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THURSDAY, JULY 23, 1874

THE PUBLIC SCHOOLS COMMISSION

THE claims of science to form an integral part of a liberal education are, without doubt, making progress. Readers of the early numbers of NATURE will remember how it was, with justice, complained that scarcely a single Scholarship or Fellowship was to be obtained at the old Universities for science alone. In more recent numbers the statement has to be modified—there is not yet a sufficient proportion. Now it is acknowledged on all hands, that the teaching of a subject at school and its recognition at the Universities are inseparably connected—and especially with regard to science. The Colleges say, We cannot give more scholarships, because a sufficient number of men of good attainments do not present themselves; and the Schools reply, We cannot spend our time on subjects for which there are so few rewards. Both profess willingness, but each calls on the other to take the initiative. One might, perhaps, be inclined to wonder that this question of pecuniary rewards should be of so much consequence as consciously to override the acknowledged main object in view—that of giving the best possible education. But it must be remembered that scholarships at the Universities are the honours of a school—the only means it has of showing to the world that it is doing its work well.

The progress due to the stimulus of scholarships is from these reasons slow, though perceptible; and the friends of science have been looking therefore to the Royal Commissions on Scientific Instruction, and on the Public Schools, to supply a stimulus from another quarter.

The proposed "Regulations" of the latter Commission which have just been issued will be welcomed by those who heartily wish for the progress of Science Teaching. Ignoring, of course, the question of University scholarships, they indirectly settle it by placing science on exactly the same level as mathematics, and enforcing the necessary outlay for its efficient teaching. And there can be little doubt that this is the right end at which to begin the reform, for it is a narrow view to consider the Universities as making the demand by offering rewards, and the schools as affording the supply. It is the public that demand scientifically educated men, and the schools first, and then the Universities, are called upon to supply them.

These Regulations apply, of course, to a very limited number of schools, some of which have already done much that is now required of them; but they are the most important schools in the kingdom, and will inevitably influence all others by the standard thus set. If these Regulations be confirmed the nail will be driven home, and science will be established as a necessary part of every public school curriculum.

The following are the Regulations to which we especially draw attention, and which are common to all the schools in the view of the Commission:—

"2. In every examination determining the position of a boy (not being one of the senior boys) in the school, or in any report of a general examination, the proportion of the marks to be assigned to mathematics shall be not less than one-eighth, nor more than one-fourth, as the governing body may think fit.

"3. In every examination determining the position of a boy (not being one of the senior boys) in the school, or in any report of a general examination, the proportion of the marks to be assigned to natural science shall be not less than one-eighth, nor more than one-fourth, as the governing body may think fit.

"4. In any examination for the senior boys, the proportion of the marks to be assigned to the several subjects of study shall be determined by the head master, with the approval of the governing body.

"5. The governing body shall from time to time determine the point in the school list above which the boys shall be reckoned as senior boys for the purposes of these regulations.

"6. The head master shall give facilities so far as practicable to any senior boy, at the request of his parent or guardian, to pursue any particular subject or subjects of study as may be deemed most expedient for him, and to discontinue any other subject or subjects of study for that purpose.

"7. The governing body shall, as soon as possible, provide and maintain out of the income of the property of the school, or out of any other means at their disposal for the educational purposes of the school, laboratories, and collections of apparatus, and of specimens."

It will be observed that the wording of Nos. 2 and 3 is identically the same, except the substitution of the words Natural Science for Mathematics—thus placing these two subjects upon exactly the same level. With regard to the limits one-fourth and one-eighth, taking it as approximately correct that the proportion of marks in an examination will be that of the time devoted to the subject, these two together will require at least one-fourth of the whole time, a larger proportion than is now given to mathematics in most schools, especially with those who are not "senior boys;" and thus an encroachment on the classical time is involved, and this lower limit is not likely, therefore, to be much exceeded, in these great schools at all events. But even this will insure greater breadth than under the old system, and will secure that every boy shall know something of the elements of science before he goes on to the elegancies of classics.

The individual character, however, of particular schools is not interfered with, for this depends essentially on the work of the senior boys; and for them by Regulation 4 the head master may arrange the marks to suit the old traditions of the school. Yet, when we consider the effect of Nos. 6 and 7, we may doubt whether the individuality will continue so well marked. For with laboratories to work in, and specimens to handle, and facilities to pursue their favourite subject, it is impossible but that some fair proportion of the scholars should be attracted by the charms of physical investigation or of natural history, and mix the honours of the school.

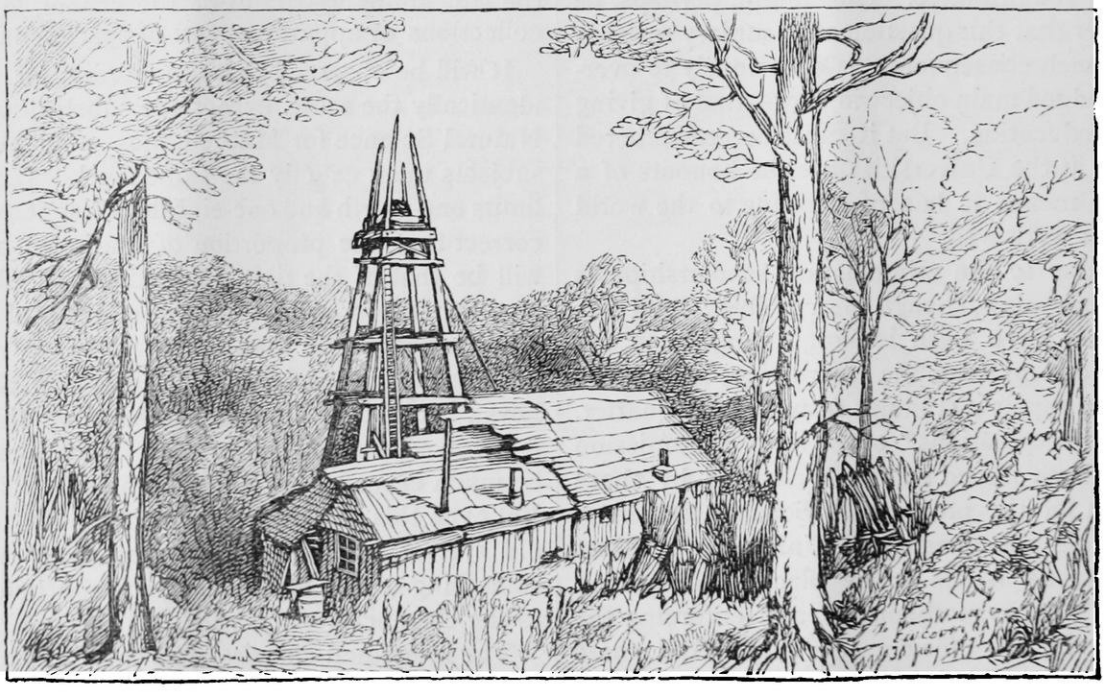
Of all the proposed Regulations, however, the most pregnant with consequences is the last.

