to supply us with substances which were capable of emitting an abundance of light. Now here there is one feature in common with the old views, namely, that the source of the light is supposed to be a photosphere surrounding a solid body which is, comparatively speaking, dark; but the reason why this body is supposed to be dark is precisely the reverse of that which was supposed in the older views. In the older views the body of the sun was supposed to be comparatively cool: here it is supposed to be so intensely hot that the substances of which it is composed have not yet got into a state in which they can emit much light. According to this theory the spots are places where the photosphere is, so to speak, blown away, and you see down into the intensely hot body of the sun, which is comparatively feebly emissive of light. This view seemed to receive some support from a remarkable discovery made by Mr. Huggins in 1858 with reference to the constitution of the planetary nebulæ. On applying the spectroscope to these planetary nebulæ he made a remarkable discovery, that the spectrum which they emit consists exclusively of bright lines, such as the spectrum we know to be produced by an incandescent gas. Many of these nebulæ have a somewhat stellar nucleus, which seems to exhibit a spectrum of a more ordinary character. Now at first sight this condition of things appeared to be just what the theory of M. Fay required, and to give an explanation of the phenomena according to that view. These planetary nebulæ give out a feeble light compared with the stars; and so, when seen through an aperture in the photosphere, we may suppose that the interior gaseous portions of the sun are too hot to glow with more than this feeble light.

Now that supposition is in contradiction to a very important extension of Prevost's theory of exchanges which was made independently by Prof. Balfour Stewart—who is here present, I am happy to see—and by Prof. Kirchhoff. According to Prevost, if you have a body contained within a heated envelope, and everything has come to its final state, and this envelope is opaque, then all the bodies within it will be of the same temperature. They will receive as much heat from the walls of the envelope as they give out by radiation, and there will be a perfect balance between the radiation and the absorption. If one of those bodies is comparatively transparent, letting through a good part of the heat which it receives from the envelope, it will give out itself comparatively little heat, otherwise it would gradually become cooler. Now the extension I have mentioned is that this is true not merely of the sum total of the heat given out or absorbed, but of each particular kind of heat or light of which that total consists; so that if we take light or heat of any degree of refrangibility, there is a balance between what is absorbed and what is given out.

Now this extension of Prevost's theory militates against M. Faye's theory of the constitution of the sun as regards the constitution of the spots. For, take the interior of the sun. If we take light of any particular degree of refrangibility, the body, that is, this supposed gas which constitutes the bulk of the sun, will be either opaque as regards that kind of light, or transparent, or partially transparent. If it is opaque it is certain to emit light of the same refrangibility. If it is transparent, then the spot would not be dark, because, as regards any kind of light for which this interior gas was wholly transparent, we ought to see the opposite side of the photosphere shining through; just as in the planetary nebulæ we do see what we have every reason to suppose to be a nucleus of the nebula shining right through its enormous semi-diameter. The stars subtend no appreciable angle, but the planetary nebulæ subtend a very appreciable angle, which can be measured, and in all probability, judging by the distance of the planetary nebulæ from us, their dimensions are gigantic as compared with the average size of the stars, and as compared in all probability with our own sun. Therefore there ought to be seen in the sun, on that supposition, the same phenomenon as *is* seen in these planetary nebulæ, namely, the photosphere on the far side shining across the gaseous globe. It seems to me that that consideration is fatal to the acceptance of M. Faye's theory as a whole, and that we must have recourse to some other.

