THURSDAY, APRIL 18, 1878

THE COMING TOTAL SOLAR ECLIPSE

THERE is no doubt whatever that the eclipse which will sweep over the United States next July will be observed as no eclipse has ever been observed before. The wealth of men, the wealth of instruments, and the wealth of skill in all matters astronomical, already accumulated there, makes us Old Country people almost gasp when we try to picture to ourselves what the golden age will be like there, when already they are so far ahead of us in so many particulars.

Draper, Hall, Harkness, Holden, Langley, Newcomb, Peters, Peirce, Pickering, Rutherfurd, Trouvelot, and last, but not least, Young, are the names that at once run easily off the pen to form a skeleton list, capable of considerable expansion with a little thought, when one thinks of the men who will be there. One knows too that all the enthusiasm of devoted students and all the appliances of modern science—appliances in the creation of which many of those named have borne so noble a part—will not be lacking. So that we may be sure that not only all old methods but all possible new ones will be tried to make this year one destined to be memorable in the annals of science side by side with 1706, 1851, 1860, and other later years.

Thank Heaven, too, there is no necessity that the thankless task of organising an "Eclipse Expedition" from this country should fall on any unfortunate individual, among other reasons because—and this is a very hopeful sign of increasing general interest taken in scientific work—Messrs. Ismay, Imray and Co., the owners of the White Star Line, have expressed in the warmest manner their desire to aid English observers by a considerable reduction of fares, and the directors of the Pennsylvanian Railway Company, as the readers of NATURE have already been made aware, have done the like in the case of observers coming from Europe in their individual capacity.[1]

The progress in that branch of knowledge which requires the aid of eclipse observations has been so rapid during the last few years that the eclipse of 1868, though it happened only ten years ago, seems to be as far removed from the present as the Middle Ages are in regard to many other branches of culture. The work done by the spectroscope since that year, when in the hands of Janssen, Pogson, Herschel, and others, it added so enormously to our knowledge, has gradually covered larger and larger ground, and each successive eclipse in 1869, 1870, 1871 and 1875, has seen some variations in its use, so that its employment has proved the most novel, if not the most powerful, side of the attack.

Young's work of 1869 will no doubt form the key-note of much that will be done this year so far as the coronal atmosphere is concerned. It will be remembered that Young in 1869 observed a continuous spectrum, while Janssen in 1871 observed a non-continuous one, for he recorded the presence of the more prominent Fraunhofer lines, notably D. This positive observation from so distinguished an observer demands attention, not only on its own account, but because of the question which hangs upon it, which is this: Does the corona reflect solar light to us or does it not, and if it does, *where* are those particles which thus act as reflectors? On this point the photographs taken in Siam in 1875 are silent, as the method employed was not intended to discriminate between a continuous and a discontinuous spectrum.

But although this point remains, how greatly has the ground been cleared since 1869. That wonderful line, "1474," is more familiar to us now! and yet there has been almost a chapter of accidents about it. In the first place, with regard to this line above all others, there appears to be a mistake in Angström's map; the solar line at 1474 is not due to iron at all; with the most powerful arc there is no iron line to be seen there. Then Secchi attributed it to hydrogen, though I am not aware on what evidence. But whatever be its origin, the fact remains that we now know by its means that the solar hydrogen is traversed and enwrapped by the substance which gives rise to the line to an enormous height, so that it forms the highest portion of the atmosphere which is hot enough to render its presence manifest to us by spectral lines. Here, so far as I know, only one point of difference remains. In 1871 I most distinctly saw the line trumpet-shaped, that is, with the base broadening as the spectrum of the photosphere was reached, while Janssen saw it stopping short of the spectrum of the photosphere. The importance of this point is that supposing one of us to be mistaken and one or other observation to represent a *constant* condition, then, if the line broadens downwards till the sun is reached we are dealing with a gas lighter than hydrogen, capable of existing at a high temperature, which thins out as the other gases and vapours do in consequence of its vapour density being below that of hydrogen; or, on the other hand, if the line stops short as a constant condition, it represents a substance which is probably dissociated at the lower levels, and is therefore probably a compound gas; and then the question arises whether it has not hydrogen as one of its constituents.

Perhaps I may conveniently refer to a paper of mine which was read at the Royal Society last Thursday in this connection, because it may be that the solar regions most worthy of the closest study at the present time are precisely these higher reaches of the sun's atmosphere. There is little doubt, I think, that around the sun's visible atmosphere matter exists at a temperature low enough not to give us its autobiography in the bright line manner, and there is evidence that matter existing under such conditions, absorbing as it must do some of the sun's light, will, if it remains elemental, give us an absorption of the fluted kind, or again will absorb only in the blue or ultra-violet region.

Now the more the chemistry of the reversing lower layer of the sun's atmosphere—that in which the upper level of the photosphere is bathed—is examined the more metallic is it found to be. For instance, my own work has enabled me to trace with more or less certainty eighteen metallic elements,[1] in addition to those recorded

[1] In fact Messrs. Ismay, Imray and Co. have just announced that they will take properly certified observers and bring them home again for the sum of 20*l.*, which is rather less than 1st class single fare; so that English observers will be carried to Denver or the Rocky Mountains and back again for the sum of 34*l.*

[1] These are strontium, lead, cadmium, potassium, cerium, uranium, vanadium, palladium, molybdenum, indium, lithium, rubidium, cæsium, bismuth, tin, lanthanum, glucinum, and yttrium or erbium.

by previous observers; but of metalloids in this region I have traced none. The persistency with which metal after metal revealed itself to the exclusion of the metalloids led me to throw out the idea some time ago, that perhaps the metalloids lay as a whole above the metals, and shortly afterwards I obtained evidence which seemed to me of a very satisfactory nature as to the existence of carbon, its presence in the sun's atmosphere being rendered probable by fluted bands, and not by lines. There were two points, however, which remained to be settled before the matter could be considered to be placed beyond all doubt.

The first was to establish that the fluted bands generally present in the spectrum of the electric arc, as photographed, which bands vary very considerably in strength according to the volatility of the metal under experiment, were really bands of carbon—a point denied by Angström and Thalèn.

This point I have settled by two photographs, in which the carbon bands remain the same, though one spectrum is that of carbon in air, the other of carbon in dry chlorine.

The next point was to insure accuracy by the most positive evidence that there was absolutely no shift in the carbon bands. Such a shift is produced when the part of the arc photographed is not perfectly in the prolongation of the axis of the collimator of the spectroscope. Its effect is to throw the lines of iron, for instance, a little to the right or a little to the left of the Fraunhofer lines with which they really correspond.

I have now obtained a photograph which supplies such evidence. There are metallic lines close to the carbon bands which are prolongations of Fraunhofer's lines, while the lines which I have already mapped at W. L., 39·27 and 39·295, in the spectrum of iron, are also absolute prolongations. Therefore there is no shift in the carbon flutings, and the individual members of the fluted spectra in the brightest portion are absolute prolongations of a fine series of Fraunhofer lines in the ultra-violet.

Now how does this connect itself with observations of the upper parts of the solar atmosphere?

Angström has already shown that the true carbon *lines* which we get when a coil and jar are employed are not reversed in the spectrum of the sun, and I have already shown that the calcium spectrum in the sun is similar to the spectrum obtained when the spark, and not the arc, is employed. Accompanying the change from a high to a higher temperature, there is a change in the intensity of the lines—some thicken, others become thinner. We can only match the relative thickness of the solar calcium lines by employing a very powerful coil and jar—so powerful, indeed, that the lines, and not the flutings, of carbon would be visible in the spark given by it. It is fair then to say that if carbon were present with the calcium *in the sun's reversing layer*, we should get the lines of carbon when we get the calcium lines appearing as they do.

As we do not get this evidence, we are driven to the conclusion that the carbon vapour exists not only in a more complicated molecular condition (as is evinced by the flutings) than the metallic vapours in the sun's atmosphere, but at a lower temperature. It must, therefore, exist *above the chromosphere*, that is, in a region of lower temperature. Lower pressure, again, is indicated by the feeble reversal, so that everything points to a high level.

The question is, will this region be recognised during the coming eclipse?

Coming down lower we reach a level better known, and of which, perhaps, the interest during the eclipse will now be less, if we except the possibilities opened out to us by photography. One good photograph of the lines visible in the lower chromosphere will be of incalculable value. Attempts may be made on the cusps just before and after totality, and if only one of these succeeds we shall have the ordinary solar spectrum as a scale. If good pictures near H can be secured, enough information now exists for that region to enable us to determine the chemical origin of the bright lines photographed. These remarks apply to attempts made with spectroscopes furnished with slits in the ordinary way; there is little doubt, however, that the method utilised for the Siam eclipse in 1875, the method suggested by Prof. Young and myself for the Indian Eclipse of 1871, will also be taken advantage of; here the chromosphere itself becomes the slit. A dispersed series of spectral images of the thing itself, instead of the spectrum of a part of the image of it focussed on a slit is obtained, the position of each image in the spectrum enabling its chemical origin to be ascertained if only a comparison spectrum can be secured at the same time.

In 1875, in the expedition to Siam, the photographs of this nature were obtained by means of a prism, and the results obtained by that expedition led me to think that, possibly, this method of using the coronal atmosphere as a circular slit might be applied under very favourable conditions if the prism, or train of prisms, hitherto employed, were replaced by a reflection grating, with which the generosity of Mr. Rutherford has made many of us familiar, for the simple reason that while a prism only gives us one spectrum, a brilliant grating placed at right angles to an incident beam gives us spectra of different orders, so-called, on each side of the line, perpendicular to its surface. Of these two or three are bright enough to be utilised on each side, so that we can get six in all.

To test this notion I made the following experiment with a grating given to me by Mr. Rutherfurd. This magnificent instrument contains 17,280 lines to the inch, ruled on glass and silvered; its brilliancy is remarkable.

In front of the condenser of an electric lamp adjusted to throw a parallel beam, I placed a circular aperture, cut in cardboard, forming a ring some 2 inches in interior diameter, the breadth of the ring being about $\frac{1}{8}$ inch. This was intended to represent the chromosphere, and formed my artificial eclipse.

At some distance from the lamp I mounted a $3\frac{3}{4}$ inch Cooke telescope. Some distance short of the focus I placed the grating; the spectrum of the circular slit, illuminated by sodium vapour and carbon vapour was photographed for the first, second, and third orders on one side. The third order spectrum, showing the exquisite rings due to the carbon vapour flutings, was produced in forty-two seconds. The first order spectrum, obtained in the same period of time, was very much over-exposed. It is, therefore, I think, not expecting too much that we

should be able to take a photograph of the eclipse, in the third order, in two minutes. Similarly, we may hope for a photograph of the second order in two minutes, and it is, I think, highly probable also that a photograph of the first order may be obtained in one minute. To make assurance doubly sure, the whole of the totality may be used during the coming eclipse, but if there be several such attempts made it will certainly be worth while to try what a shorter exposure will do.

Now, by mounting photographic plates on both sides of the axis, one solidly mounted equatorial of short focal length may enable us to obtain several such photographs, with varying lengths of exposure. I insist upon the solidity of the mounting because, if any one plate is to be exposed during the whole of totality, the instrument must not be violently disturbed or shaken while the eclipse is going on. I think, however, it is quite possible to obtain more than one photograph of the lower order spectra without any such disturbance in this way. The same plate may be made to record three, or even four, exposures in the case of the first order in an eclipse of four minutes' duration, by merely raising or lowering it after a given time, by means of a rapid screw or other equivalent contrivance, so that a fresh portion of the same plate may be exposed. Similarly, the plates on which the spectra of the second order are to be recorded may be made to perform double duty.

If one equatorial thus mounted were to be devoted to each quadrant of the coronal atmosphere, it is certain, I think, that most important results would be obtained.

J. NORMAN LOCKYER

(To be continued.)

GIGANTIC LAND-TORTOISES

Gigantic Land-Tortoises, Living and Extinct, in the Collection of the British Museum. By A. C. L. G. Günther, M.A., M.D., F.R.S. Keeper of the Department of Zoology. (London: Printed by Order of the Trustees, 1877.)

THE recent and extinct gigantic land-tortoises in the collection of the British Museum has just received at the hands of Mr. A. C. L. G. Günther, Keeper of the Department of Zoology, an elaborate and exhaustive memoir and history. As early as 1872 Dr. Günther had made much progress in the elucidation of their structure, but in 1874 the osteology of the Mascarene tortoises had still more engaged his attention. Again in 1877 new matter arising from fresh materials imported into England from the Aldabra group of islands, Mauritius, Rodriguez, and the Albemarle and Abingdon Islands, enabled Günther to complete his memoir upon these gigantic land-tortoises, recent and fossil.

This important volume contains a description of the races of the Aldabra group, the extinct races of the Mascarene group (Mauritius and Rodriguez), and lastly, the Galapagos Islands races. Dr. Günther, at p. 10, gives a synopsis of the fossil and living gigantic land-tortoises. He bases his classification upon the presence or absence of the nuchal plate—frontal portion of the skull—condition of the pelvis as to nature of the symphysial bridge, and whether the gular plate is single or double. The Aldabra tortoises, or those of the Aldabra Islands, fall under the first group, or those with the nuchal plate present, gular plate double, and frontal portion of skull convex and with the pelvis having a narrow symphysial bridge. Four species of Testudo, all living, occur in the Aldabra group.

The second group, embracing the Mascarene and Galapagos tortoises, possess no nuchal plate; the symphysial bridge is broad, and the frontal portion of the skull is flat. The Mascarene species, four in number, are all extinct, and are found by Günther to have a single gular plate and short sternum, whereas the Galapagos tortoises have a double gular plate and rather large sternum, and all but one species (*Testudo ephippium*), from Indefatigable Island, are living.

These deductions arrived at by Dr. Günther after years of long and patient labour, greatly add to our knowledge of the structure of the Testudinæ greatly removed in space; he not only shows that the Aldabra species have definite and almost individualised structure, but that they are entirely different species from their nearest or Mascarene neighbours, a great fact in the distribution of life, over an area once continuous land, but now known to be one of depression, and yet geographically contiguous, the Island of Madagascar only separating them. Here, however, we have not a wide distribution in space, and yet no species seems common to the Mascarene and Aldabra Testudinæ—the living races of the Aldabra group being entirely different from the extinct races of the Mascarenes. Dr. Günther endeavours to show that in the absence of direct genetic relationship between the tortoises of the Galapagos Islands and the Mascarenes, that some "terrestrial tortoises" were transported through some agency ("stream or current") from the American continent to the Galapagos—and similarly that those of Madagascar or Africa migrated in a similar manner to the Mascarenes. The origin and geographical distribution of species especially terrestrial is always of the highest interest to earnest students of life in its various phases. The history and origin of species, and their distribution, is perhaps one of the most difficult problems now engaging the minds of naturalists, and Gunther refers to the reappearance of the "Indian, Mascarene, and Aldabra gigantic land-tortoises in the Galapagos," as one of these—not, he says, in "typical singularity, but with all the principal secondary modifications reproduced." The greater extension of this large Chelonian type at a former geological epoch seems manifest, when we find remains at Malta corresponding with those of the Galapagos tortoises, and the close affinity between the Galapagos and the Aldabra and Mascarene species, although separated by so vast a distance; we must grant a continuity of land over the region now covered by the Pacific, and which for ages has undergone, and is still undergoing depression. No one can doubt or fail to see the great changes that have taken place in the physical geography of South Africa, whose attenuation towards the south and eastern coasts is due to depression, thus causing the isolation of Madagascar, the Mascarene Islands, and the Seychelles, such severance and island making, through causes long-continued and not equally the same areally in equal times, has produced that specialised or peculiar fauna for which many of

these islands are noted, yet partaking largely of the Madagascar or parent types.