There is no need surely in these days to insist on the absolute necessity for "laboratories and collections of apparatus and of specimens," if science is to be taught at all; and we may look, therefore, on this as simply the definition of the term "Natural Science;" it is not book learning, but science learnt from Nature herself by practical work. If a governing body be called on to provide such laboratories, we may rely on it that for the credit of their school they will do it well, and a good laboratorleaves only a good teacher to be desired, and itself helps to form and train him. The confirming of this Regulation will be a great step towards that much-to-be-desired state of things when a laboratory will be considered as necessary a part of a school as a class-room, bottles and bones as essential as books and boards. But we must not ignore what has already been done in schools like Eton and Rugby; with their laboratories and museums, such a Regulation is superfluous; but with the good work which has been accomplished before us, we have a happy omen of the result of the universal application of the principle they have voluntarily adopted. It is from these schools and others not included in the "nine," that have not fitted up their laboratories, that the Natural Science scholars are obtained, and perhaps the proportion of such scholarships to all others is as great as that of schools with laboratories to those without—probably greater. As the number of science-teaching schools increases the number of scholarships must increase too, but not at the same rate; the proper and final proportion may be left to settle itself.

On the whole we may regard these proposed Regulations with the greatest satisfaction, and it is probable that they will be looked back upon as the charter of the country's progress in scientific education. Individual efforts have been made on a grand scale, and natural science is making its way more or less efficiently into all good schools, while some are devoting themselves chiefly to its cultivation, as Taunton, Giggleswick, Burnley; but universal recognition, its acquirement of *prestige*, and consequent respect and earnest study, with the national advantages to be derived from it, can only be secured by such Regulations as these, followed or not as may be necessary, by similar ones for all the larger endowed schools.

THE SUB-WEALDEN EXPLORATION

If the word *romance* were to be imported into scientific literature there could surely be no more fitting application of it than to this recent crusade into the bowels of the earth among the woods and lanes of Sussex. Down in that southern part of the country, some hundreds of miles away from the great centres of our mineral industry, with no prospect of any pecuniary reward or of any immediate economic advantage, men are found willing to subscribe money to the extent of thousands of pounds for the purpose of settling definitely some important questions in the geology of the south-east of England, viz. at what depth from the surface the secondary strata are underlain by a ridge or platform of old Palæozoic rocks, what are the nature and age of these bottom rocks of the district, and what is the arrangement of the strata lying between them and the surface. It has long been a problem of much interest to geologists to discover whether or in what manner the great series of Jurassic rocks, which stretches across our island from the coasts of Dorsetshire to those of Yorkshire, passes south-eastward underneath the chalk. That series has been found to grow thinner towards the south-east. On the French side of the Channel it reappears in the Boulonnais, coming out from under the Cretaceous strata and resting against a ridge of Palæozoic rocks which rise to the surface between Boulogne and Calais. Nearly twenty years ago Mr. Godwin Austen drew attention to the probable extension of this ridge underneath the later formations of the south-east of England and its connection with the Carboniferous tracts in our south-western counties. It was a point of great interest in any attempt to reconstruct a map of the physical geography of western Europe during Palæozoic times. Hence, at intervals since the publication of Mr. Austen's great memoir, renewed attention has been given to the subject, until at last the idea took shape that a bold attempt should be made to settle some portion at least of the problem by putting down a bore and keeping it going, if possible, until all the Secondary rocks should be pierced and definite information should be obtained as to what lies below them. Advantage was taken of the meeting of the British Association at Brighton in 1872 to organise the scheme. For so purely scientific a project it was of course natural to look for help mainly to such well-wishers



The Sub-Wealden Exploration in Sussex—Boring at Netherfield. (Kindly lent by the Proprietors of the *Graphic*.)

to science as attend the Association meetings, rather than to the general public. Subscription lists were opened and money came in, not in overflowing abundance indeed, but yet in quantity sufficient to enable the operations to be begun. Further donations have been given, and the work has now been carried down to a depth of more than 1,000 ft.

It would be a great misfortune to science if this undertaking, after having been successfully carried so far, were now to be brought to an abrupt close for want of funds. Already the boring has put us in possession of some new and important facts in the geology of the south-east of England. It has shown that the well-known Kimmeridge clay stretches underneath the later Secondary rocks as a deep massive formation, some 700 ft. in thickness, and that it lies upon and appears to pass down into the Oxford clay without the intervention of the sandy and calcareous beds which usually separate the two deposits. The geological position of these clays is settled by means of the fossils, of which literally thousands have been taken out of the 2-in. core of rock brought up by the diamond-boring machine. It is intended, we believe, to sort the specimens and distribute them among different public museums. How much further the bore must be sunk before the remainder of the Secondary strata is pierced, to what horizons these strata will be assignable, and what will be their basement rocks, are the parts of the problem still to be solved.