Now I have mentioned already Sir William Thomson's meteoric theory, in which is involved the very important consideration of the conversion of work into heat. I do not mean at all, in stating some possible objections to that theory (which he has himself since given up), to go against the supposition that the original source of the sun's heat may have been the conversion of work into heat, but starting with the sun as it was some ages ago, has the subsequent heat been derived from itself, or from the outside? According to the theory of M. Faye, the heat would be derived from the sun itself, which would be spending its heat gradually. So far (giving my own view as to what is probable) it seems to me that the probabilities are in favour of that part of the theory. Well then, if the spots are not due to the dark body of the sun being exposed by something being removed from the outside, be it that the body is dark from a deficiency of heat or from an excess of heat, what may we suppose them to be? In a paper published in the *Philosophical Transactions* by Messrs. De la Rue, Stewart, and Löwy, the authors have advocated the view that the spots are due, not to an uprising from the centre of the sun, but to a down-pour of cooler portions of the matter which has been ejected from the sun. But here I think I cannot go on without going back to some researches in which the spectroscope plays a most important part. It is to Prof. Kirchhoff that we owe the first extensive application of the spectroscope to the study of the sun. He held that since bodies in the state of incandescent gas give out bright lines in their spectrum, according to the extension which he made, independently of Prof. Balfour Stewart, of Prevost's theory of exchanges, these glowing gases ought to absorb light of the same refrangibility coming from a body behind. Now if you had a glowing gas in front of an opaque body glowing at the same temperature, you ought to see neither dark nor bright lines, for the gas would absorb the light of the refrangibilities which itself gives out, and it would not absorb the light of the refrangibilities which it does not give out, so that in the region of the bright lines we should, even if the body behind were away, get the full amount of light due to the temperature, coming from the glowing gas itself; in other regions where there is no such bright light coming from the gas, you get the full amount of light coming from the opaque body behind. But if you suppose this gas in front, glowing though it be, to be at a lower temperature than the opaque body behind, then it would absorb more light of the kind which it gives out coming from the body behind than it gives out to replace it by virtue of its own emission, and accordingly we should see the place of those bright lines, or what would be bright lines if the gas were there alone, dark on a bright ground. By following out that theory he was enabled to identify a great number of the dark lines in the solar spectrum with the bright lines given out by elements which we know at the surface of the earth, such as iron, magnesium, and so forth. Now this throws a most important light on the constitution of the sun. It indicates that even in the outer, and, comparatively, therefore cooler portion of the sun, there must still be a temperature so enormous as to be above the boiling-point of iron, and above the boiling-point of some of the most refractory metals. And now I will refer to a later application of the spectroscope which was made by a gentleman whom I see before me. First I should say that in the year 1842, in observing a total solar eclipse, a new phenomenon was witnessed, or at least a phenomenon which, if not new, had not previously attracted general attention. The dark body of the moon was seen to be surrounded by rose-coloured prominences having the appearance of mountains. What were these? What could possibly be their nature? We had but a small time to observe them; the greatest duration of a total eclipse of the sun is a little over four minutes, and these eclipses occur only once perhaps in two years or so, and when they occur the totality extends over a strip along the earth's surface of only inconsiderable breadth, with probably a great portion of it falling on the ocean, so that if we were there present in a ship we could hardly make any observations but what could be taken by the naked eye. The study of these prominences and the nature of them must have been therefore a slow matter to get on with, so long as we were limited to the observation of them during the period of a total eclipse. The change of height of those prominences shows that they belong not to the moon, but to the sun. Of course, as the moon moved over the body of the sun they would, if they belonged to the sun, tend to get shorter and shorter as they were covered in, and would reveal themselves gradually in the same way behind the opposite side, which is just what happened. In 1860 special provision was made for the observation of these prominences, and Mr De La Rue undertook to make a series of photographs, which led to some most important results. They showed, among other things, that in some cases the prominences, whatever they were, were not at all attached to the body of the sun, but were suspended as clouds around it. They could not, therefore, be mountains clearly. Mr. Lockyer, for some considerable time prior to 1868, had been devising in his mind a possible mode of rendering those prominences visible, and studying their nature without waiting for or being dependent upon the rare phenomenon of a total eclipse. If the light which those prominences gave out consisted of bright lines, then, by applying a spectroscope of high power to the study of those bodies, we might so far reduce the intensity of the intervening portions of the spectrum where there is the diffused light coming from the immediate neighbourhood of the sun's disk as to render them visible. At last he was rewarded by success, and the announcement of this discovery was made to the Royal Society. Meanwhile M. Janssen had gone out to India to observe a total eclipse, and the special subject which he took up was to observe the spectrum of those prominences, which he did with success. The idea struck him, "Why should not this be done any day?" He tried, and the next day he succeeded. In point of absolute time this was before the observation of Lockyer, although at the time no account of it had reached this country, so that the two observations were perfectly independent of each other. Well, subsequent improvements in the method of observing those prominences have enabled us to see them at will, so that they may be observed from day to day, when we choose, from hour to hour, from minute to minute. The forms of them can be seen, and it is found that they move with astounding velocity. They are projected upwards from the sun with a velocity sometimes of 100 or even of 140 miles per second. Their forms were such as we might naturally attribute to the ejection of gas from the body of the sun. It had been conjectured that they might be of the nature of auroral discharges. Their features however indicate that they are projections of actual matter from the sun, and moreover the nature of their motion indicates the same. This gives us, then, a new idea of the vastness of the changes which are continually going on at the surface of the sun.