These gigantic land-tortoises which appear to have formerly occupied or inhabited the Mascarene Islands, are now only found at Aldabra, one of the Seychelles 1,000 miles further north. This isolation of Madagascar with its surrounding northern and eastern scattered islands and coral reefs alone indicate one continuous and extensive equatorial land. According to Wallace the Mascarene Islands were probably "earliest separated from Madagascar and before any carnivora had reached the country, hence the secure abode of groups of birds incapable of flight"; also to the same causes may be attributed in these islands the development of these gigantic land-tortoises, security, food, and time being three at least important factors for continuity of life; and surpassing as they did all others in size now living on the globe.

Dr. Günther formulates the races of tortoises indigenous to the Galapagos by the want of the nuchal plate, by the long neck and legs, and black shell, flatness of the crown of the skull, and thinness of the osseous carapace.

This diagnosis of the Galapagos races of tortoises shows them to be differentiated from the Aldabra races by the same structural characters as the Mascarene races—to which, however, they are closely allied—but differing in not possessing the double gular plate.

Dr. Günther in his elaborate notice of the extinct races of the Mascarene turtles, speaks of their being "sharply and structurally differentiated from the tortoises of the Aldabra group;" he has now ascertained through the possession of complete carapaces from Mauritius and Rodriguez, that there is an "absence of the suture which divides in most land-tortoises the gular plate of the sternum into two longitudinal halves." Again, he has proved that the Mascarene tortoises possess no nuchal plate. The solution of these structural differences of the races is due to recent researches and exploration in the Mauritius and Rodriguez, and they have resulted under Günther's determination in the three following deductions :—

1. That the specimens with a nuchal plate (and with double gulars) come from Aldabra.

2. That the specimens with simple gular (and without nuchal) come from the Mascarenes.

3. That the specimens without nuchal, and with double gular, are Galapagos tortoises.

Dr. Günther's researches conclusively show that the living gigantic tortoises of the Galapagos are more nearly allied or related to the extinct tortoises of the Mauritius, than those living in Aldabra. This generalisation of Dr. Günther's tends to show that there must have been several distinct groups and centres of Testudo ranging widely over the globe, and that some of each still survive in localities widely removed from each other; such being the Mascarene, Seychelles, and Galapagos, with remains found at Malta.

Elaborate osteological details accompany the descriptions of the species in the races of the Aldabra tortoises, the extinct races of the Mascarenes, and the Galapagos species. No less than fifty plates illustrate and accompany the letter-press to this learned memoir or monograph upon the gigantic land-tortoises (living and extinct) now in the collection of the British Museum. R. E.

OUR BOOK SHELF

Treatise on Modern Horology in Theory and Practice. By M. Claudius Saunier, Ex-Director of the School of Horology at Maçon, Chevalier of the Legion of Honour, Honorary Secretary to the Paris Society of Horologers, &c. Translated by Julien Tripplin, Besançon, Watch Manufacturer, and Edward Rigg, M.A., Assayer in the Royal Mint. (London : J. Tripplin.)

M. CLAUDIUS SAUNIER'S treatise, though mainly intended for technical readers, contains a vast quantity of useful and instructive information, likely to be quite as interesting to amateur as to professional horologists. The work, moreover, is largely illustrated by beautiful coloured copperplate engravings, which, as models of accuracy and elegance, cannot be too highly praised. If in anything the book is perhaps scarcely up to the mark, as regards recent improvements in English clockwork; but no doubt such will be fully discussed in the appendix we understand M. Saunier has in hand, and which we hope will be published before the conclusion of the English series. So far as can be judged from the first number, the work of translation is being performed efficiently.

China. A History of the Laws, Manners, and Customs of the People. By John Henry Gray, M.A., LL.D., Archdeacon of Hongkong. Edited by W. G. Gregor. 2 vols. 140 Illustrations. (London: Macmillan and Co., 1878.)

MANY books have been written on China and its puzzling people, and many attempts made to describe and account for the mode of life, the manners, and customs—to Europeans seemingly half-childish—of the latter. Hitherto, however, it is safe to say, the Chinese have not been understood. Their jealousy of foreigners, their unwillingness to admit the outside barbarian into the sanctity of their inner life is proverbial, so that the vaguest and most erroneous notions prevail concerning this remarkable people, combined with a sort of tacit conviction that their life in its various aspects is too trivial to be worth inquiring into. A perusal of Dr. Gray's work, we are sure, will greatly tend to dispel these mistaken notions. Dr. Gray evidently possesses an unusual power of winning his way into the friendship of all classes of Chinese, and this, combined with a liberal and tolerant mind and a faculty of careful observation, has enabled him to learn more about the everyday life and thoughts and motives of the people than almost any European has done before him. The work is certainly one of the most instructive that has ever been written on China, and every page is interesting. Family life in all its varied relationships is illustrated by pen and pencil, as is also official life, commercial life, professional or literary life, life in hotels, and life in the street, pawnshops, pagodas, agriculture, fortune-telling, religion, amusements; in short, it would be difficult to point out in what respect the book is defective. The illustrations are very interesting, and have mostly, we believe, been drawn by native artists. The work ought, we should think, to become a permanent standard work on China.

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.*]

The Arrangement of Museums

THE subject brought forward by Lord Wharncliffe a few days ago in the House of Lords forms part of a much larger

question which sooner or later must occupy the attention it deserves, viz., the best means of collecting and arranging museums for the purposes of instruction.

How few of those who visit the British Museum or South Kensington, amongst the less instructed portion of the public at least, carry away any distinct reminiscence of what they have seen. The mind is bewildered by the immense number of objects presented to it and the absence of any sequence in the arrangement by which to assist the memory. The principles which are recognised as applicable to education in general apply equally to the arrangement of museums in so far as their educational functions are concerned, and consist, not in overwhelming the student with an immense accumulation of facts, but in presenting to his mind only such facts as are important or typical, and in the order in which it is intended they should be remembered. The order in which the knowledge of things is best received and retained by the memory is precisely that in which the things themselves were evolved; consequently, the arrangement which in a museum is best adapted to impart instruction is at the same time that which best records the history of the things exhibited. This consideration appears to determine conclusively the arrangement which ought to be adopted wherever the education of the public is the object to be attained, but museums, whether local or national, have other objects besides the instruction of the public. They are intended for the preservation of antiquities and natural history objects, many of which are not yet classified and have no place assigned to them, and which consequently cannot be arranged in any historic sequence such as I have alluded to. They should afford materials, not for the use of the public only, but for *savants*, in promoting original research, which is one of their most important functions, and which ought not to be sacrificed for the benefit of the common herd of visitors, and the question is, whether these distinct objects can be properly combined in one museum and by the same arrangement. If my own experience as a collector may be relied upon, this cannot be the case, unless an educational museum is collected from the first with a view to sequence, and unless this object is kept steadily in view whenever any addition is made to the collection, it will miss its aim. Take, for example, the case of the British Museum, which has accumulated from time to time by the accession of more or less homogeneous collections which have been purchased or presented, and which it is important to keep together. Out of any such collection it is probable that only a very few objects could be regarded as typical of any particular phase of development, say in pottery, sculpture, or glyptic art, and the remainder, although of the utmost value to the antiquary and necessary to be retained, would only serve to confuse any arrangement that might be made either for historic or educational purposes. Or take the case of a local museum in any large country town. Two distinct functions present themselves: on the one hand it is of use in preserving the antiquities or natural history specimens of the locality; on the other hand it should consist of general collections scientifically arranged and classified for the instruction of the people of the neighbourhood. We are brought by this to consider the advisability of having two distinct kinds of museums, which would bear pretty much the same relation to one another that a glossary of scientific terms would bear to a series of elementary treatises on different sciences—the one might be termed a museum of reference, the other an educational museum; the first arranged geographically, and the second having an evolutionary arrangement; the one special and the other general; the one arranged by finds and the other by subjects; the one comprising all the various objects that can be brought together from any particular district or country, and the other consisting only of such objects as may be selected as typical or as forming connecting links of development, the one composed exclusively of originals, and the other consisting in great part of casts, reproductions, and models. This provision, although I have placed it last in the list of distinctive functions, is by no means the least important in a practical point of view, because we see that by this means the two institutions ought never to be allowed to clash. Not only are reproductions and casts as useful as originals for the purposes of instruction, but models, in some cases, are infinitely preferable, because taking less room. Might it not serve to clear our ideas if we could arrive at the principle of utilising our existing institutions so as to serve the two distinct purposes above discussed, retaining the British Museum as a museum of reference, devoting South Kensington exclusively to the purposes of education and evolutionary arrangement, and separating the loan collections as a branch distinct from both. By this means we should be enabled to carry out the objects contemplated by Lord Wharncliffe's motion, not confining ourselves to statuary alone, but organising collections to illustrate the history of various other branches of art and industry, each commencing with the rude production of savage and prehistoric man, and ending with the complex contrivances of our own time. Each year the sums hitherto devoted to annual exhibitions would be applied to perfecting and re-arranging the collection, casting out some and replacing them by others more strictly representative in their character. The final result would be a museum of super-organic evolution worthy of the nation and of any labour that might be bestowed upon it. It might be thought, perhaps, that to carry out such a system representing any considerable number of arts and sciences, unbounded space would be requisite, but when it is remembered that the specimens would be rigidly confined to such as represented a distinct step of development, excluding all abnormal excrescences, it is evident that the number of objects required for any particular series would be limited.

My own collection of savage and prehistoric objects now exhibited at Bethnal Green has been collected upon this system during the last twenty years, and although the effectual carrying out of the plan has been limited by the means at my disposal, enough has been done to show that a considerable number of subjects may be represented without any extravagant demand on space. Weapons, pottery, early ship-building, personal ornament, carving and sculpture, musical instruments, early or savage drawings, clothing, early writing, objects illustrating the origin and use of fire, religious emblems, &c., are exhibited separately in cases occupying the basement on one side of the building, and several cases are devoted to the distribution and development of particular forms of ornament. The long rooms in the Exhibition buildings at South Kensington are admirably adapted for the extension of this system. Probably the best arrangement would be to devote the whole range of the side walls to objects laid out in historic sequence and to place in cases opposite each successive stage of art, objects belonging to existing peoples which correspond most nearly to the historic or prehistoric sequence on the opposite side; by this means both ancient and modern phases would be represented, and survivals where they occur could be traced to their sources.

A. LANE FOX

The Phonograph

IN reference to Prof. Mayer's account and Prof. Fleeming Jenkins's letters, I may say that I had an opportunity of an hour's observation of a phonograph constructed by Mr. Stroh, 42A, Hampstead Road, on April 3, at the invitation of Prof. Graham Bell. The difference between words produced from the phonograph and those spoken into it gave me the same feeling as the difference between a worn print and an early proof of an engraving. When the words were uttered loudly and slowly and repeated rather faster, it was easy to catch the sense and meaning, but I doubt whether unknown English words would be recognised, and certainly unknown foreign words would present insuperable difficulties. I should myself find the phonograph as at present constructed quite sufficient for my own purposes of registering pronunciation, especially delicate shades of dialectal utterance. Some words, as *see*, almost disappear. Both *ee* and *oo* are difficult vowels, so that Prof. Bell at first thought that the first sounded like the second, while in reality both are altered to indistinct sounds that I do not remember to have heard in speech. The resemblance is so great, however, that *bite*, *bout* could not be distinguished, though one ends nearly with *ee* and the other nearly with *oo*, and there is no other difference in the words. The vowels *ai*, *oa*, as in *bait*, *boat*, are also poor; *aa*, *au*, as in *baa*, *haul*, are really the only good ones. Hence I feel totally unable to speak positively as to the change of vowel quality by altering the rapidity of rotation and therefore pitch. As far as I could observe the quality did change, as it does in speech. We tried pronouncing words backwards, sometimes with good success, but as might be expected, even when the effects were recognisable, they were not always true. Thus, *aabaa*, *aadaa*, passed muster, but *aajaa* failed. The instrument is, however, not delicate enough to bring out these differences. The mechanical obstacle of the tin-foil, which has to be indented, and offers too much resistance, seems to be the cause of this. Such a word as *Scots*, when sung rapidly, at the beginning of *Scots wha hae*, degenerated almost into the simple vowel, the

initial and final *s* were quite lost, and the action of the mutes, *c*, *t*, was almost *nil*.

The invention is highly interesting, the effects at present produced are sometimes startling (as in cries, coughs, laughter, music), the philosophy of the process (taking a permanent impression of a very complex compound vibration, and using it as a mould to reproduce that vibration) is exceedingly attractive, but at present the instrument—at least that one which I saw, differing in many respects from the one described by Prof. Mayer—has not risen beyond a lecture illustration or a philosophical toy.

ALEXANDER J. ELLIS

April 13

Phoneidoscopic Representation of Vowels and Diphthongs

PERHAPS your correspondent, Mr. Sedley Taylor, would kindly test with his phoneidoscope the propriety of calling the English combinations *ea*, *ae*, *oe*, *ie* diphthongs, and the simple vowel *I*, as pronounced in the personal pronoun, a simple sound. Perhaps also the English *ā* (as in "*name*") may be regarded as a diphthong. In Otto's German Grammar, the German combinations *ae*, *oe*, *ue*, are classed as modified vowels. I fancy *oe* is a diphthong, though in rapid speech it becomes more like the simple sound *ue*.

J. H. BLAKESLEY

Linden, Hannover, April 11

The Acoustical Properties of Soap Films.

IN connection with the interesting results recently obtained by Mr. Sedley Taylor upon the acoustic properties of soap-films, as exhibited in the simple and beautiful instrument which he has termed the Phoneidoscope, I should like to call attention to the following passage published in 1873 by Prof. E. Mach, of Prague, in his *Optisch-Akustische Versuche*:—

"Bei dieser Gelegenheit kann erwähnt werden, dass die Plateau'schen Flüssigkeitshäutchen sich vorzüglich zum Studium der Membranschwingungen eignen. Eine solche Flüssigkeitshaut vor eine tönende Pfeife gebracht zeigt meist mehrere Bäuche. Ein Lichtpunkt, der sich in der Membran spiegelt, gibt mehrere glanzende geschlossene Curven."

After some remarks on the low tones to which these films vibrate, and on their vibrations to the upper partial tones, the author passes on to another subject with the remark:—"Ich erwähne diese Experimente, weil sie vielleicht, weiter verfolgt, zur Beantwortung mancher Fragen über Membranschwingungen beitragen können."

There is no mention, however, of the rotating pairs of coloured vortices noticed by Mr. Sedley Taylor. Brewster appears to have observed similar phenomena (see *Edin. Trans.*, vol. xxiv, "On Colours of Soap Bubbles," &c.) as the result of directed currents of air upon films. I have found that the vortices are also produced when a small lightly vibrating tuning-fork, having its prongs previously wetted with soap solution, is made to touch a flat soap film produced in the ordinary manner.

SILVANUS P. THOMPSON

University College, Bristol, April 5

Cumulative Temperature

THE idea of a clock with an uncompensated pendulum for temperature integration referred to by Mr. Cooke (NATURE, vol. xvii. p. 323 and p. 448) has probably occurred to many persons, and was proposed by me in 1840; I found, however, that it was not new then. Forbes says in his Report on Meteorology (Brit. Assoc. Report, 1832, p. 213):—"A mechanical mode of taking the mean of an infinite number of temperatures has been proposed by M. Grassman, by observing the change of rate caused by the influence of temperature upon the uncompensated pendulum of a clock (*Poggendorff*, 1825). The idea is a good one, but was proposed long ago by Dr. Brewster ('Edinburgh Encyclopædia,' art. Atmospheric Clock)." The chief merit in this matter will belong to the person who puts the idea into a working form which can be proved capable of giving accurate results.

April 9

B.