Though undertaken chiefly in the interest of pure science, the project has likewise its economic aspects. It is eminently desirable to know whether any minerals of value lie among the Secondary rocks of the south of England, such as iron-stone, rock-salt, or gypsum; whether among the Palæozoic rocks underneath there is any possibility of obtaining workable coal or any of the other minerals which have made the Carboniferous formations so valuable a source of our wealth. It is likewise greatly to be wished that as full and accurate information as possible should be obtained regarding the nature of the rocks underneath with reference to the question of water-supply—a question which, important enough now, is certain before many years to become one of the most pressing social problems of the day.

On every ground, therefore, this most heroic attempt to provide data for settling some of these questions deserves hearty encouragement. On no account must it be allowed to come to an end till its express object is accomplished. If every well-wisher to science in this country would but send his contribution, not only would the present boring be conducted to a successful issue, but a great series of similar borings might be made all over the south of England. We understand that the Government, impressed with the interest and importance of the subject, has promised to contribute a sum of 1,000*l.* conditionally upon coal being found or on the boring being continued for another 1,000 ft. This aid will be valuable, but it evidently in the meantime does not supersede private efforts; it rather makes them more needful than ever. The undertaking is in excellent hands. Mr. Topley, of the Geological Survey, looks after its geological aspects. To Mr. Henry Willett, of Arnold House, Brighton, the zealous and indefatigable honorary secretary, the enterprise is mainly indebted for its financial progress so far. He has now appealed earnestly for further help, and to him we would urge all who take interest in these matters, and who have not already contributed, to send their donations, which, whether small or large, will at the present moment be of the most essential service.

A. G.

THE SCIENCE OF PAINTING

Die Farbenlehre im Hinblick auf Kunst und Kunstgewerbe. Von Prof. Wilhelm von Bezold.

THERE are two ways of popularising science. We may take up one of its great branches and treat it so simply and clearly that even the unscientific reader may with proper attention gain some insight into the principles to which the recent great advances in science have been chiefly due; or we may take up a smaller field and treat it fully and with all its applications in everyday life. He who studies a subject by the latter method will have it constantly brought under his notice, and will thus be led to observe and perhaps to experiment, and to acquire for himself that method of looking at the phenomena of nature and reasoning about them which is necessary to the understanding of every great principle in science, but which is foreign to nearly all who have not had a scientific training.

The latter method, which no doubt will prove the most successful, has been chosen by Prof. von Bezold in his work on the theory of colours. No subject is better fitted to be treated in this way, because it is in everybody's power to make observations, and perhaps even to find out some new fact. It is, however, not the only, and not even the chief, object of the author to create merely an interest in his subject outside the scientific world. He wishes his book to be of real value to the artist and to help him by theoretical speculations to such combinations of colour as shall prove most effectual. It is very doubtful whether the book will be successful in this respect. No doubt it would be a great achievement if every artist could be induced to think about the cause of the various and curious effects which are brought about by contrast and combination of colours; we therefore recommend the careful perusal of Prof. von Bezold's book to every painter. In the present state of the theory of colours, however, the attention bestowed upon it by artists will be of greater value to the subject than to themselves. It would no doubt be injurious to art if the painter were guided in his work by a theory so long as that theory is incomplete.

Painters are, however, themselves best able to bring the theory of colours into a better state; a state in which it will be beneficial to themselves and repay them for their trouble.

Two things have chiefly struck us in Prof. von Bezold's book as adding to its value and interest. The first is the care which he has taken to give his experiments in such a way that anyone without the use of large and expensive apparatus can repeat them and test for himself the truth of the author's statements. The second is the great ingenuity with which the author explains by his theory so many of the phenomena which most of us daily observe. We note one particular instance. All who have worked much at absorption spectra must have been struck by the change of colour which light of a certain wave-length undergoes when the intensity diminishes. Prof. von Bezold uses this curious fact to explain the peculiar colours seen in a landscape when viewed by moonlight, although the light reflected by the moon is identical in composition with sunlight.

In his account of the elementary principles of optics the author abandons the old method of dividing vibrations into heat rays, light rays, and actinic rays. We note this point as it is one which must soon play an important part in physics and will doubtless provoke much discussion. The author seems to prefer the following method of viewing the facts to the old one:—A body absorbs a certain class of rays peculiar to itself; whether these rays are converted into heat or into chemically active rays depends upon the peculiar properties of the body. In order, however, to include in this statement all the facts included in the old division, we must add that, as a rule, bodies absorbing the ultra-violet rays are thereby rendered more chemically active, and, as a rule, bodies absorbing the red are thereby heated. This method of looking at the matter seems to us to be the one most closely agreeing with the facts. Prof. von Bezold gives, as a proof that the red rays may be chemically active, the fact that, as the green colouring matter of leaves absorbs the red end of the spectrum as well as the blue, the red rays alone are sufficient to sustain life in the plant. He might have referred to the recent discovery of Vogel, who photographed the red end of the spectrum by mixing a red colouring matter with bromide of silver; and, on the other hand, to the fact observed by Budde, that chlorine is heated by the ultra-violet rays. The third chapter contains a short and clear abstract of recent researches on compound and primary colours. We would call attention specially to the passage in this chapter on colour and sound, in which the author refers to the influence of dwelling too much on the analogy between sound and light. Analogies are a very dangerous help to teachers, and are used by far too often. It requires at least a partial knowledge of the subject to see where the analogy begins and where it ends. Students generally either do not see where the analogy really lies, or want to carry it too far; a good many erroneous notions are thereby acquired.