Now what is the origin of these changes? It seems to me that the most reasonable idea that we can form respecting them is something derived from what takes place in our own earth, and what we can observe here. Suppose the sun to be shining, we will say on a summer's day. If we look horizontally with a telescope everything is seen to be in a state of tremor; the air is far from homogeneous. What is the reason of that? The greater part of the sun's heat passes through the upper strata of the atmosphere and reaches us, the air being transparent with regard to a large portion of the sun's heat. It warms the surface of the earth. That in turn warms the air in contact with it, and further radiates forth heat of a kind for which the air is opaque. The consequence is that the lower portions of the air in contact with the earth get warmer, and that unequally according to the nature of the ground—more on stones and gravel, for instance, and less on grass and so forth. Being warmer they get lighter, and therefore there is a constant ascent, a constant mixing of the hot and cold portions by currents of convection. As this goes on continually a stratum of air of considerable height becomes warmed in this manner, and sometimes an exchange by convection or something of the nature of convection takes place on a very grand scale. Let us take the case of summer weather. Suppose we have a succession of hot days accompanied by a good deal of evaporation, gradually these several currents of convection cause a warming of a stratum of air below of considerable height, which is also well supplied with moisture from the evaporation. At last, taking the stratum as a whole, the equilibrium becomes unstable, and there is an uprush; hence there is a kind of chimney formed, through which the air flows upwards, and then spreads out laterally overhead. This appears to be what takes place in our summer thunderstorms. The heated and moist air forms for itself a chimney, and in ascending there is a rapid deposition of what was previously vapour of water in the now condensed state of water itself, and a rapid fall of rain occurs after a time. This appears from some cause or other to be the occasion of the development of a great deal of electricity, which is manifested in the form of lightning. While this action goes on you have the in-draught towards what I will call the chimney from all sides; the vapour sooner or later gets condensed, and there is a fall of rain accompanied by lightning. Sometimes there is hail even in summer; for when the air charged with vapour gets to a particular height the vapour becomes condensed and forms rain; but it may be that the stratum of the upper air that is pierced through is below the freezing-point, and, the rain falling through this, it gets frozen. I will just call attention to one fact; according to this view, you see you may have a general current of wind over the country—say, for the sake of illustration, from west to east. Suppose there is a region to the west where an ascending current has been formed; then there is an in-draught from all sides to that place, and when the thunderstorm has not yet come on you are in a comparative calm, because the general direction of the wind being from the west, and the in-draught carrying the air from the east, the two together tend to neutralise one another; or you may have actually a wind blowing towards the region of the thunderstorm. Accordingly we know people often say that thunderclouds move against the wind. I shall have occasion to refer in my next lecture to the development of atmospheric electricity in reference to some speculations in regard to phenomena accompanying changes in the condition of the sun; but at present I merely refer to this process as illustrative of what seems to be the most natural supposition to make regarding the origin of these disturbances which are found to be continually taking place at the surface of the sun. The outer portions of the sun are the source of a gigantic amount of radiation of heat and light which passes out in all directions. By this radiation those outer portions must tend to a certain extent to cool down, and consequently, as the same physical conditions hold good, if the same physical laws hold good, at the surface of the sun that we have on our own earth, you may easily suppose that, having become cooler than they were, the substances become specifically heavier, and accordingly give rise to currents of convection similar to those that we have in our own atmosphere from a similar cause, but operating in one respect in a different way, because in the solar atmosphere there is a cooling from above, but in that of the earth a heating from below. Those minor currents of convection ascending and descending naturally enough give rise to that mottled appearance which is always seen on the sun's surface, because if the interior of the sun be hotter than the portions which have cooled by radiation, then the ascending portions would naturally, being at a higher temperature, be brighter, the descending portions darker, and small (comparatively speaking) descending currents may very likely, as it appears to me, be the cause of these appearances. Now just as at the surface of the earth these minor currents of convection are continually going on, and mixing up the heated portions below with less heated portions above, till at last a great catastrophe takes place, and we have a thunderstorm or even a cyclone; so the same thing may take place at the surface of the sun, and minor currents of convection may gradually cause a cooling of a greater stratum, and at last the equilibrium becomes unstable, and a great change takes place between the superficial portions and those which lie beneath, and we have the manifestations of faculæ and spots. According to this view the faculæ would consist of the heated portions on a larger scale coming from the interior, and the spots of a subsequent down-rush on a large scale of the portions which had been erupted and had cooled by radiation. Kirchhoff supposed that the spots were due, not to depressions of the sun, but to clouds of comparatively cool gases or vapours rising above the general surface. This was in contradiction to the relative altitudes of the sun-spots and the general surface as made out originally by Wilson, and subsequently confirmed by the observations of others; and moreover there are some other difficulties connected with it. Let us suppose that there is an eruption of hydrogen which has got cool, then if that exists and there is a cold draught at some distance above the sun, we cannot say it would absorb any longer the rays which it is capable of absorbing when glowing, because the correspondence of emission and absorption only necessarily holds good on condition that the substance is at a given temperature. If the temperature changes it is possible, and in many cases we know it is a fact, that the mode of absorption may change with it. We know that the cold hydrogen is transparent; we know, theoretically at any rate, that glowing hydrogen must be opaque with regard to light of the particular refrangibility which it emits; hence a cool mass of gas might cease to be opaque even by virtue of its being cooled. Again, if we had a cloud of, say, vapour of iron, and if this were condensed into actual drops or globules of molten iron in the upper portion of the atmosphere, they would form such a very rare sort of mist as would be something like a very rare haze which barely obscures the sun, and would not give rise to more than a slight general darkening. But if the gases in descending got warmed again, they would then be in a condition to absorb light specifically; but being at a lower temperature than the sun they would not give out nearly so much light as they absorb.