The Southern Drought

IN response to your question appended to my letter in the last number of NATURE, I am able to give you the time of the last great drought in the Gilbert Islands. In 1870 I visited these and several other islands in the South Pacific (an account of my cruise appeared in Dr. Petermann's *Mittheilungen* for June, 1871), and at that time there was a very general drought. I was among the Gilbert Islands during October, and found that no rain had fallen there for several months. The cocoa-nut and pandanus-trees, upon which the people almost entirely depend for food, were very much dried up, and the fruit upon them were small, both in quantity and in size. This drought continued for two years after my visit, and the famine became so severe that many of the people were starved to death. Had it not been for the fish they procured, it is doubtful whether any of them would have survived, for the cocoa-nut and pandanus-trees ceased to yield fruit, and the poor people were obliged to chew the roots of the trees.

Since that time I have heard of another season during which there was little rain, in consequence of which there was comparative scarcity, but this was not to be compared with the great drought of 1870-1872.

I regret to say no long-continued observations on the rainfall have been made in Samoa. My own time was so fully occupied with other matters, during my residence there, that I neglected this one. As the droughts there have not been great enough to cause anything like distress, the periods of their occurrence have, unfortunately, not been recorded.

S. J. WHITMEE

Blackheath, April 5

Research in Libraries

BEFORE this "voice from Australia" can reach London, I hope that some steps will have been taken towards carrying out Dr. Mallet's valuable suggestion (NATURE, vol. xvi. p. 457) so far as regards the British Museum and other leading European libraries.

The benefit of the proposed arrangement would, I am sure, be felt in Australia as much as in America. Anybody living here, in the North of Queensland, who may wish to consult a scientific book must take a sea voyage of 700 or 1,100 miles at a cost of 16*l*. or 20*l*. in money and at least a fortnight or three weeks in time. It may happen that one has a busy friend in the library city who will undertake the search through good-nature, but most people would prefer to employ a competent man who would do so as a matter of business.

Should the trustees or directors of the great libraries hesitate (and they may) to accept the responsibility of recommending searchers, probably it would answer nearly as well if the searchers were to advertise references to well-known scientific or literary men. Perhaps a hint might be taken from the Register House in Edinburgh. Titles to land in Scotland require registration for their completion. A purchaser, to satisfy himself that the seller has not previously alienated or burdened the subjects, has to overhaul the books of the register. This is done for him as a rule by professional searchers, some of whom are official and some unofficial. The system has worked admirably for some centuries I believe. Any Scotch lawyer could explain its details.

The subdivision of labour suggested by Dr. Mallet would enable a much higher use to be made of the system than the mere hunting-up of references. For example, if there were a searcher in Paris—a well-read geologist—to whom I could intrust an order for "any references in French geographical works bearing on the date of the erosion of the terrace between the Queensland coast range and the Pacific," or some such information, what possibilities would open out to the dwellers in distant isles, nay, even to the comparatively privileged inhabitants of London itself?

ROBERT L. JACK

Geological Survey Office, Townsville, Queensland, Jan. 14

Mimicry in Birds

WITH reference to the correspondence on this subject which has recently apeared in NATURE, may I add the following instance, which has fallen under my own observation?—

On the coast of Kent is a tract of land protected from the sea by an embankment of shingle, and known as the "Reculver Marsh." It is frequented by skylarks and ring-plovers. Almost all these larks have incorporated the well-known alarm note of the plovers into their song. With such distinctness is this double note brought in, that the first time I heard it I could with difficulty convince myself that it was not uttered by *Ægialitis hiaticula*.

In the surrounding district, where larks are equally numerous, I have never detected the peculiar note.

This power of imitating the songs of birds is well known to bird-fanciers and dealers; hence birds taken from the nest are considered worthless by those who admire the natural song. I myself had a Siskin that sang the goldfinch's song, and a nuthatch that I sent to a bird show came back with a wonderful medley of notes, of which he seemed extremely proud, the call-note of the canary and several notes of the blackbird being amongst those I could clearly recognise. J. YOUNG

Notting Hill

Harrow School Bathing-Place

WILL you kindly allow me to appeal through your columns for suggestions how to cure a nuisance which we suffer from year after year in our bathing-place here, and for which we have as yet found no remedy?

The water which is pumped into the bath from a considerable depth is beautifully clear at the beginning of the season, but as soon as the weather becomes hot and the rays of the sun attain power, countless filaments, consisting of confervæ, &c., spring up from the brick floor of the bath, and push their way rapidly to the surface, the depth of the water varying from about four feet to six feet. As the boys plunge from the side into the water and swim about the bath these long wavy stems are shivered into myriads of fragments, which collect on the surface of the water and form there a disagreeable and ugly scum, which detracts not a little from the pleasure of bathing during a great part of the summer term. We have taken some pains to discover a remedy for this, whether by chemical or other means, but as yet have been quite unsuccessful. The weed reappears in equal exuberance year after year and we are helpless. If any of your readers can contribute to the removal of this annual plague, he would confer a great benefit on the school, and any practical suggestions would be gratefully received either by G. Griffith, Esq., Harrow, or by ARTHUR G. WATSON

Harrow, April 8

London Clay Fossils

I SHOULD be glad if any of the contributors to NATURE would kindly inform me of any fossiliferous sections of the London clay at present open in the immediate neighbourhood of London. Many of those named in Whitaker's "Geology of London," such as Highgate, Hampstead Heath, &c., are closed, while others at Lewisham, &c., yield no fossils except a few fragments of wood. HERMANN H. HOFFERT

South Kensington Science Schools, April 15

Meteor

As the meteor of April 2 was seen at Ashwell, Herts, and with much the same course and splendour as observed at Leicester (but without any accompanying sound), it must have been very much further off than your Leicester correspondent imagines.

So bright a meteor, falling so early in the evening, cannot fail to have been much observed. H. GEORGE FORDHAM

Odsey Grange, Royston, Herts

The Nightingale

IN case you have received no earlier communication to a similar effect, you may possibly think it worth while to record that I heard a nightingale twice on the 14th instant, in a plantation by the side of Hanger Lane, in Ealing. It was but an abortive song, such as the first of the season is very apt to be, as if he were rather shy of the sound of his own voice. But there was enough of it to leave no possible doubt as to the identity of the performer. I may add that I have in previous years heard him in the same spot two or three days earlier than elsewhere in this neighbourhood.

I heard the wryneck ("cuckoo's mate") also several times on the same day in Gunnersbury and Hanger Lanes, having heard him once the previous afternoon (13th) in Kew Gardens.

Gunnersbury, April 16 G. J. PEARSE

FLOATING MAGNETS[1]

FOR one of my little books of the Experimental Science Series I have devised a system of experiments which illustrate the action of atomic forces, and the atomic arrangement in molecules, in so pleasing a manner that I think these experiments should be known to those interested in the study and teaching of physics.

A dozen or more of No. 5 or 6 sewing needles are magnetised with their points of the same polarity, say north. Each needle is run into a small cork, ¼ in. long and $\frac{3}{16}$ in. in diameter, which is of such size that it just floats the needle in an upright position. The eye end of the needle just comes through the top of the cork.

Float three of these vertical magnetic needles in a bowl of water, and then slowly bring down over them the N. pole of a rather large cylindrical magnet. The mutually repellent needles at once approach each other and finally arrange themselves at the vertices of an equilateral triangle, thus ∴. The needles come nearer together or go further away as the magnet above them approaches them or is removed from them. Vibrations of the magnet up and down cause the needles to vibrate, the triangle formed by them alternately increasing and diminishing in size.

On lifting the magnet vertically to a distance, the needles mutually repel and end by taking up positions at the vertices of a triangle inscribed to the bowl.

Four floating needles take these two forms

Five ,, ,, ,,

Six ,, ,, ,,

Seven ,, ,, ,,

I have obtained the figures up to the combination of twenty floating needles. Some of these forms are stable; others are unstable, and are sent into the stable forms by vibration.

These experiments can be varied without end. It is certainly interesting to see the mutual effect of two or more vibrating systems, each ruled more or less by the motions of its own superposed magnet; to witness the deformations and decompositions of one molecular arrangement by the vibrations of a neighbouring group, to note the changes in form which take place when a larger magnet enters the combination, and to see the deformation of groups produced by the side action of a magnet placed near the bowl.

In the vertical lantern these exhibitions are suggestive of much thought to the student. Of course they are merely suggestions and illustrations of molecular actions and forms, for they exhibit only the results of actions in a plane; so the student should be careful how he draws conclusions from them as to the grouping and mutual actions of molecules in space.

I will here add that I use needles floating vertically and horizontally in water as delicate and mobile indicators of magnetic actions, such as the determination of the position of the poles in magnets, and the displacement of the lines of magnetic force during inductive action on plates of metal, at rest and in motion.

The vibratory motions in the lines of force in the Bell telephone have been studied from the motions of a needle (floating vertically under the pole of the magnet), caused by moving to and fro through determined distances, the

[1] A note on Experiments with Floating Magnets, by Alfred M. Mayer. Reprinted from the *American Journal of Science*.

thin iron plate in front of this magnet. These experiments are worth repeating by those who desire clearer conceptions of the manner of action of that remarkable instrument.

SUN-SPOTS AND TERRESTRIAL MAGNETISM

IN a remarkable article on "La Météorologie Cosmique," which has appeared in the *Annuaire* of the Bureau des Longitudes, for 1878, M. Faye says with reference to the influence of sunspots on the earth's magnetism, that the observations of Cassini "give 1787·25 for the date of the maximum observed then at Paris, whilst the latest observations—those of Mr. Broun, himself at Trevandrum—assign 1870·85 for the epoch of the last maximum. The interval is 83·60 years. On dividing this by 8, the number of periods in this interval, 10·45 years, are found for the duration of the period. That is to say, almost exactly the value already found by Lamont by means of his own observations at Munich. The period of the spots deduced by M. Wolf, 11·1 years, not being equal to that for the magnetic variations, these two phenomena have no relation to each other."

I desire to offer a remark on this conclusion, which seems to me too hasty. On examining the two periodic series, that for the diurnal variation of declination and that for the frequency of the solar spots, we see that there is a perfect coincidence in their phases though the length of successive periods is not constant. We may find a mean length of ten, eleven, or more years, according to the epoch from which the calculation is begun, but we shall always find the same length from both series if we commence at the same date.

It seems to me then that the true way to determine whether there is an intimate connection between the two phenomena is to compare their phases, and see whether the maxima and minima of the one coincide with those of the other. If there is identity in these respects, we must without doubt find the same mean values for the periods.

M. Faye accepts the date 1787·25 as that of a maximum for the oscillations of the declination. If we look then at the curve, Fig. 2, given by him in the article in question, we see that this corresponds exactly with a maximum of sun-spot frequency. In like manner similar coincidences are seen in the epochs deduced from the observations of Arago and others up to the present time when compared one by one with the sun-spot observations of Schwabe, Carrington, Secchi, as well as of those made at Kew. The conclusion seems to me very different from that of M. Faye. We are entitled to apply the rule he has given (p. 634): "If two series of phenomena, however different they may appear at first, follow exactly the same period, they ought to be referred to the same cause."

There is another passage upon which I desire to offer a remark: "Two kinds of meteors exercise a considerable influence on the direction of the magnetic needle, these are the auroræ boreales and the cyclones."

For the first there is a general agreement, but for the cyclones what observations have we which prove any such influence? If cyclones exercise a considerable influence on the direction of the needle, in what phase of the phenomenon does this occur? Is it on their formation, on their passage over some particular meridian, or when their centre is over a place? In the last case each cyclone will be a source of disturbance, which will be manifested as it progresses, and not simultaneously at all places, which, however, is what really occurs in the case of magnetic disturbances. Electricity is, without doubt, a cause, but only in the case of such considerable discharges as the aurora polaris; but not the local electricity which may accompany cyclones. When there is a storm, and the thunder rolls, and the electrometer shows enormous variations of atmospheric electricity, changing sign continually, the magnetic needle continues its usual and regular progress. Of this we can offer hundreds of examples. JOAS CAPELLO

Lisbon, February 22

P.S.—The mean movements of the magnetic needle in the Lisbon Observatory, from eight A.M. to two P.M. are given in NATURE, vol. xiii. p. 448, for the years 1858 to 1875; the following are the corresponding mean ranges for the next two years:—

1876 ... ... 5·81′ 1877 ... ... 5·54′

So that the mean movement was less in 1877 than in 1876.

OUR ASTRONOMICAL COLUMN

NEW COMPANION TO ALDEBARAN.—Mr. S. W. Burnham notifies his discovery with the 18½-inch Alvan Clark refractor of the Dearborn Observatory, of a minute star much nearer to Aldebaran than that which makes the double star H. VI. 66; he compares it with the ruddy bright star, as resembling, in difficulty and appearance, Mars and his outer satellite. The mean of three days' observations gives the angle 109°·0, and the distance 30″·35 for 1877·90, or if the second result which, as printed, differs nearly ten degrees from the other two, the angle will be 111°·9. The secular proper motion of Aldebaran, according to Mädler, is 19″·1 in the direction 157°; some years must elapse before the question of physical or optical duplicity can be decided. Eight days' measures of the close companion of Sirius, by Mr. Burnham, with the same instrument, assign for the angle of position 52°·4, distance 10″·83 at the epoch 1877·97.

THE STAR LALANDE 37813.—Mr. J. E. Gore writes from Ballisodare, Co. Sligo, with reference to this star, which appears in the reduced catalogue as a *second* magnitude, and which, observing in the Punjab in August, 1877, he had found a little less than Lacaille 8308 or 7 m. This is one of the errors in the catalogue which, as in a case recently noticed in this column, can only be cleared up by referring to the *Histoire Céleste*. The observation was made on August 20, 1795, and the star No. 37813 was really estimated 7·8 m. *a* Aquilæ was observed immediately before it, and entered 2 m.; it is this erroneous magnitude for the bright star of Aquila that has become attached to the star of which Mr. Gore writes. There is a very noticeable proper motion in N.P.D., apparently about + 0″·48 annually, as shown by comparison of the observations of Lacaille, Lalande, Jacob, and Argelander, with the position in the Washington Catalogue for 1860.

THE MINOR PLANETS.—Discoveries in this group still progress. No. 186 was detected by M. Prosper Henry at Paris, on April 6, shining as a star of 11·5 m., and No. 187 by M. Coggia at Marseilles, on April 10; it was estimated 10 m. No. 178 (Palisa, 1877, November 6) has been named *Belisana*, and No. 184 (Palisa, 1878, February 28) it is proposed to call *Deiopeia*. With already *seven* additions to the list, it would not appear that 1878 is likely to fall short of the most prolific of preceding years in these discoveries.

THE TRANSIT OF MERCURY ON MAY 6.—If we calculate strictly from Le Verrier's tables of sun and planet, using therefore the value of the sun's diameter which he deduced from the transits of Mercury in his memoir, printed as an addition to the *Connaissance des Temps* for 1848, we shall have the following formula for determining the time of the first *external* contact of limbs in the approaching transit:—

$$t = 3\text{h. } 13\text{m. } 1\text{s.} - [1{\cdot}8723]\, r \sin l - [1{\cdot}9079]\, r \cos l, \cos (L - 56^\circ\ 49'{\cdot}3)$$

in which t is the Greenwich mean time of contact, r the

radius of the earth at the place for which we are computing, l its geocentric latitude, and L the east longitude from Greenwich; the quantities within square brackets are logarithms.

At the Royal Observatory the first external contact is found to occur at 3h. 11m. 35s; the sun will set at 7h. 31m., about 30m. after least distance of centres, so that more than half the transit may be observed. At Edinburgh the first contact takes place at 2h. 58m. 53s. Edinburgh mean time, and the sun will set at 7h. 36m. The first *internal* contact at Greenwich and Edinburgh occurs 3m. 7s. later. The angle from North point of external contact is 45° towards East for direct image.

At Ogden, Utah, to which position it has been stated that a French Expedition is proceeding for the observation of the phenomenon, Mercury enters upon the sun's disc at 7h. 44m. A.M., and the egress takes place at 3h. 18m. P.M., the duration of the transit being 7h. 34m.