The most interesting chapter in the book, however, is the one on Contrast of Colours; the examples are well chosen, and the coloured illustrations in the accompanying plates are in all cases convincing. The author shows with great success how little we may trust our own eyes as regards colour, and how difficult and even impossible it is to form a correct judgment of the relative darkness of two shaded fields, so long as they are not on the same ground.

The last chapter, which treats of the combination of colours, is necessarily the least complete; it shows, however, that the application of the theory to the arts has fairly begun. It has already been said that this beginning does not justify us in demanding from painters obedience to rules which have not been proved to be valid without exception. It may be easy to discover the application of these rules in acknowledged masterpieces, and yet be difficult to state them in such an exhaustive way that compliance with them will in all cases lead to perfect harmony. So long as this is not done it must not be expected that the painter will derive substantial help from the theory of colours.

ARTHUR SCHUSTER

OUR BOOK SHELF

Illustrations of the Principal Natural Orders of the Vegetable Kingdom. Prepared for the Science and Art Department of the Council of Education. By Prof. Oliver, F.R.S., F.L.S. (London, Chapman and Hall, 1874.)

FEW books published of late years will be of greater practical value to the botanical teacher or student than this. The want has long been painfully felt of a work which will give in as few words as possible the salient characters of each of the more important natural orders, unencumbered by minutiæ of structure which concern only the more advanced student. This want we have here most admirably supplied, not only by 150 pages of text, but by upwards of 100 plates, which present in the most lucid form a representation (plain or coloured, as may be preferred) of a section and "diagram" of a flower belonging to many orders, together with a drawing of the fruit, seed, or other organ the structure of which is of special importance. The very comprehensive title of the work might, unless the contrary is pointed out, lead to a little disappointment, when it is found that the descriptions, and still more exclusively the plates, refer almost entirely to the more important *European* orders; very brief accounts, or in some cases none at all, being given of such remarkable extra-European groups as the Cycadeæ, Gnetaceæ, Proteaceæ, Bignoniaceæ, Piperaceæ, and others. As far as European botany is concerned, we cannot conceive that the work could have been better carried out. The plan which has been adopted of treating separately groups which are united together into a single order in our more advanced text-books—as for instance Fumariaceæ as distinct from Papaveraceæ; Oxalideæ and Tropæolaceæ from Geraniaceæ, and Droseraceæ from Saxifragaceæ—seems to us altogether commendable in a work designed especially for beginners. There has long been felt a desire that in text-books of botany the morphological and physiological portion should be divorced from the systematic and descriptive. We trust that in future this may be carried out, and that writers of text-books will confine themselves to the former branch, leaving the student to gain his elementary knowledge of the latter branch from special works like the one before us.

A. W. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Photographic Irradiation

IN answer to Mr. Ranyard (NATURE, vol. x. p. 205), I have to state that the opaque bar in my experiments was placed as close to the collodion as possible without touching it, not farther than ·01 in. from it, and that there were no photographic traces of diffraction bands.

Allow me now to suggest a possible explanation of the different results given by Mr. Ranyard's and my own experiments. One important difference in the arrangement of the two experiments was, that in the one case the opaque bar was in contact with the collodion, and in the other case it was placed at a very short distance from it. In the experiments with the bar in contact with the collodion, the nitrate of silver solution on the surface of the plate would not form a true plane but would be curved upwards at the edge of the bar; and further, this curve would not be regular, but would have irregularities corresponding to every irregularity in the edge of the bar. This irregular curved fluid surface would cause irregular refraction of the light falling at the edge of the bar, and would give rise to bright and dark parts on the sensitive surface; the bright parts would be extended by molecular irradiation underneath the opaque bar, and would give rise to the irregular brushlike projections mentioned by Mr. Ranyard, instead of the uniform extension obtained when the bar is kept a short distance from the collodion. It is also possible that the irregular curved fluid surface may at certain points, where the bar was not in actual contact with the collodion, have bent the rays of light underneath the bar and given rise to the irregular extension of the image. JOHN AITKEN

Darroch, Falkirk, July 18

I MUST confess myself at issue with Mr. Stillman as to the result of his experiment with the strip of blackened wood laid upon the collodion film. I have tried a similar experiment, and find the images of bright objects sharply cut off. Even with a film of four thicknesses of collodion and an exposure of ten minutes, I cannot detect the smallest encroachment. The minute brushes mentioned by me in my last week's letter only occasionally occur, and appear to be due to a circulation in the liquid film beneath the opaque object, probably caused by some chemical impurity, for I notice that the brushes only occur when the film beneath the opaque object is soiled.

It cannot be argued that because there is a difference in the amount of irradiation in two pictures taken by different processes (instruments, exposures, and other conditions being similar), that therefore the spreading action must take place within the film, for the plates prepared by the two processes may not be equally sensitive, and the pictures may really correspond to what, with the same process, would be different amounts of exposure. Or again, the relative rates at which faint and intense light imprint themselves in the two processes may differ. Want of sensitiveness to the action of faint light is, I imagine, the reason why irradiation is apparently decreased by the use of the red collodion. A. COWPER RANYARD

Vapourising Metals by Electricity

IN a paper in NATURE (vol. x. p. 190) Mr. H. Hopkins gave a short description of some experiments on vapourising metals by electricity between two microscopic slides, and said that the layer thus produced can be investigated by a microscope, and employed in various ways to determine the character of the metal.

But the author did not point out the *wonderful drawings* shown by the layer, chiefly when a slight gold sheet is used.

This fact, very interesting in connection with molecular vibrations, has been illustrated by Prof. Magrini in a lecture delivered at the Museum of Florence, some years ago, and translated in *La Revue Scientifique* (t. iv. p. 770), with some woodcuts prepared by Prof. Magrini himself.