That seems to me to be the most natural explanation of the spots and of the phenomena attending them. I may have something more to say about this on a future occasion; but, as I see the time is going on, it would probably be more agreeable to you that I should postpone anything further I have to say to you upon this subject until my next lecture, in the course of which I hope, as I have said, to point out a speculation as to the connection which exists between sun-spots and certain phenomena which we know exist at the surface of the earth. There are probabilities to my mind in favour of it, but I will, with your permission, defer allusion to it to my next lecture.

(*To be continued.*)

THE HELVETIC SOCIETY OF NATURAL SCIENCES

THIS Society held its sixty-fourth annual session at Aarau on August 8, 9, and 10, under presidency of Prof. Mühlberg, whose opening discourse treated of recent progress in physiology and chemistry. An account of the proceedings (of which we here offer a brief *résumé*) will be found in the *Archives des Sciences*.

In the Section of Physics and Chemistry Prof. Forel read a valuable paper on the periodic variations of glaciers. These periods of advance and retreat are proved to embrace several years (five to twenty and more); they are due in the first instance mainly to variation in velocity of the glacier, and this to small variations in the thickness of the *névé* repeated in the same sense for several years, the consequent variation of velocity becoming much more pronounced as the glacier descends, and the ultimate effect being separated by many years from its original cause. The varying heat of summer appears to be of quite secondary importance. In one of three papers, communicated by M. Raoul Pictet, he described his new method of distillation and rectification of spirits by a rational use of low temperatures. The two processes are performed at once; and with considerable economy a purer product is obtained. Another paper explained the principle of his rapid steamer, now being made, and the working of which will be watched with interest. The third treated of the different qualities of steel as regards magnetisation and permanence of magnetic power. (To this and the preceding, reference has been already made in our columns.)

M. Krippendorff exhibited a model of a balloon, to be propelled in light winds by escape of compressed air at the end of a wooden axis rendered horizontal or inclined according to the direction aimed at (by shifting the suspension of the car). The air would be compressed by four men into a small copper receiver at the other end of the axis; and a second reservoir holding liquid carbonic acid would be at hand in case of need. In a micro-telephone described by Prof. Amsler-Laffon, the flame of a manometric capsule (like those of König) is inserted in a telephone circuit; its conductivity being increased with vapours of potassium. Its change in form and size through vibrations of a thin plate of steel under sound, entails changes in electric resistance, and the telephone is affected accordingly. The apparatus is said to be very sensitive. Some useful hints on representation by projection of longitudinal and transversal vibrations are given in a paper by Dr. R. Weber. MM. Soret and Sarasin indicated a new method of determining the angle of rotation of quartz, and showed, in a curve, how the rotatory power varies with the wave length.