At the next transit at the descending node on May 10, 1891, the last external contact at Greenwich, according to Leverrier's tables, will occur at 4h. 50·4m. A.M., and as the sun will not rise till 4h. 19m., but little of the transit can be witnessed in this country. In the transit at the opposite node on November 10, 1894, the first contact of limbs appears to fall close upon sunset here. On November 7, 1881, as will be seen from the *Nautical Almanac*, the transit will be wholly invisible in England. It thus follows that on the afternoon of May 6 next, we shall have in these islands the only favourable opportunity of viewing the planet Mercury projected upon the sun's disc that is afforded during the present century.

GEOGRAPHICAL NOTES

AFRICA.—M. F. Deloncle, a member of the Geographical Society of Lyons, has recently translated into French a remarkably interesting itinerary of the voyages made by a Spanish friar in the middle of the fourteenth century. The work was originally written in the Catalonian dialect and devoted chiefly to travels in Africa.

The Society of Geography has prepared, for the Paris Exhibition, a map of Africa, measuring 2 m. × 2 metres, and showing the route of every explorer from 1754 to Stanley, in 1878. The number of travellers is 121, of whom not less than 42 are French; but a large number of these explored either Madagascar or the Desert round Algeria. The first name written in this list is Mayeur, a traveller now quite forgotten, who crossed the northern part of Madagascar.

NEW MEXICO.—During the season of 1877 a party of the U.S. Geographical and Geological Survey of the Territories, under the command of Lieut. C. C. Morrison, was detailed to survey the section of New Mexico lying between the 105th and 108th meridians and between the 33rd and 35th parallels, about half of which is mountainous, the rest being mesas and plains. In giving an account of their explorations at the last meeting of the Royal Geographical Society, Mr. T. W. Goad, the meteorologist of the party, mentioned some points in regard to the physical features and characteristics of the country surveyed, which attracted special notice. Between the Sierra Blanca and the Oscura Mountains a lava flow was met with of over seventy-five miles in length, with an average breadth of three miles. This Mal País, as the Mexicans call it, resembles a black river, widening and narrowing as the country undulates. This stretch of lava, owing to denudation, is somewhat higher than the surrounding country, and is full of caverns. Several of these were visited by the survey party, but the only one of importance was near Fort Stanton, which, like the others, was in a limestone formation, and proved of considerable length; some persons, indeed, asserted that no one had been to the end, though a distance of five miles was measured. The exploration of this cave was of a most uncomfortable nature, necessitating long crawls through narrow passages, and obliging the explorers to wade up to their waists in ice-cold water for hours. Stalactites and stalagmites of immense size were met with. The lake in the cave was said to contain eyeless fish, but none of the party were able to catch or see any. The cañon, again, of the Rio Grande, below Castilla, is of peculiar interest, because it differs in most respects from other cañons, and instead of being worn away by the action of the water alone, it was probably commenced by volcanic action. The sides are of trap-rock, and although the cañon itself is very narrow, its depth was estimated at 1,000 feet. The river at this point has a great fall and rushes along with a velocity of ten miles an hour. Mr. Goad describes the climate of New Mexico as delightful.

GEOGRAPHICAL ANNUAL.—The new volume of *L'Année Géographique*, for 1876, has at length appeared. The delay has been caused by the resignation of the editorship by M. Vivien de St. Martin, whose time is now so fully occupied with other work. The new editors are MM. Maunoir and Duveyrier, and the new volume is quite up to its predecessors. The volume for 1877 will be published about June.

METEOROLOGICAL NOTES

METEOROLOGY OF STONYHURST.—The results of the meteorological and magnetical observations at Stonyhurst for 1877 are already published. In addition to the very full statement of the results for the year, and which are compared with the averages of previous years brought down to date, there are given observations of crops, flowers, trees, and shrubs; observations of the cirrus clouds made at the observatory in connection with Prof. Hildebrandsson's large inquiry into the upper movements of the atmosphere; and a discussion of the hours of occurrence of the barometric maxima and minima during the eight years ending 1875. This discussion has been evidently conducted with great care and with full knowledge of the subject in hand. The results arrived at are of great importance, the chief points being that there is a tendency of the maxima to occur between 10 and 11 A.M. and P.M., the total number from midnight to noon being, however, considerably in excess of that from noon to midnight; and that the minima occur with nearly the same regularity as the maxima, but at different hours, viz., about 3 and 4 A.M. and P.M. The importance of these results lies chiefly in the circumstance that they accord with the hours of the critical phases of the diurnal fluctuations of the barometer, and peculiarly so as regards the annual results. We are much pleased to see from the report that Father Perry is engaged with the discussion of the meteorological observations made at Kerguelen during the Transit of Venus Expedition, to the results of which meteorologists will eagerly look forward.

WEEKLY STATISTICS OF THE WEATHER.—The Meteorological Office has begun to issue weekly statistics of the weather of the British Islands for agricultural and sanitary purposes. For this object the country is divided into two divisions, the one being suited for the production of wheat, and the other for the rearing of stock. For each of the ten regions into which these two divisions are sub-divided there are published the highest, the lowest, and the mean temperature of the week, and the degree to which the last is above or below the average of the week, together with the number of days of rainfall, its amount, and the difference between the latter and the average rainfall of the week. To these follow general remarks on the weather as regards frost, winds, storms, and any irregularity that may have occurred in the rainfall at the selected stations. This step is in the right direction, and the scheme will no doubt soon receive greater extension and further development in order that

it may the fuller meet the requirements of the classes for which it is intended. It is desirable, for instance, if not indeed essential, that the mean temperature be given to tenths of a degree and not merely to whole degrees, particularly when it is kept in view that no inconsiderable portion of Great Britain is but little removed from the limits of the successful cultivation of the wheat, and the rainfall to hundredths of an inch, so as to mark off clearly the practically rainless districts during each week. The number of stations situated on the coast preponderates too largely. Additional stations from several of the great agricultural centres are needed, and a partition of the country into more districts than ten, it being evident that a division of Scotland merely into east and west, and of Ireland into north and south, is inadequate. Scotland, for instance, should be divided at least into north-east, north-west, south-east, and south-west divisions, these differing essentially from each other in their climatic and agricultural peculiarities.

Missouri Weather Reports, Nos. 1, 2, and 3.—The system of weather service for the State of Missouri is being satisfactorily and energetically developed by Prof. Francis E. Nipher, Washington University, St. Louis. The second report, being for January last, is accompanied with a table showing the rainfall at thirty-eight stations in Missouri and a map on which the amounts are entered and isohyetal lines drawn showing where the fall was nothing, one inch, two inches, and three inches respectively. From this map the distribution of the rainfall, a correct knowledge of which is so important to farmers and others, is seen at a glance. The distribution of the heavy snowfall of the 30th and 31st is particularly detailed, and we are pleased to see the frankness with which Prof. Nipher informs his observers that it has been impossible to give a proper account of the remarkable storm of the 26th, which entered the northern part of the state at 8 A.M. and soon thereafter developed into a severe thunderstorm in central and southern Missouri, owing to the times of the beginning and ending of the storm not being given carefully for a sufficient number of places. We feel assured that the observers will gladly see to the rectification of this and supply the information desiderated in future. From the first report we see that the mean temperature of December was 12°·4 above the average of the month; and with this high temperature, the mean of the month being 45°·6, vegetable and animal life was prematurely urged forward at an undesirably rapid rate. A valuable table accompanies this number, which has been prepared by Dr. Engelmann, giving the mean monthly temperatures and extremes and the mean rainfall at St. Louis for forty-two years, from which it appears that the mean of the coldest month, January, is 31°·7; the warmest month, July, 79°·2, and of the year, 55°·4. The highest temperature noted during these forty-two years was 104°·0 in July, 1860, and the lowest—23°·0 (below zero) in January, 1873. The mean annual rainfall is 42·46 inches, the largest monthly fall being 5·39 inches in June, and the least, 2·13 inches in January.

Extraordinary Rain-Storm in Canada.—A continuous storm of rain, extending over two or three days, and covering a considerable portion of North America, occurred in the end of February, the weather for some time before having been unusually mild. Near the coast rain prevailed, in the Quebec district much snow fell, about Ottawa, sleet, hail, rain, and snow fell in succession, and on advancing westwards through Canada, and into the United States, the precipitation appears to have been heavier. In Central Canada the floods seem to have been most destructive, and immense damage has been done to the towns built on the rivers, by the loosening of the ice by the floods, which, floating down the swollen rivers, carried bridges and other structures before it. Much damage was also done by the ice running aground at various points, and thereby damming up the rivers, by which extensive stretches of low-lying grounds were submerged.

Comparative Atmospheric Pressure of New Zealand and Great Britain.—Mr. C. Rous Marten, whose name has been so long and so favourably associated with the meteorology of New Zealand, has published a short paper on this subject in the *Transactions* of the Wellington Philosophical Society. The mean pressure of the atmosphere of Great Britain calculated from fourteen stations distributed from the Channel to the Moray Frith, is 29·848 inches; and of New Zealand, as similarly determined from fourteen stations from Southland to Mongonui, 29·918 inches. The interest of the comparison lies in this, that pressure diminishes in both countries at a somewhat rapid rate on proceeding into higher latitudes, and that though the New Zealand stations lie on the average in about 12° lower latitudes than British stations, yet the pressure does not greatly differ in the two countries. The strong resemblances between the climatologies of the two countries result from the peculiar distribution of pressure common to both and the lie of their mountain ranges, by which the prevailing winds are westerly, and being laden with the vapour of the ocean they have traversed, are productive of rainy climates in the west, and dry climates in the east.

NOTES

Invitations have recently been issued by the Rector of the University of Pavia to the various scientific societies of Europe, to participate in the ceremonies connected with the unveiling of the statue of Volta on April 28.

The Electro-metallurgical Company of Brussels has lately completed a colossal statue of Jan van Eyck, in bronze, by the system of electric deposition. The galvanic process occupied several months, although a thickness of but six to eight millimetres was attained. It is probably the largest object which has been produced by this method, being over twelve feet in height, and is regarded as a much more perfect imitation of the model than could be obtained by casting.

The meeting of the delegates of the French Sociétés Savantes will take place as usual at the Sorbonne, in the first week after Easter. M. Bardoux will preside over the meeting for the distribution of prizes, and deliver an address summarising all the measures contemplated by the Government for promoting popular instruction.

M. Bardoux has given the decoration of the Legion of Honour to the oldest schoolmaster of France, who has been teaching since 1818 in the very parish where he was born. The ceremony took place at Clermont-Ferrand at a dinner given by the Prefect in honour of the Minister. The whole scene is said to have been very impressive.

M. Asseline, a journalist and a member of the Municipal Council of Paris, died suddenly a week ago. He was one of the Society of Mutual Autopsy recently established in Paris for investigating by *post mortem* examination all the circumstances of death, and his case was the first instance of the application of the rules of the Society. The autopsy was made by Dr. Broca, the president of the Society, and the results published in the papers.

The Municipal Council of Paris has appointed a Commission of ten members in order to take part in the proceedings of the French Association for the Advancement of Science, which will take place at Paris, as we have already reported. They will sit in their official capacity.

A Société de Mineralogie has been formed in Paris, with M. Des Cloiseaux as president. It meets on the second Tuesday of each month in the mineralogical laboratory of the Sorbonne,

A *Cours Annexe* has been created at the Sorbonne for physical astronomy. M. Wolff will lecture on the observational methods of physical astronomy, and the constitution of celestial bodies.

M. Ossian Bonnet, Director of Studies to the Polytechnic School, has been appointed successor to M. Leverrier in his capacity of Lecturer on Mathematical Astronomy.

The Italian Cryptogamic Society, founded in 1858 by De Notaris, has just been reconstituted under the presidency of Prof. F. Ardissone, of Milan. It consists of two classes of members: ordinary (*effetivi*) and foreign. The former consist entirely of Italian, the latter of foreign cryptogamic botanists, the foreign members being elected by the vote of the ordinary members. The Society will publish annual volumes of its "atti," and, in addition, one or more fasciculi every year, each containing fifty new or interesting species of cryptogams, at a cost of 10 lire (Italian) the fasciculus. The British corresponding members at present are the Rev. M. J. Berkeley, Dr. R. Braithwaite, Dr. M. C. Cooke, Mr. Jas. Stirton, and Mr. John Smith. Cryptogamists who are not members of the Society are invited to contribute descriptions or specimens of new species, for which they will receive in exchange the volume or fasciculus containing their contributions.

The Birmingham Natural History and Microscopical Society, one of the most active of our provincial societies, have resolved to spend about 100*l.* in improving and adding to their apparatus.

The Faculty of Medicine at Lyons has taken the initiative in a subscription for the erection of a monument to the late Claude Bernard on the Quai de la Vitriolerie.

Dr Puluj, of Vienna, exhibited at a recent session of the Imperial Academy, an ingenious arrangement for signalling by means of the telephone. The vibrating membranes in two connected telephones are replaced by a pair of tuning-forks giving the same number of vibrations per second. A bell is placed close to each fork and a brass ball is suspended from a thread between the two, but in contact with the fork. If one of the forks be put in vibration by means of a hammer the movement is communicated to the other, which causes a loud ringing on the bell by means of the ball. A response can be sent back in the same manner, and after replacing the vibrating membranes, the usual method of communication begins.

A French inventor, M. Brégnet, has recently completed a so-called mercury telephone, which is quite a variation on the systems already in use. It is composed of two instruments for transmission and reception, connected by means of wires. Each of these consists of a glass vessel, containing acidulated water and mercury, into which is inserted a capillary tube filled with mercury. One wire connects the mercury in the tubes, and the other that in the vessels. When a person speaks before the transmitter, the vibrations of the air are communicated to the mercury, and cause variations in the electromotive force, which are transmitted to the receiver, and there give rise to vibrations of the air appreciable by the ear. A later simplification of the apparatus consists in using a tube with alternate drops of mercury and acidulated water, forming thus a series of electro-capillary elements.

We are glad to know that one of the signs of our times is a more appreciative and intelligent interest in the things lying around us, including the beauties of nature as well as those affairs of a more human interest. Messrs. Marcus Ward and Co., in their new monthly publication, entitled, *Our Native Land*, a copy of which we have just received, certainly deserve well of those who think that the habit of observation can be fostered and developed by calling attention to the many things of beauty and interest in our own country. The work is to consist of reproductions of water-colour sketches, with descriptive notes, and the publication breaks ground by giving coloured plates and text illustrating "Derwentwater," "Ambleside," and "Rydal Falls." The publication is as excellent in execution as it is admirable in idea, and the reproduction of the water-colour of Ambleside is admirable; it is one of the finest specimens of chromolithography that we have ever seen. Its truth to the colour of nature and the softness of the atmospheric effects, leaves little, if anything, to be desired.

Macmillan and Co. are preparing for publication a "Journal of a Tour in Morocco in 1871, including a Visit to the Great Atlas," by Sir J. D. Hooker, P.R.S., &c., and John Ball, F.R.S., with a Sketch of the Geology of Morocco, by George Maw, F.G.S. The work will be illustrated by Mr. Whymper.

Gen. de Nansouty, the director of the Pic du Midi Observatory, has been appointed Officer of Public Instruction as a reward for his efforts and successes. He had already been made, eighteen months ago, Officer of the Academy. The General Council of Vaucluse framed, at its last session, a resolution for establishing a meteorological observatory on the top of Mount Ventoux, a mountain about 2,000 metres high, situated in the most admirable position for an extensive view of an immense region.

The intellectual abilities of the Japanese race have been evidenced in a striking manner by a quartette of students from that country now studying in Berlin. One of these, Dr. Dirokitao, has lately invented an ingenious optical instrument termed the leucoscope, which measures the variations in the perception of light and colour by the human eye, in accordance with the strictest mathematical laws. Another, who has attained the rank of lieutenant in the Prussian army, has introduced a remarkable simplification into the mechanism of the Mauser rifle, which has succeeded the historic needle-gun. Two more who are prosecuting their chemical studies under Prof. Hofmann, have published for two years past several interesting synthetical researches on the aromatic series.