A. RODIER

Earth-shrinkings and Terrestrial Magnetism

IN my previous letter (vol. ix. p. 201) I gave some reasons for believing that the earth is shrinking chiefly about its equatorial region, and is being thrust out in the direction of the Poles, and that the distribution of this force may be correlated with that of terrestrial magnetism. As this view is somewhat novel and revolutionary, and if true will lead to considerable modification of the theories generally held on cosmical forces, I wish to support it by some other considerations.

I must predicate, as to a great extent proved, that volcanoes are not found in areas of upheaval. On this point I think the evidence is conclusive, and as I have previously written about it I shall not again enlarge upon it. I must predicate also that the earth as a whole is shrinking. This I tried to show in my previous letter. It follows from these facts that the large areas we know to be rising must be compensated by larger areas that are sinking, and that we may in a measure map these latter areas out by mapping out volcanoes; for, *ex hypothesi*, they occur either in areas of depression or along the border lines of the oscillating land.

Thus occurring, and themselves with the related phenomena of earthquakes, being the most vigorous proofs we have of the mobility of the earth's crust, we may predicate further that they will be found most actively at work where movements of the earth are most vigorously active, and that where they are liberally scattered, there the earth's crust is the most yielding. Now if we examine the distribution of volcanoes from this point of view we shall find that our main position is amply supported. Within the Arctic circle there is only one volcano, so far as we know—that of Jan Mayen. Within the Antarctic there is not one. North of the 60th degree of north latitude we have the volcanoes of Iceland, and three or four in Alaska, and these only. South of the 60th degree of south latitude we have Mount Erebus and its companions in the South Shetlands, and these only. Between the parallels of 40 and 60 the number of volcanoes increases considerably. In the northern hemisphere they probably number over sixty; but the vast majority of these are contained in the semicircular line of volcanoes formed by the Kurile and Aleutian Islands, and which crown that vast area of depression, the Pacific Ocean. In the southern hemisphere we still have exceedingly few, perhaps not more than a dozen, and these along the line of the Andes. It is in the region bounded on the north and south by the 40th parallels of latitude that we find volcanoes distributed in the greatest profusion, and the focus of distribution is even more narrow than this, for it may be bounded in fact by the 20th parallel on each side of the Equator. It is here we have that region described by so many writers in graphic terms, the Eastern Archipelago, with its 109 volcanoes in active operation. "From Papua to Sumatra, every large island," says M. Reclus, "including probably the almost unknown tracts of Borneo, is pierced with one or more volcanic outlets. There are Timor, Flores, Sumbawa, Lornbok, Bali, and Java, which last has no less than 45 volcanoes, 28 of which are in a state of activity, and lastly the beautiful island of Sumatra. Then to the east of Borneo, Ceram, Amboyna, Gelola, the volcano of Ternata, sung by Camoens, Celebes, Mundanao, Mendora, and Luzon; these form across the sea, as it were, two great tracks of fire." (Reclus, "The Earth," 498.) Here also is that wonderful congeries of Pacific volcanoes described by the same graphic author. "The volcanoes of Abrim and Tauna, in the New Hebrides, Turahoro, in the Archipelago of Santa Cruz, and Semoya in the Salomon Islands, succeeding one after the other, connect the knot of the Feejees to the region of the Sunda Islands, where the earth is so often agitated by violent shocks. This region may be considered as the great focus of the lava-streams of our planet." It is within the same narrow limits also that we have the most active signs of movement in the Atlantic basin, namely, in the Little Antilles group of the West India Islands. In regard to the two regions last mentioned, there is a fact remarkably confirming the general position I argued in favour of in a previous letter, namely, that volcanoes are indicative of areas of depression, and which was unknown to me when I wrote it. M. Reclus says—"It is a remarkable fact that the two volcanic groups of the Antilles and the Sunda Islands are situated exactly at the Antipodes one of the other, and *also in vicinity of the two poles of flattening, the existence of which on the surface of the globe has been proved by the recent calculations of astronomers.* (Op. cit., p. 503.)

These facts seem to me to support very strongly my contention that the earth is shrinking chiefly in its equatorial region. Volcanoes are in my view the mediate and not the immediate results of the shrinking of the earth; earthquakes on the contrary are its immediate result. There is considerable difficulty in mapping out a chart of their frequency and intensity, but we may say safely that such a chart would have a deeply-coloured zone in the equatorial regions, that it is there where earthquakes and especially submarine earthquakes chiefly abound, and abound also in their more vigorous type. This can only be if that area is also the chief area of disturbance of the earth's crust. Another fact which points in the same direction is that discussed by Bischof, namely, that the soundings in the greater oceans increase as we near the equator, this increase taking place relatively to the land masses and not being merely due to the bulging out of the water in those parts by the force of attraction. So that if we accept the level of Africa or the Pampas of Brazil as a mean we shall find the greatest pits and hollows in the crust in the equatorial region.

In regard to the connection of this earth-shrinking with terrestrial magnetism, I wish to quote one or two paragraphs from Dr. Zollner's paper in the "Philosophical Magazine" on the origin of the earth's magnetism, to the conclusions of which, however, I cannot in any way assent. I quote him on the subject of the correlation of earthquakes with magnetic disturbances. He is quoting from Mr. Lamont's work.