An interesting observation is reported by Prof. Dufour, who finds in deformation of images produced on large surfaces of calm water, a new proof of the roundness of the earth. This may often be witnessed on the Lake of Geneva, *e.g.* the reflected steeple of Montreux, seen from Morges; and in the case of ships some kilometres distant at sea. Prof. Forel, from a study of the recent earthquakes in the Cantons of Vaud and Neuchâtel, finds analogies to the phenomena of a vibrating plate in Chladni's experiments; the intensity and direction of a shock, *e.g.* being very different in places quite near each other. Guided by theoretical considerations, M. Chappuis has measured the liberation of heat through condensation when water is introduced suddenly into an evacuated tube filled with charcoal in temperature equilibrium with the water, and from the data, and the compressibility of water he infers the adherent water to be under a pressure of at least 36 million atmospheres. Among other subjects discussed were the measurement of radiant heat with the differential thermometer (Dufour), the determination of tartar and tartaric acid in wines of commerce (Piccard), and the action of bromine on a mixture of water and sulphide of carbon (Ureck).

In Zoology M. Fatio gave some account of his continued researches on disinfection with sulphurous acid. The vapours act in two ways on all organisms which depend on oxygen for life, viz. asphyxiating them by suppression of that element, and gradually burning them interiorly, the acid being dissolved in their humours or aqueous parts; the doses and times of application are varied accordingly. The more aqueous in substance an animal or plant is, the more quickly is it affected. The dose and time of application, in different receivers, will also be varied according to the temperature affecting diffusion of gas and the hygrometric state of the air and enveloping material. M. Fatio operated successfully on vibrions and bacteria in infusions submitted to an atmosphere mixed with sulphurous acid (the depth of the liquid here determines the time of exposure), and the range of application is evidently wide. M. Vogt gave some interesting facts showing the extensive adaptation of colours in animals of the Saharan Desert to that of the ground. With regard to the exceptional colour of nearly all Coleoptera, viz. black, he considers they find protection in their bad smell, and also their strong resemblance, when contracted and feigning death, to excrement of gazelles, goats, and sheep. The animals brought to the surface by water of Artesian wells in that region M. Vogt finds to be quite without the characters of animals living in caverns and subterranean water; their eyes are well developed, and their colours pronounced. They are indeed proved to live but temporarily underground. With albuminised paper Prof. Forel fixed 40 metres as the limit of penetration of chemical rays into water, but Dr. Aspen has, by a different method, got a photographic effect in the Lake of Zurich as far down as 90 metres. The researches of Dr. Yung on the influence of food on frog development have been formerly noticed; and of the remaining subjects we merely note the sense of colour in Cephalopoda (Keller), a peculiar mode of copulation in dendrocœle marine worms (Lang), and the conditions of production of rhythmical contractions in the wing membranes of bats (Luchsinger).

In the Botanical Section M. Buser read a paper on Swiss willows, and Prof. Schnetzler gave some observations on the vegetation of *Lathræa squamaria* on tree-roots.

To the Section of Geology M. Jaccard submitted a project of maps of the "erratic phenomenon" in Switzerland, on the plan of those constructed by MM. Falsan and Chantre for the Rhone Valley. Dr. Rothpletz discussed the *rôle* of faults in the geology of the Alps, showing that these are by no means exceptional, and deserve more study than they have hitherto had. Dr. de la Harpe presented a collection of Egyptian nummulites. Dr. Gillieron had a paper on the age of the red schists of the Simmenthal. Prof. Mayer-Ermann furnished proof that the Loire must have flowed into the Parisian Gulf of the North Sea during the whole Eocene period, and that it was only at the end of the Inferior Neogene or Aquitanian epoch that it made the bend at Orleans and entered the Atlantic. The Pleistocene of Central Europe formed the subject of an instructive paper read by Dr. Rothpletz at the first general meeting.

In Medicine a paper was read by Dr. Bircher on the extension of deaf-mutism in Switzerland, and its relations with goître and cretinism. He finds that these three are merely different manifestations of one and the same principle of degeneracy of race, a principle which, in Switzerland, is endemic in the Triassic, Marine Molassic, and Eocene formations.