The canvas for the great Paris captive balloon is quite ready; it forms 46 rolls, weighing 60 kilogs. each, having a length of 80 metres, and a breadth of 113 centimetres. It was submitted to a traction of 1,000 kilogs., under which it has extended 25 millimetres per metre. After some time the increase in length was reduced to 12½ millimetres. The net is almost finished. It is composed of 256 ropes 11 millimetres each in diameter, and bearing a strain of 1 ton.

In a note in the *Bulletin* of the French Scientific Association, Col. Gazan gives some interesting observations on the fracture of iron. During his sojourn in the arm manufactories of St. Etienne and Tulle, at the central depôt of artillery, and at the manufactory of Châtellerault, he was able to make important researches on iron. The fracture of iron may be nervous, in grains more or less fine, or in facets sometimes having a surface of several square millimetres; often it presents a mixture of these three features. Thus it is impossible to judge of the quality of an iron before breaking it; and it is on this account that in arm manufactories they break a certain number of bars with which they make a certain number of pieces for which they are intended, and which are afterward broken to ascertain their resistance, that is, the goodness of the iron, which, moreover, is still rendered brittle in presence of phosphorus, arsenic, or sulphur. The best irons are the nervous, then those of fine grain and with facets. On railways it has been proved that rails placed in the direction of the magnetic meridian are affected quite differently from rails placed at right angles to this direc-

tion; the former oxidise and do not become brittle, the latter do not oxidise, but do become brittle. In intermediate directions the rails participate more or less in the qualities of those which are placed in the two extreme directions. What becomes of the iron which is now so plentifully used in the construction of building—girders among others? Is not this a subject for serious research?

THE French Minister for Public Works has accepted the plans of an underground railway in Paris, which was worked out by order of the Prefect of the Seine. According to these it is intended to build the central station seven metres underneath the gardens of the Palais Royal. Three different lines will radiate from that spot, viz.: (1) to the Exchange, the Opera, the railway station of St. Lazare, then to Batignolles, communicating with the Great Western Railway and the Chemin de Fer de Ceinture; (2) to Les Halles, the rue Turbigo, the Boulevard Sebastopol, the Boulevard de Strasbourg, the Great Eastern and Great Northern Railways; from the Boulevard de Strasbourg a branch line would lead to the Vincennes and Lyons Railway Stations, passing underneath the Seine to the left bank of the river; (3) to the rue de Rennes, the Montparnasse Railway Station, the station for Sceaux, and to Gentilly. The cost of the lines is estimated at 6,000,000*l.*, and is to be borne jointly by the State, the Departement de la Seine, and the City of Paris.

WRITING in *La Nature*, M. Hélène calls attention to the excellent example set by Switzerland in regard to popular meteorology. There is hardly a town but has in one of its squares, perhaps at the side of a lake, an elegant column with instruments required for observation of the usual phenomena. Thus in Fribourg, is a black marble column (about 2·65 m. high) on a granite platform. On the north face is an alcohol thermometer, with double graduation cut in the marble; on the west a mercury barometer; on the east a hair hygrometer. The south face has an inscription giving the longitude, latitude, altitude, barometric and thermometric means, and annual rainfall. On a globe crowning the column are lines giving the direction of the four cardinal points. An inscription near the base tells that the column was erected by the Fribourg Society of Natural Sciences. The monument cost not more than 1,500 to 2,000 francs. Such columns often give various other kinds of information, *e.g.* the hour in different cities of the globe when it is midday at Berne, the heights of neighbouring mountains, measures, variations of lake level, records of severe winters, &c., in short the chief points which a natural curiosity would seek knowledge of. They are generally erected by cantonal societies.

WE have received the first two parts of the tenth edition of Cooley's "Cyclopædia of Practical Receipts," revised and partly rewritten by Prof. R. V. Tuson, F.C.S. To what extent the work has been brought up to date may be learned by looking at the articles on Spectrum Analysis and Anemometers; in the latter case the anemometers now in use are dismissed in a foot-note.

INTERESTING antiquities, coins, vases, &c., have recently been found at Strassburg in some excavations which are being made in connection with water-works. In some parts a number of skeletons of animals have been discovered, amongst others a well-preserved jaw with tusks of a prehistoric boar, and some deer horns, &c.

AT Cologne a meeting of the International Society against the pollution of rivers, the soil, and air, took place a few weeks ago. Its reports are published by Herr Hugo Voigt, at Leipzig.

THE International Congress for the investigation of the history of America before Columbus, will meet at Brussels during 1879. Originally it was intended to hold the meeting at some American city.

THE United States of North America possessed only forty-nine public libraries in the year 1800. The number has now risen to no less than 3,682, and the number of volumes contained in them exceeds thirteen millions.

TWO new institutions are about to be established in Germany; one at Bielefeld, for textile industries, and another at Iserlohn, for metal industry.

ON March 11 the Ural Mountains were first crossed by a railway train upon the occasion of the opening of the new line from Perm to Jekaterinburg.

ON the 14th inst. the Institution for the Deaf and Dumb at Leipzig celebrated the 100th anniversary of its foundation. It is the oldest institution of the kind in Germany.

A NEW eruption is reported to have occurred in Iceland on March 24, in the vicinity of Mount Hecla.

DURING the past three years Admiral Duperré has met with considerable success in his efforts to develop the resources of the French colony in Cochin China. He first started an experimental farm just outside Saigon, where sugar-cane, cotton, indigo, coffee shrubs, &c., were planted under the superintendence of a botanist from Paris. From this farm thousands of coffee plants, &c., are distributed every year all over the colony among the French and native planters. Tobacco has also been successfully cultivated, and attempts are about to be made to prepare the leaf for the European market, and an official from the tobacco manufactory at Paris has been appointed to superintend this work. The sugar-cane is found to flourish well in Cochin China, and experiments are being made with a view to discovering the best means of turning it to profitable account.

AT p. 16, vol. xvi. of NATURE, is an account of a new stimulant known as pitury, which it was shown had been proved by Baron von Mueller to be derived from *Duboisia hopwoodi*, a plant described by himself in 1861. It was mentioned in the paper above alluded to that the better known species of *Duboisia*, namely, *D. myoporoides* of Robert Brown might possibly prove to be of some medicinal value. This prophecy has since been borne out, for in a paper read by Dr. J. Bancroft on Duboisia and Pituri before the Queensland Philosophical Society at Brisbane, a good deal of information is given on both these new medicinal products. With regard to *D. myoporoides*, which is a small tree or shrub, we are told that it is found in various localities from the neighbourhood of Sydney to that of Cape York, and that it has also been found in New Caledonia and New Guinea. It grows plentifully on the borders of the vine scrubs about Brisbane and springs up abundantly after the clearance of forest land. The valuable part of the plant seems to be the leaves, from which an extract was, in the first place, made, and its effects tried upon some cats and dogs, which, during the time they were under its influence, were as helpless as if they were totally blind, falling down when the slightest obstacle came in their way. A trial of its effect was afterwards made on the human eye in several cases, and its action in dilating the pupil was found to be very powerful and rapid. The active principle seems to be almost identical with atropine, both as regards its action and its strength, and it is used in Sydney and Brisbane in place of that alkaloid. A good deal of attention has been given in this country to the new agent by Dr. Ringer and Mr. Tweedy. The former says that it has the power of drying the mouth or preventing the flow of saliva, and that it also produces headache and drowsiness, while the latter considers it quicker and more energetic in its action than atropine, and considerably more so than the strongest extract of belladonna. In every case in which it had been used by him he found its action entirely satisfactory. This subject, which is one of importance, inasmuch as it promises to open up a new

source of supply of a substance fully as efficacious as, or perhaps more so than, atropine or belladonna, has for some time past attracted much attention in the colony where the plant grows, and has quite recently been brought to the notice of the Pharmaceutical Society. It is perhaps worth noting, that one of the colonial names of *Duboisia myoporoides* is the cork wood tree, so named from its light brown corky bark. The wood is of a light yellow colour, even grained, but soft, and used in the colony for carving. Specimens of the wood are contained in the Kew Museum.

THE additions to the Zoological Society's Gardens during the past week include an Arabian Baboon (*Cynocephalus hamadryas*) from Arabia, presented by Dr. A. P. Woodforde; two Chacma Baboons (*Cynocephalus porcarius*) from South Africa, presented by Capt. W. L. Coke; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. Milward; a Great Kangaroo (*Macropus giganteus*), a Laughing Kingfisher (*Dacelo gigantea*) from Australia, presented by Lieut. Crawford Caffin, R.N.; a Short-eared Owl (*Otus brachyotus*), European, presented by Mr. W. K. Stanley; a Golden-winged Parrakeet (*Brotogerys chrysoptera*) from the Amazons, received in exchange; a South American Rat Snake (*Spilotes variabilis*) from South America, deposited; a Yellow-footed Rock Kangaroo (*Petrogale xanthopus*), born in the Gardens.

THE DETERIORATION OF OIL PAINTINGS[1]

OIL paintings are subject to various kinds of changes, which may be considered as diseases, requiring different treatment according to their different nature. A science needs to be formed, a pathology and therapeutics of oil paintings. The pathology would have to describe and explain those diseases and their progress, and to develop the methods by which a correct diagnosis could be arrived at in each individual case. The therapeutics would teach the remedies which might be applied either to cure or to alleviate the disease, or at least to stop its progress. A hygiene would follow, which would have to teach how to avoid pernicious influences, and which, besides, while giving precepts for the technical process of painting, would have to forestall those constitutional diseases which, even in cases where no noxious influences can be traced, are the causes of decay, after a comparatively short period of existence. As medical science is above all things based on anatomy and physiology, so the exact knowledge of the structure of a picture would have to be acquired previously to any study of its disease. Unfortunately, direct investigation alone can procure no such exact knowledge; on the contrary, we are obliged to enter upon a minute historical investigation of the material as well as of the technical methods adopted by artists of different schools and different periods.

The excellent works of Cennino Cennini, Mérimée, Sir Charles Eastlake, Mrs. Merrifield, and others, have already furnished most valuable material; but still the field for investigation remains unlimited; for, in order to enable us to secure the conservation of each valuable painting, we ought to know exactly how it was made. The artists of the present time would spare infinite trouble to the investigators of future times, if, along with their works, they would leave the account of their practice in the case of each picture. A treatment without exact knowledge of the normal condition, as well as of the nature of the disease, is, as we shall see, as dangerous for the picture as it would be in the case of living beings.

Professional restorers of pictures admit this danger in a general way; each of them, however, is convinced that he himself, by his personal knowledge, skill, and care, knows how to avoid it. The public pays too little attention to the subject, and therefore it occurred to me that it might be useful to give a short account of what we know about this question, of the changes to which oil paintings are exposed, as well as of the means either to avoid or to cure them.

We have to consider, first, the material on which the artist has painted, that is, as far as oil painting is concerned, principally wood and canvas.

[1] Paper read at the Royal Institution, Friday, March 1, by R. Liebreich M.D., M.R.C.S., M.R.I.

Secondly, the priming, that is, the substance with which the surface was prepared in order to be made fit for painting.

Thirdly, the painting itself, that is, the pigments and vehicles used for it, and the liquids that were added during the painting, the mediums, meguilp, siccatire, varnish, essential oils, &c.

Fourthly, the coat or coats of varnish spread over the picture.

The wood on which a picture has been painted may either warp, or get chinks in it, or become worm-eaten, or even altogether rotten. Against warping, the remedy usually applied is moisture. If the panel is very thick, it is first made somewhat thinner; then the back is moistened, and the picture is left to lie on its back for twelve to twenty-four hours, after which time it will be found to have bent straight. Of course this must not be continued longer than necessary, otherwise the convex surface, instead of becoming plane, would become concave. When straight, the picture is kept so by beads which have to be adapted in a particular way, a certain degree of shifting being allowed for the expansion and contraction of the wood.

Cracks in the wood are drawn together by inserting pieces of wood of a special shape.

Sublimate solutions are employed to destroy worms.

Trifling losses of substance are replaced by cement. Small portions of rotten wood, not extending too near the painting, are cut out and replaced by wedge-shaped pieces. If, however, the greater part, or the whole substance of the panel, is rotten, the picture must be separated from it and transferred to new wood, or rather to canvas.

This was first tried by Hacquin in Paris, and was performed successfully upon many pictures, and, among others, upon one of Raphael's Madonnas, in the Gallery du Louvre, and upon Sebastian del Piombo's "Resurrection of Lazarus," now in the National Gallery. The process no longer appears so very marvellous; it is generally executed in the following way:—

First of all, the surface of the picture is pasted over with gauze and paper. After that the wood is made straight by moistening, or, if necessary, by making incisions with the saw, into which cuneiform pieces of wood are driven. By means of a tenon-saw the panel is to be sawn into little squares, which must be removed by a chisel, and in this way the thickness of the wood is reduced to half an inch; it is then planed until it becomes no thicker than paper, and the rest is removed by means of a knife and with the fingers. The painting being thus severed from its basis, it can be fixed on canvas, if the priming is sufficiently preserved. In the opposite case, a mixture made of chalk and glue, or something of the kind, must be put on first, and very evenly smoothed, after being dry. This done, the new canvas has to be fixed upon it by means of a mixture of glue, varnish, and turpentine, and the substance of the picture pressed tightly and evenly against it by means of warm irons.

In order to avoid deterioration, the most minute precepts have been given for preparing the panel. It has to be taken from the best oak, or nut-trees, or cedars. The wood is to be cut into boards during winter-time, and kept till autumn before being dried; it can then be prepared only in the following spring, &c. It would certainly be preferable to give up wood panels altogether for large pictures, and only to think of means to make the canvas stronger. For small pictures, panels offer certain advantages, and can be more easily preserved from decay.

In the canvas we meet with the results of injuries or spontaneous decay. A rent may be mended by rags of linen stuck at the back of the picture. Even a hole may be filled up by pieces taken from other decayed paintings. If the picture is considerably damaged, it will be best to line it. But if the whole canvas is rotten and tattered, it will be preferable to sacrifice it by pulling off the threads one by one, after having secured the painting itself by pasting paper on the front of it. This done, the painting is transferred to another canvas in the same way as those removed from wood.

There are different modes of priming, which may be brought under two principal heads: the distemper and the oil priming.

1. The canvas is distempered by a mixture of chalk or plaster and paste, or glue, which may be laid on raw, unbleached canvas, or this latter may be beforehand prepared with glue or paste. Several coats of this mixture must be put on in succession, one being perfectly dry before the next can be applied. Many of the older oil paintings are painted on such ground. It has the advantage of being quicker prepared, of absorbing the excess of oil, of permitting the colour to enter into the

priming, and to dry quicker, and moreover, of containing a white absolutely innocuous to the others.

The inconveniences, on the other hand, are: that it more easily breaks, and under the influence of humidity separates from the canvas.

2. The oil priming consists of several coats of oil colours. As each of these must be perfectly dry before the next is laid on, and as, moreover, time must be given to the whole to dry completely before painting upon, in order to avoid the sinking in of the colours, the whole preparation is much slower than the distemper. Nevertheless it is now generally adopted.

Rey, in France, has pointed out a process which is a compromise between the two methods; he begins by distempering, and after several coats of distemper, having dried one after the other, he puts a coat of oil which, as it were, changes the distempered ground into an oil-colour ground.