"Kreil has given many cases," he says, "where magnetic disturbances coincided with earthquakes; hence he thinks—conection between the two phenomena probable. I have observed myself an extremely curious case in this respect on April 18, 1842; at 0.10 A.M., I saw by chance that the needle of the declination instrument received a sudden jerk so that the scale was pushed out of the field of view of the telescope. The oscillations continued for some time; at last the ordinary tranquillity was restored. After some days I received the news from Colla, in Parma, that he had observed violent oscillations of the needle, and comparisons showed that the movement had begun at the same moment in Parma as in Munich. A short time after, the report of a French engineer was published, on a violent earthquake which he had observed in Greece; and now it was found that the earthquake had taken place in the same minute in which the oscillations of the needle had been observed in Parma and Munich. This, together with the many cases collected by Kreil and Colla, leaves scarcely any doubt as to the presence of a close connection; but it is undecided whether one phenomenon is the consequence of the other, or whether they both come from the same source. The same connection between earthquakes and magnetic disturbances was observed by Lamont at the earthquake which took place in Greece in December 1861. He communicates his observations to *Poggendorff's Annalen* (vol. cxv. 176) in the following words: "As the connection of the magnetism of the earth with earthquakes still belongs to the insufficiently ascertained relatives, it will not appear irrelevant if I communicate a fact bearing upon this question. On December 26, 1861, at 8 o'clock A.M., when I took down the position of the magnetical instruments (some of which are put up in the magnetical observatory, viz. two for declination, two for intensity, and two for dip), I observed in all the instruments an uncommon restlessness, consisting in a quick and irregular decrease and increase in the declination, and at the same time a trembling in the vertical direction. The trembling of the needle only lasted for a short time, but the quick changes lasted until 8.30 o'clock with gradually increasing violence. Some days later the news was received of an earthquake which, exactly coincident with the above observations, had caused great destruction in many parts of Greece." (Philosophical Magazine, June 1872.) This goes far to show that terrestrial magnetism it to be correlated with the force which is shrinking the earth. HENRY H. HOWORTH

COLLIERY EXPLOSIONS

IT is astonishing that, notwithstanding the many generations during which coal-mining has been carried on in this country, so comparatively little has been done to investigate scientifically the causes of explosions in coal-mines, and thereby discover an antidote to a constantly recurring danger, one which adds considerably to the yearly bills of mortality, and still more to the number of widows and orphans. No doubt a considerable proportion of these sad accidents is owing to the carelessness of miners themselves, but very many are, without doubt, also due to ignorance, on the part of all concerned, of the conditions under which coal-mining must be carried on. Only the other day a melancholy tale of death and widespread mourning comes from Wigan—fifteen men killed, leaving behind them at least thirty-one persons destitute of the means of gaining a livelihood. We are afraid that the frequency of such accidents has made the public somewhat callous in the matter; but a little consideration must show the vast importance of acquiring a thorough knowledge of the conditions under which they may happen. To this end the paper recently read before the Royal Society by Mr. William Galloway, Inspector of Mines, is an important contribution; and we hope that the author and others who are competent will continue their investigations until, if explosions cannot be prevented, they may at least be foreseen and provided against.

The opinions promulgated by Sir Humphry Davy and the eminent Colliery Viewers who were his contemporaries, regarding the security afforded by the use of the safety-lamp, have been accepted with hesitation by many of their successors during the last twenty or thirty years; and this is not to be wondered at when we consider the large number of disastrous explosions by which thousands of lives have been lost in mines in which these lamps were in constant use. The illustrious inventor himself had discovered and pointed out, that if the lamp were exposed to the action of an explosive current, the flame might pass through the meshes of the wire-gauze and so originate an explosion; but when in good order it was considered to be safe under all other circumstances, until the experiments were made which form the subject of Mr. Galloway's paper.

At first, and for many years after the introduction of the safety-lamp, the cause of nearly every explosion was attributed to carelessness on the part of the workmen using it; then it was observed that a quantity of firedamp, sufficient to render some of the air-currents explosive, was sometimes suddenly given off by the strata, and these "outbursts of gas," as they are called, were assumed, in the absence of any other explanation, to have caused many explosions. On Dec. 12, 1866, however, the great explosion took place at the Oaks Colliery; as it was known to have happened simultaneously with the firing of a heavily-charged shot in pure air attention was drawn to the coincidence; and it appears that some search has usually been made for evidence of recent shot-firing in mines in which explosions have occurred since that date. Accordingly we find from the reports of the Inspectors of Mines that shot-firing was carried on in seventeen out of twenty-two collieries, at which important explosions have happened since Dec. 12, 1866; safety-lamps were certainly used in twelve of these collieries, and probably in the whole seventeen; in eight cases it was ascertained that a shot had blown out the tamping at or about the time of the explosion; in two an empty shot-hole was found from which it was supposed the tamping had been blown; in three a shot had been fired, bringing down the coal or rock; lastly, there were five collieries at which two or more explosions took place simultaneously, in different parts of the mine unconnected by a train of explosive gas. The Seaham explosion was a remarkable one; a heavily charged shot was fired in pure air in one of the in-take air-courses, and, according to the statement of three men who survived, the explosion of firedamp followed the shot immediately.

Two methods of accounting for the simultaneousness of the explosion of firedamp with the firing of the shot have been suggested in the reports of the Inspectors of Mines: one of them supposes that the firedamp has been ignited directly by the shot; the other that the concussion of the air caused by the explosion of gunpowder dislodges gas from cavities in the roof and from grooves, and that this gas passing along in the air-currents is ignited at the lamps of the workmen. In some instances when it has been known to be highly improbable that any gas existed nearer to the shot-hole than 10, 20, or even 40 ft., the advocates of the former hypothesis have taken it for granted that the gases issuing from the shot-hole were projected through the air as far as the accumulation of firedamp, retaining a sufficiently high temperature to ignite it on their arrival. On the other hand the advocates of the latter hypothesis have not attempted to show how the gas, which they assumed could be dislodged in quantity by a sound-wave and its reflections, could be ignited in those cases in which safety-lamps only were used. It is no doubt highly probable, however, that when once an explosion of firedamp has been initiated in one way or another, and large bodies of air are driven through the passages of a mine with great velocity, explosive accumulations will be dislodged from cavities and grooves and pressed through the safety-lamps with the velocity requisite to pass the flame.