THE ARCHÆOLOGICAL CONGRESS AT TIFLIS

THE proceedings of this Congress, recently held at Tiflis, were both interesting and animated. No less than 700 members arrived at Tiflis from various parts of the Caucasus, and fifty-five from various parts of Russia. The foreign members were few—Prof. Virchow, who took advantage of his stay in the Caucasus to make an excursion to Ossetia, and Messrs. Aeger and Hubsch from Vienna. The Congress was opened by Count Ouvaroff in one of the halls of the palace, before an audience of about 800 persons. The President of the Congress, M. Komaroff, pointed out that the Congress had met with much sympathy from all interested in the study of the Caucasus, as well as much help from the teachers of primary and secondary schools, who had sent in many interesting objects for the exhibition. We notice among the objects exhibited a most interesting collection of bronze antiquities from Ossetia, Bosphorian antiquities from a *kourgan* of the province of Kouban, stone implements from Tzalka, Georgian ornaments and stone implements from the provinces of Novgorod and Tver. Ossetia has been known for many years for a great find of interesting bronze implements, of figures of animals, curved hatchets with spirals and zig-zag ornaments and with figures of animals, as well as religious objects belonging to some unknown worship; the collection, which was bought some time ago by M. Chantre, is very complete, and will soon be described by him. The new collections from a *kourgan* at the Sievers Station consist of massive gold, and represent subjects of Greek mythology. On the same day the excellent Caucasian museum which was founded several years ago, but was closed for two years for unknown reasons, was re-opened.

Count Ouvaroff made an interesting communication on the remains of the Stone period which were found near Irkutsk, on the bank of the Angara River, at Talminskoy village. Many human skeletons, with stone and bone implements, and perforated teeth of animals, were found there, together with hatchets of jade (nephrite), which numbered as many as two hundred. This is the first find of jade implements in graves in Russia. This communication gave rise to an interesting discussion, during which M. Moushketoff, the well-known traveller in Turkestan, spoke of the great monolith of nephrite at Samarcand, on the grave of Tamerlane. It has the shape of a parallelopiped, 7·8 feet long, 1·5 foot wide, and 1·2 foot high, and weighs about 1800 pounds, whilst the greatest pieces of nephrite which are found in boulders do not weigh more than 700 or 750 pounds. It is well polished, but is broken through its centre. The rock resembles very much that of Khotan. As to the places where nephrite is found *in situ*, our knowledge is still very limited. Messrs. Shaw and Hermann Schlagintwert have seen nephrite mines in the Kwen-Lun, close by Balaktchi, at a height of 12,000 feet; according to Dr. Stoliczka it appears there as veins in chlorite-slates and quartzites. Two other places where nephrite is found are known north of the Kwen-Lun Mountains, close by the Kilian Pass, at a height of 6070 feet, and near Kamat village on the highway to Khotan, at a height of 5790 feet; a fourth is presumed to be at the sources of the Yourson-tush, or Khotan River. But the nephrite implements which we found in graves were mostly made from boulders of this rock, which are often found in Eastern Siberia on the shores of Lake Baikal, and on the Boutogol Mountain in the Sayan Highlands; however, we do not know that nephrite was found *in situ* in these latitudes. All implements which are in the St. Petersburg museums were made of nephrite from Eastern Siberia, whilst the Kwen-Lun jade is used only in recent Chinese products.

Prof. Samokvasoff made a communication on his finds in the graves on the Caucasus, in the neighbourhood of Pyatigorsk. He excavated about 200 graves belonging to the Stone, Bronze, and Iron periods. In the larger graves he found bronze implements together with stone ones, and as there are in these graves, together with bones of sheep, several split human bones which do not belong to skeletons, he supposes that during the Bronze period the inhabitants of this part of the Caucasus were Anthropophagists. This opinion, however, was not concurred in by the majority of members of the Congress.