With oil priming it is of importance that the principal colour be white-lead, to which are added comparatively small quantities of yellow, black, or other colours. For a whole century a school, that of Bologna, predominated in Italy, which abandoned this principle. During the second half of the seventeenth and the first half of the eighteenth century, most of the Italian masters of other schools followed its example. Probably for the purpose of obtaining more easily the desired effect of the chiaroscuro, they painted on a brownish-red priming, which consisted of bolus mixed with umber. Not one of those pictures has kept its original colouring. Not only has the priming caused all the dark parts to grow much darker, but it has destroyed, or nearly so, all the glazing, so that only those colours can be recognised which either contain white, or are glazed on white. I can show you numerous instances of this, for, on account of the extreme fertility of this school, there is little difficulty in procuring pictures of masters of that time or of their pupils.

Wood priming does not require the same elasticity as that of the canvas, which ought to be capable of being rolled. Therefore the priming of the wood shows less variations. It is generally composed of chalk or plaster, tempered with starch, paste, size, or glue, and more or less thickly laid on. In some pictures of different centuries we find, either between the wood and the priming, or between the priming and the painting, canvas, and, exceptionally, even paper.

The diseases of the priming are not of a very complicated nature. They manifest themselves principally in three different ways:—1. By cracks in the priming itself. 2. By the severance of the priming from the painting. 3. By the severance of the priming from the wood or the canvas. The third disease is by far the most frequent, especially among pictures on canvas distempered with paste. If small pieces only are scaling off or blistering, they are fixed again to the ground by letting a solution of size pass between the detached part and the canvas, and pressing both gently together. If the deterioration extends over a considerable surface, the picture has to be lined. While this is being done, and while the gluing substance penetrates into the picture, the detached parts are pressed on again with slightly heated irons. If the whole priming threatens to come off, it will be better to take the picture entirely from the panel or canvas, and to transfer it to a new canvas.

I shall show you examples illustrating the before-mentioned points, and among them two pictures; one in oil, taken off from canvas, the other in tempera, taken off from wood. Both of them, strange to say, have escaped destruction without having been transferred to a new canvas, and without being covered with paper, as is usually done, before taking them off. They show you the painting by itself from both sides. I have, of course, used every precaution in bringing them safely over from Florence, where I happened to discover them carelessly stowed away among heaps of old pictures.

We come now to the most important part of the picture, the painting itself. We meet very often with the idea that the old masters had been in possession of colours, that is pigments, the knowledge of which has been lost, and that this accounts principally for the difference between the oil painting of the fifteenth and sixteenth centuries, on the one hand, and that of the eighteenth and nineteenth on the other. But this is a great mistake. We know perfectly well the pigments used by the old masters; we possess the same, and a considerable number of new ones, good as well as bad, in addition. In using the expression of good and bad I am principally thinking of their durability. From this point of view the pigments can be placed under three headings:—

1. Those which are durable in themselves, and also agree well with the other pigments with which they have to be mixed.

2. Such as when sufficiently isolated remain unaltered; but when in contact with certain other pigments change colour, or alter the others, or produce a reciprocal modification.

3. Those which are so little durable that, even when isolated from other pigments, the mere contact of the vehicle, the air, or the light, makes them in time fade, darken, or disappear altogether.

The old masters used, without reserve, only those belonging to the first of these categories. For those belonging to the second they imposed on themselves certain limits and precautions. Those belonging to the third they did not use at all.

That some of the modern masters have not followed these principles is not owing to a lost secret, but to the fact that they disregarded those well-known principles, and even consciously acted against them. In Sir Joshua Reynolds's diary, for instance, we read that in order to produce certain tints of flesh, he mixed orpiment, carmine-lake, and blue-black altogether. Now orpiment is one of the colours of the second category, carmine-lake one of the third. That is to say: orpiment, as long as it remains isolated, keeps its brilliant yellow or reddish-orange colour; but when mixed with white-lead it decomposes, because it consists of sulphur and arsenic, and it, moreover, blackens the white-lead, because the sulphur combines with it. Carmine-lake, even if left isolated, does not stand as an oil colour, and therefore has been superseded by madder-lake.

Unfortunately some of the most brilliant colours are perishable to such a degree that they ought never to be used; yet, it seems to me, that just in one branch of art in which of late remarkable progress has been made, I mean landscape painting, the artists, in order to obtain certain effects of colour not easily to be realised, do not always resist the temptation to make use of a number of pigments, the non-durability of which is proved beyond doubt. However that may be, I think it pretty certain that the pigments in themselves play only a subordinate part in the deterioration of oil paintings, and that the principal part belongs to the vehicle with which the colours are ground, and to the liquids which are added during the painting. I hope, therefore, you will excuse my making some elementary explanations about these liquids.

Oil and fat are bodies consisting of carbon, hydrogen, and oxygen. They may be considered as salts in which glycerine, as a basis, is combined with different acids, stearic acid, palmic acid, oleic acid. If oil is exposed to the air it changes; certain kinds of oil remain liquid; others become thicker and darker, and are gradually transformed into hard and opaque bodies. The drying of oils is based upon a chemical process, during which the oil oxidises by absorbing oxygen from the air, and combining a part of it with carbon to form carbonic acid, and another part with hydrogen to form water. The different oils dry with different rapidity, but this rapidity may be modified by the presence of certain substances, or by certain treatment. Linseed oil, for instance, according to the way in which it has been pressed out of the seed, contains more or less mucilaginous substances. These latter impede the drying of the oil, and have therefore to be removed by a refining process. If linseed oil in a shallow vessel is exposed to the air and light, and especially to a green light, it soon begins to dry, and is transformed first into a kind of varnish and gradually into a solid opaque substance. The drying may be quickened by boiling, and more particularly by the addition of lead, zinc, or manganese. In this way a quick-drying oil varnish may be prepared and used as a siccative. It follows that there are certain substances which impede the drying of oils, and others which facilitate it. Amongst the pigments are some which belong to this category of bodies; white-lead, zinc-white, minium, vermilion, for instance, facilitate the drying; others, such as ivory-black, bitumen, madder-lake, will impede it. Supposing, now, we should add to each of the different pigments the same quantity of oil, the drying of it would progress at different rates. But in reality this difference is very greatly increased by the fact that the different pigments require very different quantities of oil, in order to be ground to the consistency requisite for painting.

Pettenkofer quotes the following figures, given to him by one of the colour manufacturers:—

100 parts (weight)	White-lead	require	12 parts of oil.
,, ,,	Zinc-white	,,	14 ,,

100 parts	(weight)	Green chrome ...	require	15	parts of oil.
,,	,,	Chrome-yellow ...	,,	19	,,
,,	,,	Vermilion	,,	25	,,
,,	,,	Light red	,,	31	,,
,,	,,	Madder-lake	,,	62	,,
,,	,,	Yellow ochre	,,	66	,,
,,	,,	Light ochre	,,	75	,,
,,	,,	Cassel's-brown ...	,,	75	,,
,,	,,	Brown manganese	,,	87	,,
,,	,,	Terre verte	,,	100	,,
,,	,,	Parisian-blue	,,	106	,,
,,	,,	Burnt terre verte ...	,,	112	,,
,,	,,	Berlin-blue	,,	112	,,
,,	,,	Ivory-black	,,	112	,,
,,	,,	Cobalt	,,	125	,,
,,	,,	Florentine-brown ...	,,	150	,,
,,	,,	Burnt terra sienna	,,	181	,,
,,	,,	Raw terra sienna ...	,,	240	,,

According to this table a hundred parts of the quick-drying white-lead are ground with twelve parts of oil, and on the other hand, the slow-drying ivory-black requires one hundred and twelve parts of oil.

It is very important that artists should have an exact knowledge of these matters. But it seems to me that they are insufficiently known to most of them. All, of course, know perfectly how different the drying quality of different colours is. But that these different colours introduce into the picture so different a quantity of oil, and how large this quantity is in the colours they buy, and further, that the oil as well as the mediums or siccatives they add to dry the colours, are gradually transformed into a caoutchouc-like opaque substance, which envelops and darkens the pigments; and moreover, that the oil undergoes—not in the beginning, but much later on when it is already completely dry—changes of volume, and so impairs the continuity of the picture—all this is not sufficiently known. Otherwise, the custom of painting with the ordinary oil colours to be bought at any colourman's, would not have been going on for nearly a hundred years in spite of all the clearly shown evil results; results due, chiefly, TO THE PRINCIPAL ENEMY OF OIL PAINTING, THAT IS TO SAY, THE OIL.

That the masters of the fifteenth and sixteenth centuries did not use colours prepared in this way you may consider as absolutely certain; and if we hear the lost secret spoken of, and if we read that the pupils of the old masters had to pledge themselves to keep the secret, we may be sure that it is neither the method of painting nor the pigment used for it which is concerned in that secret, but exclusively the way of preparing the colours. The preparation was a very complicated one, varying with the different pigments; and we know that the pupils passed six years, that is half of the apprenticeship, in grinding the colours for the master.

And therefore it is to this very point that everyone who wishes to study the method of the old masters must first of all direct his attention. I, too, was led by the study of this question to analyse and restore old pictures. The possibility of making such analysis we owe to the relation between the old masters and their pupils. Of course we could not dissect or chemically analyse works of Titian or Raphael. But fortunately the pupils painted with the same material and by the same method as the masters, and thousands of pictures by the pupils, *well preserved* or in different stages of decay, may be easily procured.

I have myself, from among a very great number of such pictures, selected about one hundred specimens, part of which I have brought before you. As their artistic value is not, as you perceive, of the highest description, we need not feel any scruple in experimenting upon or even destroying them, if we can thereby gain any valuable information.

(*To be continued.*)

GAS-LIGHTING BY ELECTRICITY

FOR some time past the street lamps in Pall Mall, Waterloo Place, and part of Regent Street, have been connected by wires, which may have led the uninitiated to think that a new method of fixing telegraphic wires was about to be adopted. This is not the case, however, for although the wires were connected with a battery, they were not intended to convey telegraphic messages, but to experiment on a new method of lighting street lamps by means of electricity. The inventor of this method is Mr. St. George Lane Fox, who recently described his invention to the Society of Arts. Should Mr. Fox's method be adopted, the wires, instead of running from lamp to lamp above ground, will be carried along under ground, and the only thing visible would be a small piece of boxed-in mechanism just under the burner of each lamp. The experiment which was made on Saturday afternoon was not, we believe, completely successful. The magneto-electric machine and the battery which supply the current were placed in a small temporary instrument-house at the bottom of Waterloo Place. At the first trial the whole of the lamps in the circuit were lighted by the current, though in a second trial some of the lamps failed to respond to the current; but that this was owing to some local cause is probable from the fact that the first and last lamps in the circuit always responded to the discharge. We shall endeavour to explain the method adopted by Mr. Fox.

Fig. 1.

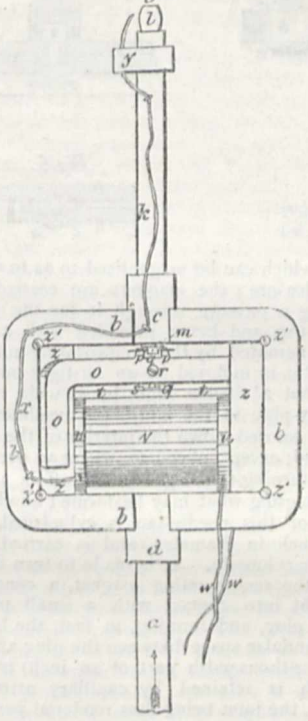
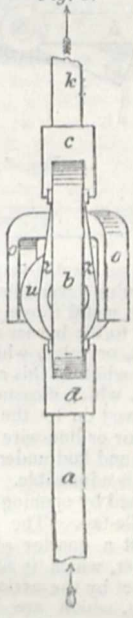


Fig. 2.



In the first place he supplies every lamp with an apparatus similar to Fig. 1; next the lamps must be connected with an insulated conductor, so that, starting from a central station, a wire would travel through each of these machines and back again to the station. Mr. Fox proposes that several of these circuits, each connecting and controlling 200 or 300 lamps, should proceed or radiate from a central station, so that from one point several thousand lamps could be operated upon almost instantaneously.

The method by which he has succeeded in producing the ignition of the gas at a considerable distance, and at numerous points, is by supplying each lamp with a small induction coil, so that the primary wires of each one of these induction coils forms part of the circuit, so in fact as to preserve without a break the metallic continuity of the line. After several experiments it occurred to him that in reality the amount of work to be done in producing a number of small electric sparks was extremely minute, although at the same time requiring to be produced almost instantaneously. Now the amount of work which an electric battery will produce is dependent on the time during which action continues, and in a single instant, or say the thousandth part of a second, the actual amount of power available is naturally extremely small, and he thought that if he could by any means accumulate this power for a short time and then bring it suddenly to bear upon the circuit, the desired result would be obtained. By means of an apparatus he succeeded in accumulating the electric current and storing it up into the condenser or

electric reservoir, which is composed of glass plates and tin-foil laid side by side alternately.

The condenser, however, is not charged direct by the battery, but the current is made to work this Ruhmkorff induction coil, from which there is derived a current having an enormously increased electromotive force, and it is this electricity that is stored up in the condenser.

Having charged the condenser in this fashion, the whole of the electricity is at once sent through the line, and produces most extraordinary results. So much, then, for the lighting of the gas. The process of turning on and off the gas, although involving many important details, is very simple. Mr. Fox makes use of the soft iron core which runs through the centre of the coil to produce a reciprocating horizontal motion of a permanent horse-shoe magnet, suspended on needle-points just above the coil. The soft iron core with the primary coil is, in

Fig. 3.

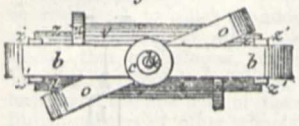


Fig. 5.

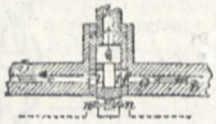


Fig. 4.

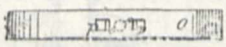


Fig. 6.

fact, an electro-magnet, which can be magnetised so as to render its poles reversible at pleasure; the magnets are carried in a small metal frame, having a passage through it for the gas to pass to the burner at the top, and being provided with a stop-cock, or valve, which is actuated by the reciprocating magnet. The whole of this apparatus is inclosed in an air-tight metallic case, which measures about 2¼ inches high, by 2½ wide, and is screwed on to the supply-pipe in the lamp, the insulated conductor or line-wire being carried down the interior of the lamp-post and laid under ground, except, of course, where an overhead line is admissible. The turning of the gas on and off is accomplished by opening and closing what may be termed an electric needle-tap. The plug of this needle-tap is cylindrical, and about a quarter of an inch in diameter, and is carried in a socket, which it fits rather loosely. It is made to turn in this socket by the action of the reciprocating magnet, a couple of studs, which are brought into contact with a small pin or lever connected with the plug, and forming, in fact, the handle of the stop-cock. The annular space between the plug and the socket (which is about one-thousandth part of an inch) is filled with some liquid, which is retained by capillary attraction between the two surfaces, the joint being thus rendered perfectly gas-tight. The oil of bitter almonds or glycerine are both well adapted for this purpose, on account of their non-oxidisable character, and from the power they possess of resisting the action

Fig. 7.

Fig. 8.

Fig. 9.

of very low temperatures. A special feature in the apparatus is the introduction of a fixed core, which can be magnetised, so as to render its poles reversible at pleasure, and in conjunction with it a movable magnet, the polarity of which is permanent. An electric current sent either forwards or backwards for a few seconds will turn the gas on or off in every lamp in the circuit according to the direction of the current.

To put the system into practical operation, there would be for any district of, say two or three thousand lamps, a central station, from which the wires would proceed in every direction, so as to command a number of distinct circuits; all that is necessary to have at the central station would be a battery of some sort. Mr. Fox would much prefer a magneto-inductor. By means of a switch and a commutator the electric current from this machine can be directed so as to operate separately on each one of the circuits, and by this means turn the gas on or off. When the gas is turned on it is lighted by sending a discharge from the condenser. It is constructed of alternate metallic plates, with an insulator or dielectric between them; the conducting surfaces in this case are of tinfoil, and the dielectric of crown glass. The coil used for charging the condenser need not give more than about three-quarters of an inch spark in the air. The discharge, like the current, will of course have to be sent through each circuit separately, and this is also done by means of the switch arrangement.