In the beginning of the year 1872 Mr. Galloway first thought it probable that a sound-wave originated by a blown-out shot, in passing through a safety-lamp burning in an explosive mixture, would carry the flame through the meshes of the wire-gauze in virtue of the vibration of the molecules of the explosive gas. An explosion which took place at Cethin Colliery in 1865 is a good example of one that may have been caused in this way. Several days after the explosion the safety-lamp of the overman was found securely locked and uninjured, lying at a distance of a few yards within an abandoned stall which was known to have contained firedamp. Shot-firing was carried on in this mine, and it is not improbable that a sound-wave from an overcharged or blown-out shot had passed through this lamp and ignited the explosive mixture shortly after the overman had entered it; moreover, the Inspector of Mines in his report says he has no doubt that the gas in this state was ignited and was therefore the origin of the explosion, but he is unable to state by what means it was fired.

A number of experiments were made by Mr. Galloway in connection with this subject: the cost of apparatus, &c., was provided for by the liberality of the Government Grant Committee of the Royal Society.

The first experiment was made on Jan. 16, 1872, in the physical laboratory of University College, London. A sheet of wire-gauze 1 ft. square was inclined at an angle of 70° and a slow current of gas and air from a Bunsen-burner was directed against its lower surface; part of the explosive mixture passed through the meshes, and when ignited produced a flat flame 3 in. long by 1 in. wide about the middle of the upper surface of the wire-gauze. A glass tube 3 ft. 4 in. long by about 3½ in. diameter was placed horizontally with one end opposite to the flame on the same side of the wire-gauze and distant from it about 1½ in. At the other end of this tube a sound-wave was produced by the explosion of a mixture of coal-gas and oxygen contained in soap-bubbles. When the sound-wave passed through the tube the flame was carried through the meshes of the wire-gauze and ignited the gas issuing from the Bunsen-burner on the other side.

Some experiments similar to the first were made in one of the laboratories of the Royal College of Chemistry in Dec. 1872. The glass tube was replaced by a tin-plate tube about 20 ft. long by 2 in. diameter: paper and other diaphragms were inserted at a distance of 10 ft. from the origin of disturbance to insure that only a sound-wave was propagated through the tube. The results were the same as before.

Two sets of apparatus, a larger and a smaller, were then constructed; in both the sound-wave of a pistol-shot is conveyed through tin-plate tubes to a distance of about 20 ft., then it passes through a safety-lamp burning in an explosive mixture. In the smaller apparatus the tube is 3 in. in diameter; one end is closed by a disc of wood with a hole in the middle large enough to receive the muzzle of a pistol; at a distance of 10 ft. from the disc there is a diaphragm of sheet india-rubber, and at the farther end is a safety-lamp with gas-flame. At the bottom of the safety-lamp there is a circular chamber with holes round about from which gas can be made to escape, and when this gas, rising up, mixes with the air it forms an explosive mixture surrounding the wire-gauze cylinder. The pistol by means of which the sound-wave is produced is charged with ·205 gramme of gunpowder, and a tamping paper is rammed down well upon the charge. When the shot is fired through the hole in the wooden disc, while the explosive mixture surrounds the lighted safety-lamp, the flame is instantly carried through the meshes by the vibration, and ignites the gas on the outside. In the larger apparatus the tube is 8 in. in diameter, and 21 ft. long; at one end there is a wooden disc as before; at 20 ft. from the disc there is a sheet india-rubber diaphragm, and the extreme end is closed by a sheet of thin paper tied over it. Part of the last 12 in. (thus isolated from the rest of the tube and from the exterior) is enlarged sufficiently to hold a safety-lamp, and it is provided with an inlet below for air or air and gas, and a chimney above for the sake of the products of combustion. A lighted Davy or Clanny lamp of ordinary construction having been placed in this space, gas is made to mix with the air which flows up through it in consequence of the draught caused by the lamp: the appearances presented by the flame are observed through a small glass window, and when they indicate that the air is explosive the shot is fired. The flame within the safety-lamp is passed through the meshes, explodes the mixture in the isolated space, blowing out the paper end, and, passing backwards through the inlet, ignites the gas where it first mixes with air. In this case the shot consists of ·41 gramme of gunpowder tamped as before.

The lamps that were tested in this apparatus are those known as the Davy, Clanny, Stephenson, Mueseler, and Eloin. The flame was easily passed through the Davy lamp, with rather more difficulty through the Clanny, and not at all through any of the others.

The first experiments with these two sets of apparatus were made in January and February 1873, at the Meteorological Office, where Mr. Scott most kindly provided accommodation: the experiment with the smaller apparatus was shown at the Royal Institution, by Mr. Spottiswoode, on the evening of Jan. 17; and afterwards at one of the Cantor Lectures of the Society of Arts, by the Rev. Arthur Rigg. The next experiments were made in No. 7 Pit, Barleith, near Glasgow, with firedamp from a blower, but the flame could not be passed through the safety-lamps on account of the impurity of the gas, which contained only 75·86 of light carburetted hydrogen. The last experiments were made in the C Pit of Hebburn Colliery, near Newcastle-on-Tyne, also with firedamp from a blower, and as the firedamp was very explosive, the flame was easily passed through the Davy-lamps of each apparatus.