The chief work of the Congress was in the branches of History and Antiquities; but we notice also a special sitting for communications in French and German, during which several papers were read connected with the natural sciences. Thus Dr. Obst, Director of the Leipzig Ethnographical Museum, read a paper upon the results of the statistical researches on the colour of hair and eyes in Saxony, and M. Smirnoff gave the results of the same inquiries with the Armenians and Georgians of Transcaucasia, as well as with the Russian population of the provinces of Kouban and Stavropol. Out of 2500 Armenian children there were 63 per cent. of dark, 4 per cent. of fair, and 33 per cent. of mixed (fair hair with dark eyes, or *vice versâ*). Of 1400 Russian children there were only 14·5 per cent. of dark, and it is deserving of notice that M. Smirnoff could not discover any difference between Great Russians and Little Russians, the number of fair children being 33·3 per cent. in the former, and 32·0 in the latter, whilst the mixed make respectively 52·2 and 53·5 per cent. As to Georgians and Imers, the observations are not sufficiently wide, but it may be stated that purely dark children are less numerous (50 to 55 per cent.) than with Armenians.

Prof. Virchow gave a long and interesting lecture on the chief problems of the Ethnology and Archæology of the Caucasus, accompanied with some remarks on the civilisation of its former inhabitants. Speaking on the usually-received opinion that the Caucasus was the highway for populations coming from Asia to Europe, Prof. Virchow expressed some doubts as to the crossing of the Caucasian passes by whole tribes at a time when the communications were so difficult and the ice-covering descended lower than now. It would be most important, therefore, to know if the first inhabitants of the Caucasus came from the north or from the south. Speaking further of the Ossetians, Prof. Virchow was astonished not to find among the adult population a single true fair type, which might seem contradictory of former opinions; only among children did he find fair-haired individuals with rosy Flemish cheeks. On the other hand, some measurements have brought him to the conclusion that the Ossetian skull is short and high, very different from the German type of skulls. Dolichocephalic skulls are very rare, and show that the tribes of the Caucasus have undergone much mixture with other people. As to the antiquities found in Ossetia, Prof. Virchow considers that the civilisation they speak of was far more recent than that discovered by Dr. Schliemann at Troy, as it does not contain stone implements, but has, on the contrary, curved fibulæ which were unknown at Hissarlik. The ornaments of the Ossetian bronze-implements, and especially the figures of stags, horses, and mountain-sheep, seem to show a connection between the former inhabitants of the Caucasus with those of the Altai Mountains.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The following are the courses of instruction in natural science to be given this term at Oxford:—Prof. Odling lectures on the atomic theory, Mr. Watts on organic, Mr. Fisher on inorganic chemistry, and Mr. F. D. Brown on physical chemistry. The Linacre Professorship of Physiology, vacant by the death of Prof. Rolleston, will not be filled up in time for the new professor to undertake this term's lectures. Mr. Hatchett Jackson will give the professorial lectures, taking the nervous system for his subject; Mr. Thomas will lecture on comparative anatomy; and Mr. Robertson will form a class for practical microscopy. Prof. Pritchard will give a course of lectures on the theory of the transit instrument and on the planetary theory, and will form an elementary class three evenings a week at the University Observatory. Prof. Lawson lectures on vegetable histology at the Botanic Garden; Prof. Maskelyne on crystallography; and Prof. Prestwich on the principles of geology at the Museum. Prof. Westwood gives informal instruction on the Arthropoda every afternoon.

At Christ Church Mr. Vernon Harcourt gives a course of lectures on the metallic elements, and Mr. Barclay Thompson a course on the Lemuridæ and Simiadæ. At Magdalen Mr. Yule continues his demonstrations on the chemistry of the tissues and secretions. At Balliol Mr. Dixon forms a class for the determination of the composition and vapour-density of organic substances. At Exeter Mr. Morgan lectures on histology.

At Trinity College the Millard Scholarship in Natural Science has been awarded to Mr. A. E. Field from the Modern School, Bedford.

SCIENTIFIC SERIALS

The American Journal of Science, September.—Benjamin Peirce.—Emerald green spodumene from Alexander County, North Carolina, by E. S. Dana.—Objects and interpretation of soil analyses, by G. W. Hilgard.—Mineralogical notes, by B. Silliman.—Liquefaction and cold produced by the mutual reaction of solid substances, by E. M. Walton.—Spectrum of arsenic, by O. W. Hartington.

Journal of the Franklin Institute, September.—On the effect of prolonged stress on the strength and elasticity of pine timber, by Prof. Thurston.—Relative economic efficiency of Corliss condensing and non-condensing engines, &c., by Chief-Engineer Isherwood.—Discussions on rails (continued).—Burnishing and ductilising steel, by Mr. Reese.—Industrial education from a business standpoint, by Mr. Clark.