The accompanying figures will enable the reader more clearly to understand the description we have given above.

Fig. 1 is a front elevation, Fig. 2 a side elevation, and Fig. 3 a plan of the apparatus; Fig. 4 is a plan of the permanent magnet; Figs. 5 to 9 represent details to be referred to.

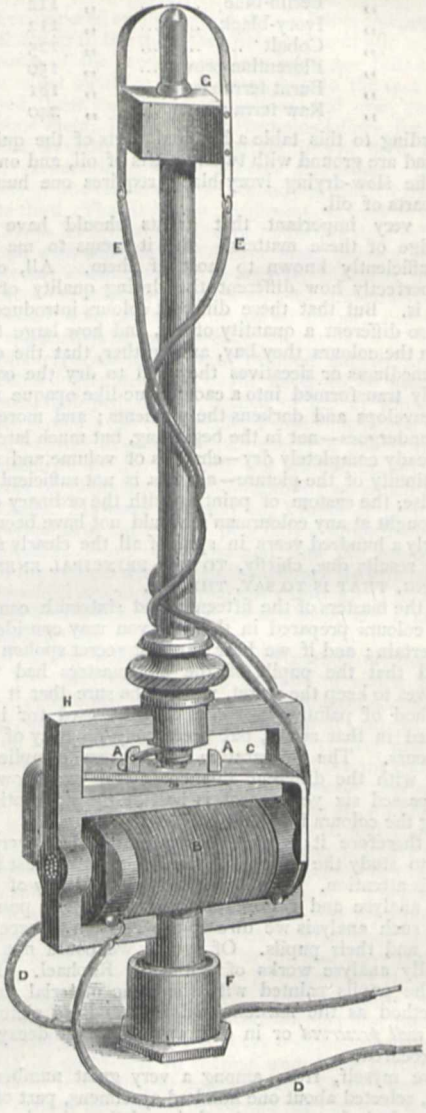


FIG. 10.

a is the gas-pipe leading from any ordinary source of supply; *b b* is a rectangular frame of white metal or brass, cast or made with a hollow core, and having two cylindrical portions, *c d*. The part *d* is screwed upon the gas-pipe *a*, which supports the apparatus, and the part *c* receives the stop-cock; this cock, which is shown in sectional elevation in Fig. 5, and in sectional plan in Fig. 6, is composed of a brass tube *e* (shown separately in Fig. 7), which fits into the cylindrical part *c*, and has two openings, *f f*, corresponding with the passages *g g*, in the opposite sides of the frame *b b*; *h* is the plug of the cock (shown separately in Fig. 8); it is made with a very slight downward taper, and has two apertures or ways *i i*, corresponding with the openings *f f* in the tube *e*, and it is hollowed out in the middle. When the gas is turned on, the apertures *i i* come opposite the

openings *f f*, the gas having then a free passage from the pipe *a* through the two sides of the frame *b b*, and into and through the plug *h*. It will be seen on reference to Fig. 6, that a small turn of the plug is sufficient to open or close the cock. *k* is a pipe screwed into the tube *e*, and leading to the burner *l*. *m* is a projection at the lower end of the plug, and *n* is a pin passed through the same. The plug is supported on the point of the pivot on which a magnet turns, so that very little power is required to turn the plug. *o* is a permanent magnet, which may be either cast in steel, with the two projecting pieces *p p*, or made out of a steel bar bent into the proper shape, and in this case the projections *p p* are produced by screwing in two pieces of metal. *q* is the pivot on which this magnet turns; it is passed through a vertical hole in the magnet, and fixed by a screw *r*. The lower end of the pivot rests in a steel step *s*, which is supported by a small wooden beam *t*, secured to the ends of the wooden bobbin *u*. *v* is the induction-coil; it is composed of a core of soft iron wires, two layers of primary wires wound with covered copper wire of about No. 20 BWG, and upon these about ten to fifteen layers of secondary wire of about No. 40 BWG. The primary wires *w w* form part of the circuit by which the lamps to be lighted or extinguished simultaneously are connected. One end of the secondary coil is connected to an insulated wire *x*, leading to the burner *l*, where it terminates in a platinum point, and the other end is connected to the frame *b*, or to any other metallic part of the apparatus, so as to be in metallic connection with the burner. The insulated wire *x* passes through an earthenware support *y* (seen in plan in Fig. 9), fixed to the pipe *k*. The soft iron core projects about three-eighths of an inch from each end of the wooden bobbin *u*. The bobbin is fastened to wooden supports *z z*, which are fixed to the frame *b* by screws z^1 z^1.

Fig. 10 (for the use of which we are indebted to the Society of Arts) is a view of the complete apparatus as attached to a gas lamp.

AMERICAN SCIENCE

THE March number of the *American Journal of Science* opens with a valuable paper, in which Prof. Norton collates the various observations made on Coggia's comet. The theory of cometary phenomena he arrives at is (briefly) that the direct action of the sun on the side of the nucleus exposed to the solar rays is to form an envelope of gaseous carbonic oxide. This envelope of diamagnetic gas is traversed by the ideal lines of magnetic force proceeding from the nucleus, which are also lines of conduction through the gas. The electricity set free by the ascending currents of gas, by reason of the diminished gaseous pressure, is propagated along these lines, and the impulsive force of the electric currents detaches streams of the successive molecules of the gas in the direction of the lines of conduction. Both the nucleus and the sun exert repulsive forces on the escaping molecules; but their effective actions may be either repulsive or attractive, according as their attraction prevails over the attraction of gravitation, or the reverse. The author elucidates this theory at some length.

In a reply to Mr. Mallet's review (in the *Philosophical Magazine*) of General Abbott's paper on the velocity of transmission of earth-waves, in which the value and accuracy of the Hallet's Point observations were doubted, the General describes some new observations on the subject, which seem to establish these points: 1. A high magnifying power of telescope is essential in seismometric observations. 2. The more violent the initial shock the higher is the velocity of transmission. 3. This velocity diminishes as the general wave advances. 4. The movements of the earth's crust are complex, consisting of many short waves first increasing and then decreasing in amplitude, and, with a detonating explosive, the interval between the first wave and the maximum wave, at any station, is shorter than with a slow-burning explosive.

A new method for decomposition of chromic iron, proposed by Mr. Smith, consists in exposing it (in an exceedingly fine state) with bromine to a temperature of 180° C. from two to three days. Prof. Marsh furnishes an account of some new Dinosaurian reptiles.—Prof. Kimball describes some experiments on journal friction at low speeds.—There are also notes on some reactions of silver chloride and bromide, brightness of the satellites of Uranus, &c.

The new number of *Appalachia*, the journal of the Appalachian Mountain Club, contains a valuable address by the president, Dr. S. H. Scudder, in which he reviews the principal scientific expeditions in the United States during the past year. Dr. Scudder himself is attached to the Hayden Survey, and made the discovery of the beds of fossil insects at Florissant, near Manitou, Colorado. During the past year 20,000 fossil insects have been exhumed from this quarry.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The fifth and final report of the Syndicate appointed in May, 1875, to consider the requirements of the University in different departments of study, has been issued. The Syndicate have considered the question of the residence to be required of professors. They are of opinion that it is desirable—(1) that the time for which the University may require the residence of professors shall be left to be determined by the University in the case of each professorship, without any general statutable restriction; (2) that no professor shall be considered to satisfy the condition of residence who is not for the time required making his home within a mile and a half of Great St. Mary's Church, unless special permission, available for not more than one year at a time, but renewable, be granted by the Vice-Chancellor and Sex Viri, and that such permission shal not be granted unless the Vice-Chancellor and Sex Viri are satisfied that the professor has made such arrangements as will secure his being reasonably accessible in Cambridge during term time. The Syndicate have also had under their consideration the importance of individual personal intercourse between students and teachers, and it has also been suggested that the inspection and revision of students' note-books by the teacher may in many cases be of considerable use. The precise manner in which such personal intercourse may be most effectually secured will probably vary very much in different subjects and for different teachers, but it seems important that the arrangements should be such that the professor himself may in all cases see a portion of the work of his class, so as to make himself accurately acquainted with their wants. The Syndicate have referred to the Board of Medical Studies the question whether it is desirable to found a complete medical school in Cambridge so as to make it possible for a student to complete his whole medical course here, or whether it is better for all concerned, while making the teaching at Cambridge as perfect as possible in the scientific subjects which are the basis of medicine, to leave students to carry on elsewhere the greater part of their clinical studies and most of what relates directly to the practice of medicine. The reply of the Board of Medical Studies states that they consider it inexpedient that students should complete their whole professional education at any single medical school, and that it is therefore desirable that students should pursue their studies away from Cambridge for a year or more before commencing practice, either before or after their final M.B. examination. They believe, however, that it would be in most cases advantageous to students to carry their medical studies in Cambridge further than is usually done at present, and in some cases as far as the final M.B. examination, and they are therefore of opinion that the University should provide systematic instruction in all the subjects necessary for a medical degree, as is done at other Universities. In order that this may be carried out satisfactorily the Board of Medical Studies think that the University should provide:—1. A Professor of Pathology. 2. A Professor of Surgery. 3. Systematic teaching in (1) midwifery and the diseases peculiar to women (2) medical jurisprudence; (3) sanitary science; (4) mental diseases. 4. Systematic clinical teaching.

R.G.S. PUBLIC SCHOOLS' PRIZE MEDALS.—The following is the award of the Public Schools' Prize Medals annually given by the Royal Geographical Society:—Physical Geography—Gold Medallist, William John Newton, of Liverpool College; Silver Medallist, Christopher Mounsey Wilson, of Clifton College; Honourably Mentioned—E. G. Harmer, University College School; M. H. Clifford and M. A. Soppitt, of Dulwich College; and J. S. G. Pemberton, of Eton College. Political Geography—Gold Medallist, William Wallis Ord, of Dulwich College; Silver Medallist, George Arnold Tomkinson, of Haileybury College; Honourably Mentioned—A. R. Ropes, of the City of London School; A. Kay, of Rossall School; and D. Bowie, of Dulwich College.

GREIFSWALD.—The University has received a grant of 381,000 marks for a new library building, and 200,000 marks for the construction of a physical laboratory.

SCIENTIFIC SERIALS

Bulletin of the Nuttall Ornithological Club. A Quarterly Journal of Ornithology. Vol. III. January, No. 1.—This journal, on entering upon its third volume, has increased its quarterly numbers from a thin part of twenty-four pages to a part containing forty-eight pages and a coloured plate. It will continue, as before, under the editorial management of Mr. J. A. Allen, assisted by Prof. Baird and Dr. E. Coues, and it is intended that the volume for the current year should contain an exhaustive *résumé* of the current literature relating to North American Ornithology. The present number contains—Dr. E. Coues: On *Passerculus bairdi* (with plate), and *P. princeps*.—H. W. Henshaw on the species of Passerella.—W. A. Cooper: On the breeding of *Carpodacus purpureus*, var. *Californicus*.—W. Brewster: On the first plumage of North American birds.—J. A. Allen: On Wallace's theory of birds' nests.—N. S. Goss: Breeding of the duck hawk in trees.—Notes of recent literature and general notes.

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. xi. fasc. iii.—On the action of so-called catalytic force viewed according to the thermodynamic theory, by M. Tommasi.—Study on the dominant diseases of vines, by M. Garovalio and Cattaneo.—On the chronology of Tyrrhenian volcanoes, and on the hydrography of the Val di Chiana previously to the miocene epoch, by M. Verri.—On the permanent magnetism of steel at different temperatures, by M. Poloni.—On the plasmogonic production of leptothrix and leptomitus, by M. Cattaneo.—On the refrigeration of pulverulent metallic solids (continued), by M. Cantoni.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 28.—"On the Reversal of the Lines of Metallic Vapours," by G. D. Liveing, M.A., Professor of Chemistry, and J. Dewar, M.A., F.R.S., Jacksonian Professor, University of Cambridge. No. I.

In order to examine the reversal of the spectra of metallic vapours, the authors observe the absorptive effect produced on the continuous spectrum emitted by the sides and end of the tube in which the volatilisation takes place. For this purpose they use iron tubes about half an inch in internal diameter, and about twenty-seven inches long, closed at one end, thoroughly cleaned inside, and coated on the outside with borax, or with a mixture of plumbago and fireclay. These tubes are inserted in a nearly vertical position in a furnace fed with Welsh coal, which will heat about ten inches of the tube to about a welding heat, and they observe through the upper open end of the tube, either with or without, a cover of glass or mica. To exclude oxygen, and avoid as much as possible variations of temperature, they introduce hydrogen in a gentle stream through a narrow tube into the upper part only of the iron tube, so that the hydrogen floats on the surface of the metallic vapour without producing convection currents in it. By varying the length of the small tube conveying the hydrogen, they are able to determine the height in the tube to which the metallic vapour reaches, and to prevent further displacement of the vapour, and thus to maintain different lengths of the iron tube full of metallic vapour at a comparatively constant temperature for considerable periods of time.

By this means the following observations have been made up to the present time:—

The first metal experimented on was thallium, one of the most volatile of metals. After arranging the current of hydrogen so as to keep the tube free from air, but without any rapid movement of the gas, they saw the characteristic line reversed, and maintained it so for a considerable time.

The metal indium, closely allied in its behaviour and volatility to thallium, was next examined, and they observed the bright blue line reversed. This was most plainly visible when that portion of the vapour which was nearest to the sides of the tube was looked through.

They had great difficulty in preventing the oxidation of magnesium in the tube, and in using tubes wider than half an inch, did not succeed in getting any reversal, but with half-inch tubes the *b* lines were clearly and sharply reversed, also some dark lines, not measured, seen in the blue. The sharpness of these lines depended on the regulation of the hydrogen current, by which the upper stratum of vapour was cooled.

A piece of metallic lithium was introduced, and gave no results. Sodium was next added in the same tube, and this did not bring out the reversal of the lithium lines. Similarly, chloride of lithium and metallic sodium, introduced together, gave no better results. To a tube containing potassium vapour, some lithium chloride was added, but no lithium line appeared. On adding metallic sodium to this atmosphere, and more lithium chloride, the bright-red lithium line appeared sharply reversed, and remained well defined for a long time. It is worthy of observation that the lithium line was only reversed in a mixture of the vapours of potassium and sodium, and it seems highly probable that a very slightly volatile vapour may be diffused in an atmosphere of a more volatile metal, so as to secure a sufficient depth of vapour to produce a sensible absorption. This would be analogous to well-known actions which take place in the attempt to separate organic bodies of very different boiling points by distillation, where a substance of high boiling-point is always carried over, in considerable quantity, with the vapour of a body boiling at a much lower temperature. It is a matter for future investigation how far chemical interactions taking place in a mixture of metallic vapours affect the volatility of a third body, and what relation, if any, this may have to such phenomena as the increased fusibility of mixtures of salts of potassium and sodium, and the well-known fluidity of the alloy of those metals.

As the authors have had occasion to use sodium and potassium in their tubes, they have had opportunities of observing the absorption spectra of these metals, and they find that there is a great deal yet to be observed in regard to these spectra. Up to the present time they have not observed any of the appearances noted by Lockyer, "On a New Class of Absorption Phenomena," in the *Proceedings* of the Royal Society, vol. xxii., but they have repeatedly noted the channelled-space spectrum of sodium described by Roscoe and Schuster, in the same volume of the *Proceedings*. They observed in their tubes no channelled space absorption by potassium, but continuous absorption in the red and one narrow absorption band, with a wave-length of 5,730, not corresponding with any bright line of that metal.