Annalen der Physik und Chemie, No. 9.—On the relation of friction-constants of mercury on temperature, by S. Kock.—On the internal friction of solutions of some chromates, by K. F. Slotte.—Some experiments on heat-conduction, by C. Christiansen.—On the vapour-tensions of liquid-mixtures, by D. Konowalow.—On an electro-dynamic balance, by H. Helmholtz.—On the change of the thermo-electric position of iron and steel by magnetisation, by V. Strouhal and C. Barus.—The cycle obtained through the reaction current of electrolytic transference, and through evaporation and condensation.—On the electromagnetic rotation of the plane of polarisation of radiant heat in solid and liquid substances, by L. Grunmach.—The height of the earth's atmosphere, by A. Kerber.—On the courses of a free particle on the rotating earth-surface, and their significance for meteorology, by A. Sprung.—On the ether as a means of action at a distance, by G. Helm.—Remark on the paper on a new volumenometer, by A. Paalzow.

Journal de Physique, September.—The principle of conservation of electricity, or second principle of the theory of electric phenomena, by G. Lippmann.—Researches on the refringent power of liquids, by B. C. Damien.—The devioscope, or apparatus showing directly the ratio between the angular velocity of the earth and that of any horizon round the vertical of a place, by G. Sire.—Processes for making figures for demonstrations with the aid of projections, by M. François-Franck.—Notes from the *Journal* of the Russian Physico-chemical Society.

Archives des Sciences physiques et naturelles, August 15.—Comparative study of different qualities of steel as regards magnetisation and permanence of their magnetic power, by M. Pictet.—Some theorems of thermodynamics and their application to the theory of aqueous vapour, by G. Cellerier.—On Comet *b* of 1881, by MM. Thury and Meyer.—On the comet of August, 1881, by M. Meyer.

Bulletin de l'Académie Royale des Sciences de Belgique, No. 7.—On bicarbonate of ammonia, by M. Melsens.—Some experiments on thin liquid films, by M. Plateau.—Effects of lightning on trees placed near a telegraph wire, by M. Montigny.—Analysis of the light of Comet *b*, 1881, by M. Fiévez.—On the theory of binary forms with several series of variables, by M. Le Paige.

Rivista Scientifico-Industriale, August 15.—On the causes of earthquakes, by Dr. Lucchetti.—The Pliocene fossils of Sambenedetto del Tronto, by Prof. Spada.

September 1.—Measurement of velocity on railways, by A. Milesi.—Automatic apparatus for coiling metallic wires (with silk or cotton), by G. Serravalle.

Verhandlungen des naturhistorischen Vereins der preussischen Rheinlande und Westfalens, 1880, Second half.—Wandering tones, by H. Reauleaux.—Geognostic results of earth-boring near the infantry barracks in Osnabruck, by W. Treckner.—On the application of the electro-dynamic potential to the determination of ponderomotive and electromotive forces, by R. Clausius.—Description of the spiders hitherto observed at Bonn, by P. Bertkau.

1881.—First half.—The quartzite and slate on the eastern border of the Rhine slate hills and their neighbourhood, by C. Chelins.—On the distribution of animals in the Rhöngebirge and the Main valley with reference to Eifel and the Rheinthal, by F. Leydig.—Contributions to the insect-fauna of the coal-formation of Saarbrücken, by F. Goldenberg.

Memorie della Società degli Spettroscopisti Italiani, July.—Protuberances observed at Rome during the first quarter of 1881, by P. Tacchini.—Two solar regions in constant activity during 1880, by the same.—On the distribution of spots, faculæ, and protuberances on the sun's surface during 1880, by the same.—On direct and spectroscopic solar observations made at Rome in the first quarter of 1881, by the same.

SOCIETIES AND ACADEMIES

VIENNA

Imperial Academy of Sciences, October 6.—V. Burg in the chair.—The following papers were read:—T. Singer, on secondary degeneration in the spinal marrow of dog.—R. Pribram and Al. Handl, on the specific viscosity of liquids and its relation to the chemical constitution.—James Moser (Cambridge), on the microphonic action of selenium-cells.—V. Dvorak, on some acoustic phenomena of motion, especially on the acoustic radiometer.—Boh. Brauner, contributions to the chemistry of cerium metals.—E. Goldstein, on the band-spectrum of air.—T. Schlesinger, a sealed packet relating to the unity of natural philosophy.

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