With reference to the absorption spectrum of sodium vapour they remark that it is by no means so simple as has been generally represented. The fact that the vapour of sodium in a flame shows only the reversal of the D lines, while the vapour, volatilised in tubes, shows a channelled space absorption, corresponding to no known emission spectrum, appears to be part of a gradational variation of the absorption spectrum, which may be induced with perfect regularity. Experiments with sodium, carried out in the way described, exhibit the following succession of appearances, as the amount of vapour is gradually diminished, commencing from the appearance when the tube is full of the vapour of sodium, part of it condensing in the cooler portion of the tube, and some being carried out by the slow current of hydrogen. During this stage, although the lower part of the tube is at a white heat, we have always noticed, as long as the cool current of hydrogen displaced metallic vapour, that, on looking down the tube, it appeared perfectly dark. The first appearance of luminosity is of a purple tint, and, with the spectroscope, appears as a faint blue band, commencing with a wave-length of about 4,500, and fading away into the violet. Next appears a narrow band in the green, with a maximum of light, with a wave-length of about 5,420, diminishing in brightness so rapidly on either side as to appear like a bright line. This green band gradually widens, and is then seen to be divided by a dark band, with a wave-length of about 5,510. Red light next appears, and between the red and green light is an enormous extension of the D absorption lines, while a still broader dark space intervenes between the green and the blue light. The dark line in the green (wave-length about 5,510) now becomes more sharply defined. This line appears to have been observed by Roscoe and Schuster, and regarded by them as coinciding with the double sodium line next in strength to the D lines, but it is considerably more refrangible than that double line. In the next stage, the channelled space spectrum comes out in the dark space between the green and blue, and, finally, in the red. Gradually the light extends, the channels disappear, the D lines absorption narrows, but still the dark line in the green is plainly

discernible. Lastly, there is only D lines absorption. The blue and the streak of green light at first observed seem to the authors due to luminosity of the vapour itself, where it is somewhat cooled, the later stages being mixed phenomena of absorption and emission.

As the absorption line, with wave-length about 5,510, has not been distinctly recorded by other observers, they have endeavoured to trace it under somewhat different conditions from that of the vapour volatilised in white hot-iron tubes. This absorption-line is easily seen when a gas-flame is observed through a horizontal glass tube, about three inches long, containing sodium volatilised in the middle of the tube by the heat of a Bunsen's burner, and equally well whether the tube contains hydrogen or nitrogen, besides sodium. They have also observed the same absorption-line when a piece of commercial magnesium ribbon (which always contains sodium) is ignited in a horizontal position, so that the metal melts and produces an elongated flame. It is of some interest to note that absorption-lines of about this wave-length, in the solar spectrum, are given by Kirchhoff and Angström not corresponding with emission lines of known elementary bodies.

When potassium vapour is observed, whether in the iron tube or in a glass tube, an absorption-line is seen, with a wave-length of about 5,730, which is more refrangible than the yellow double emission line of potassium, and does not correspond to any known bright line of that metal.

They reserve, for a future communication, the discussion of the identity or non-identity of these absorption-lines with lines in the solar spectrum and the inferences which may be drawn from such determination.

The method of observation described may be used to observe emission-spectra as well as absorption-spectra, for if the closed end of the tube be placed against the bars of the furnace so as to be relatively cooler than the middle of the tube, the light emitted by the vapours in the hottest part is more intense than that emitted by the bottom of the tube. This succeeds admirably with sodium, but they have not specially observed it with other vapours.

Chemical Society, March 22.—Dr. Gladstone, president, in the chair.—The following papers were read:—On aromatic nitrosamines, by Dr. O. N. Witt. The author gives an account of his study of some complicated reactions of diphenylnitrosamine. He has found that ordinary ethylic nitrite contains nitric acic, and has therefore used mixtures of pure amylic nitrite and nitric acid for acting on diphenylamine, and has obtained mononitrodiphenylnitrosamine in light yellow plates melting at 133·5° C., and two bodies which, on the removal of their nitroso groups, yielded dinitrodiphenyamine and an isomeric substance. The final product of the action of strong nitric acid is hexanitrodiphenylamine.—The next paper was on a new process for the volumetric estimation of cyanides, by J. B. Hannay. The cyanide is dissolved in water, and the solution rendered alkaline by ammonia. A standard solution of mercuric chloride is run in with constant stirring until the liquid is distinctly opalescent. The end reaction is sharply marked and very delicate. The presence of silver does not interfere, so that the process can be used for estimating the cyanides present in a plating bath.—The last paper was on certain bismuth compounds, Part 7, by M. M. P. Muir. The author has compared the behaviour of bismuthous and phosphorous chlorides in certain reactions; the latter substance acts as a reducing agent in some cases in which the former does not exert any such action. The author has also studied two oxalates of bismuth, the production of the so-called bismuthates, and some experiments with bismuthous iodide.—Mr. Williams exhibited a fine sample 24 oz. of natural salicylic acid, also about one gallon of pure methylic alcohol.

Linnean Society, March 21.—W. Carruthers, F.R.S., vice-president, in the chair.—Mr. G. T. Saul exhibited an example of the enormous development of adventitious roots from a species of *Berberis*.—On behalf of Mr. J. Willis Clark of Cambridge, there was exhibited mounted specimens of the male, female, and young of the fur-bearing seal of the North Pacific. Mention was made of the "rookeries" of these creatures, containing over 3,000,000 seals in a compact area. Like old Turks, a male dominates over a harem of a dozen or fifteen females, which he guards with jealous care, for two months or more, never stirring from the spot, and meantime fights terrific battles for its maintenance. A neutral zone exists to the rear of the breeding-grounds, where the enforced bachelors and adolescent young of both sexes repair. These come and go continuously, passing to and fro through free lanes of passage. Others of these animals delight in dashing among the breakers on the surf, or in droves frolic and play on the sand and grassy dunes adjoining the more rocky ground of the "rookery." The method of shaving the fleshy side of the skin, thus cutting loose the roots of the long coarse hairs, and retaining the superficial fine fur of commerce was explained, as also other interesting points in the economy and natural history of the Otaries.—The Secretary read the gist of a paper on the venation of the leaf of hemlock (*Conium maculatum*), by Mr. J. Gorham. The latter's observations show that in a piece $\frac{1}{8}$ inch long, by $\frac{1}{8}$ inch wide, by registration of the veinlets in a tabular form, and constructing these in figure, an exact counterpart of the venation of the entire leaf results. Comparisons of leaves of different umbelliferous genera prove that each can be detected and recognised from the merest fragment.—A communication was made by Mr. B. Clarke on a new arrangement of the classes of zoology, founded on the position of the oviducts, or when these are absent on the position of the ovaries, including a new mode of arranging the mammalia.—A notice in abstract was given on some genera of the Olacaceæ, by Mr. J. Miers. He describes a new genus, Rhaptarrhena, from Brazil, allied to Aptandra; also three other genera, Myoschilos, Arjona, and Quinchamalium, which possess a distinct though small calyx and separate calycle.—The Rev. M. J. Berkeley and Mr. C. E. Broome gave a list of fungi from Brisbane, Queensland. Among these Agarics, Clavarei, and fleshy fungi are scarce; interesting forms of Polyporei obtain while leaf-parasites are poorly represented. Some species are identical with Ceylon and South American kinds, and several are common to Europe.—The following gentlemen were elected Fellows of the Society:—John Evans, F.R.S., C. P. Ogilvie, Arthur Veitch, and Sydney H. Vines, B.A.

Zoological Society, March 19.—Mr. Arthur Grote, vice-president, in the chair.—The Secretary exhibited the type specimen of *Dicrurus marginatus* of Blyth, and pointed out its identity with *Muscipipra vetula* (fam. Tyrannidæ).—Mr. J. W. Clark, F.Z.S., exhibited and made remarks on some stuffed specimens of the Sea Lion (*Otaria ursina*) of the Prybylov Islands, which had been presented to the Museum of the University of Cambridge by the Alaska Commercial Company.—A communication was read from the Marquis of Tweeddale, F.R.S., containing the sixth of his contributions to the ornithology of the Philippines. The present memoir gave an account of the collections made by Mr. A. H. Everett in the Island of Leyte.—Mr. P. L. Sclater, F.R.S., read a report on the collection of birds made during the voyage of H.M.S. *Challenger*, in the Sandwich Islands, and pointed out the characters of a new species of duck, of which it contained specimens, and which he proposed to call *Anas wyvilliana*.—A communication was read from Mr. W. A. Forbes, F.Z.S., containing notes on a small collection of birds from the Samoan Islands and the Island of Rotumah, Central Pacific.—A communication was read from Mr. F. Nicholson, F.Z.S., containing a list of the birds collected by Mr. E. C. Buxton, at Darra Salam, on the Coast of Zanzibar.—Messrs. F. Du Cane Godman and Osbert Salvin gave descriptions of new species of Central American butterflies of the family Erycinidæ.—Prof. A. H. Garrod, F.R.S., read some notes on the visceral anatomy of *Lycaon pictus* and *Nyctereutes procyonides*.—A communication was read from Mr. Andrew Anderson, F.Z.S., containing the description of a new Indian *Prinia*, obtained in the Bagesur Valley, North-Western Himalayahs, which he proposed to name *Prinia poliocephala*.

Meteorological Society, March 20.—Mr. C. Greaves, president, in the chair.—Mr. B. L. Smith was elected a Fellow.—The discussion on Dr. Tripe's paper on the winter climate of some English sea-side health resorts was resumed and concluded, after which the following papers were read:—Notes on a waterspout, by Capt. W. Watson, F.M.S.—Notes on the occurrence of globular lightning and of waterspouts in Co. Donegal, Ireland, by M. Fitzgerald.—Observations of rainfall at sea, by W. T. Black.—The discussion on the subject of waterspouts and globular lightning was adjourned till the next meeting, on April 17.

Anthropological Institute, March 26.—Mr. John Evans, D.C.L., F.R.S., president, in the chair.—The following new members were announced:—Dr. Sebastian Evans and Dr. Allen Thomson, F.R.S.—A paper was read by Mr. Francis A. Allen on the original range of the Papuan race. This paper was a brief *résumé* of the opinions held by many anthropologists

with regard to the origin, characteristics, and distribution of these races, and an attempt to prove that they once extended on the west as far as Africa, and on the east as far as America. The writer especially dwelt upon the statements of Herodotus with regard to the eastern and western Ethiopians, and the black Colchians, and referred to the legend of the Asiatic Memnon, and the existence of black races in Central America, within the historic period. The director then read a paper by Dr. Julius von Haast, F.R.S., on some ancient rock paintings in New Zealand. The author considered that when these rock paintings were carefully studied by archæologists and linguists, they would prove that at one time there had been an introduction of a far higher civilisation than the Maories ever reached.

Institution of Civil Engineers, April 2.—Mr. Bateman, president, in the chair. The paper read was on the Huelva Pier of the Rio Tinto Railway, by Mr. T. Gibson, Assoc. Inst. C.E.

EDINBURGH

University Chemical Society, February 20.—John Gibson, Ph.D., F.R.S.E., presiding.—Mr. W. L. Goodwin read a paper on a method of removal of iron from cupric sulphate for analytical purposes, in which he stated that this could be performed by the replacement of the iron by cupric hydrate.—Mr. Alexander Macfarlane, M.A., B.Sc., read a paper on the disruptive discharge of electricity, in which he gave the difference of potential necessary to produce sparks at different distances up to ten millimetres, and also with different pressures and gases as dielectrics.

February 27.—W. Inglis Clarke, B.Sc., in the chair.—A paper on electrolysis was read by R. M. Morrison, D.Sc., Chemical Demonstrator of the University, in which he traced the history of electrolysis down to the present time, showing that as recently as 1840 the art was practically in its infancy, and that at the present day it was in numberless ways made use of. The chief points of theoretical and practical interest were dwelt upon, both with regard to the various metals which could practically be used, and to the solvents from which the best results were obtainable.

VIENNA

Imperial Academy of Sciences, January 10.—On the behaviour of propylic glycol in a high temperature, by M. Linnemann.—On the direct transformation of isobutylic iodide into trimethylcarbinolamin, by M. Brauner.—On artificial malic acid from evernic acid, by M. Loydl.—On the Maxwell-Simpson synthesis of aerolein from dliodacetone, by M. Voelker.—On the behaviour of β bibrompropionic acid towards iodide of potassium, by M. Zotta.—On the so-called rag-illness of workers in paper manufactories, by M. Frisch.

January 17.—The undulating nutation of internodes, by M. Wiesner.

January 31.—Determination of the path of the second comet of 1874, by M. Wenzel.—Contributions to a fuller knowledge of the Tunicata, by M. Heller.—On Ampère's fundamental electrodynamic experiments, by M. Ettinghausen.—On the behaviour of phoroglucin and some related substances towards woody cell membranes, by M. Wiesner.—On the degeneration of leaf-growth of some Amygdaleæ, produced by species of *Exoascus*.—On the theory of surface potential, by M. Wassmuth.—Contribution to study of electricity, magnetism, terrestrial currents, magnetic variation, declination, inclination, and intensity, by M. Daubrawa.—On a simple method of drawing a tangent to the ellipse and parabola, by M. Zimels.

PARIS

Academy of Sciences, April 8.—M. Fizeau in the chair.—The following among other papers were read:—Extract from a work by M. Chevreul, on the vision of colours. M. Chevreul describes some effects obtained by rotation, with diminishing speed, of a disc having one half red the other white, as compared with a similar disc viewed when at rest.—On the transparence of coloured flames, by M. Gouy. For measuring very weak radiations the objective of the collimator of a spectroscope is half covered with a plane mirror which reflects the rays from a second collimator parallel to the axis of the first. Thus in the focal plane of the telescope are got two superposed spectra, received on a slit parallel to the lines, which serves as eye-pieces. The two flames compared send their rays through the two collimators respectively; the eye sees through the prisms half of each of the objectives as a circle with its two halves of the same colour, but differing in brightness. The same brightness is given them by means of two Nicols on the second collimator. The angle of the principal sections is then read, and indicates the result of experiment. Coloured flames, got from a mixture of common gas and air with a finely-powdered salt in it, were carefully regulated and inclosed in another flame at the same temperature, but without metallic vapour. M. Gouy demonstrates the transparency of flame for the rays it does not emit, and for its own radiations.—On the variation of indices of refraction in mixtures of isomorphous salts, by M. Dufet. He finds that the differences between the indices of a mixture of two isomorphous salts and those of the component salts are in inverse ratio of the number of equivalents of the salts present in the mixture.—Direct fixation of oxygen and sulphur in benzine and toluene, by MM. Friedel and Crafts. Such fixation is accomplished by the intervention of chloride of aluminium; the authors cite it as supporting their hypothesis about this class of reactions.—Researches on nitrification by organic ferments, by MM. Schlœsing and Muntz. The vegetable organisms, mould and mycoderms, which are strongly productive of combustion of organic matter, do not produce nitrification; on the contrary, they transform nitric acid, placed at their disposal, first into organic matter then, partly, at least, into free nitrogen, the last phenomenon being often attended by production of ammonia. Hence they effect a loss of the combined nitrogen on the surface of the globe. The function of nitrifying combined nitrogen seems to be the special attribute of a group of particular beings, and not common to all the organisms which are intermediaries of combustion.—Absorption by the living organism of carbonic oxide introduced in small quantities into the atmosphere, by M. Gréhant. Man or an inferior animal caused to respire for half an hour in an atmosphere containing only $\frac{1}{1\,\frac{1}{0}}$ of carbonic oxide, absorbs this gas sufficiently for about half of the red corpuscles combined with the gas to become incapable of absorbing oxygen, while in an atmosphere containing $\frac{1}{144}$ of carbonic oxide, about a fourth of the red corpuscles are combined with this gas.—On the organ called chorda dorsalis in *Amphioxus lanceolatus*, by MM. Renaut and Duchamp. Amphioxus deprived of red blood containing hæmoglobin in its special elements, has no longer a chorda dorsalis comparable in its structure to that of all vertebrates.

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