After this, experiments were made on a larger scale in part of a new sewer in North Woodside Road, Glasgow. The sewer is ovoid in section; it is 6 ft. high and 4 ft. wide at its greatest dimensions; part of it is a tunnel in the solid rock, part is built in brickwork through surface-drift. The gas safety-lamp of the smaller apparatus was placed on a board fixed across the sewer at a height of 2 ft. 8 in. from the bottom, and surrounded with an explosive mixture of coal-gas and air in the same way as when it was used in connection with the tin-plate tubes. Shots were fired from a pistol at certain distances from the lamp (the details of the distances and the charges required to pass the flame in the paper and sections of the sewer are given in the plates which accompany it). One hundred and nine feet was the greatest distance available in the part built of brick, and at this point a sound-wave of sufficient intensity to pass the flame was produced by firing a charge of 3·882 grammes = 59 grains of gunpowder. At 96 ft. from the lamp a charge of 3·276 grammes was required when the sound-wave passed through the brickwork tunnel all the way, and 2·184 grammes when it passed through the tunnel in the solid rock. These experiments seem to be perfectly conclusive.

Mr. Galloway's discovery—that when the vibration of the air which constitutes a sound-wave has a certain amplitude, it can transmit flame through the wire-gauze of the Davy and Clanny lamps—furnishes an additional argument against retaining these lamps in use, at least in the hands of ordinary workmen. On Dec. 15 1815, Davy said he was convinced that, as far as ventilation was concerned, the resources of modern science had been fully employed; he then proceeded to describe a "safety lantern," which is identical in principle with the Stephenson lamp, and is extinguished in an explosive mixture (Phil. Trans. 1816, p. 2). This "safety lantern" was afterwards discarded in favour of the Davy lamp proper, the principal advantage of which was stated to be that it would not only preserve the collier from the firedamp, but enable him to apply it to use, and destroy it at the same time that it gave him a useful light (Phil. Trans. 1816, pp. 23 and 24). Fortunately the ventilation of mines is now better understood than it was in the days of Davy, and the quantities of air employed are usually very much greater. It is certain, however, that in some mines of the present day the ventilation could be doubled or trebled with advantage; and since this is merely a matter of expense it may be asked why it is not done, when it would ensure comparative immunity from danger? On the other hand it is now almost universally admitted to be highly dangerous to continue work in an explosive atmosphere, so that safety-lamps should be used only as a precaution against possible outbursts of gas or when work is carried on in the neighbourhood of gas that cannot be easily dislodged; it is evident, therefore, *primâ facie*, that lamps constructed on the principle of the "safety-lantern," such as the Stephenson, Mueseler, &c., which are extinguished in an explosive mixture, are far safer than lamps like the Davy or Clanny, which continue to burn under the same circumstances, and are then liable, at any instant, to have the flame driven through the wire gauze and communicated to the external explosive atmosphere.

THE COMET

[The following letter appeared in last Thursday's *Times*, from the columns of which journal it is reproduced, with a few verbal alterations.]

I WAS enabled on Sunday night (12th inst.), by Mr. Newall's kindness, to spend several hours in examining the beautiful comet which is now visiting us, by means of his monster telescope—a refractor of 25 in. aperture, which may safely be pronounced the finest telescope in the world, or, at all events, in the Old World.

The view of the comet which I obtained utterly exceeded my expectations, although I confess they were by no means moderate; and as some of the points suggested by the observations are, I think, new, and throw light upon many recorded facts, I beg a small portion of space in the *Times* to refer to them, as it is important that observers should have their attention called to them before the comet leaves us.

I will first deal with the telescopic view of the comet. Perhaps I can give the best idea of the appearance of the bright head in Mr. Newall's telescope, with a low power, by asking the reader to imagine a lady's fan opened out (160°) until each side is almost a prolongation of the other. An object resembling this is the first thing that strikes the eye, and the nucleus, marvellously small and definite, is situated a little to the left of the pin of the fan—not exactly, that is, at the point held in the hand. The nucleus is, of course, brighter than the fan.

Now, if this comet, outside the circular outline of the fan, offered indications of other similar concentric circular outlines, astronomers would have recognised in it a great similarity to Donati's beautiful comet of 1858 with its "concentric envelopes." But it does not do so. The envelopes are there undoubtedly but, instead of being concentric, they are excentric, and this is the point to which I am anxious to draw attention, and, at the risk of being tedious, I must endeavour to give an idea of the appearance presented by these excentric envelopes. Still referring to the fan, imagine a circle to be struck from the left-hand corner with the right-hand corner as a centre, and make the arc a little longer than the arc of the fan. Do the same with the right-hand corner. Then with a gentle curve connect the end of each arc with a point in the arc of the fan half way between the centre and the nearest corner. If these complicated operations have been properly performed the reader will have superadded to the fan two ear like things, one on each side. Such "ears," as we may for convenience call them, are to be observed in the comet, and they at times are but little dimmer than the fan.

At first it looked as if these ears were the parts of the head furthest from the nucleus along the comet's axis, but careful scrutiny revealed, still in advance, a cloudy mass, the outer surface of which was regularly curved, convex side outwards, while the contour of the inner surface exactly fitted the outer outline of the ears and the intervening depression. This mass is at times so faint as to be invisible, but at other times it is brighter than all the other details of the comet which remain to be described, now that I have sketched the groundwork. These details consist of prolongations of all the curves I have referred to backwards into the tail.

Thus, behind the bright nucleus is a region of darkness (a black fan with its pin near the pin of the other pendant from it, and opened out 45° or 60° only will represent this), the left-hand boundary of which is a continuation of the lower curve of the right ear. The right-hand boundary is similarly a continuation of the lower curve of the left ear. Indeed, I may say generally—not to enter into too minute description in this place—that all the boundaries of the several different shells which show themselves, not in the head in front of the fan, but in the root of the tail behind the nucleus, are continuous in this way—the boundary of an interior shell on one side of the axis bends over in the head to form the boundary of an exterior shell on the other side of the axis.

At last, then, I have finished my poor and, I fear, tiresome description of the magnificent and truly wonderful sight presented to me as it was observed, on the whole, during some hours' close scrutiny under exceptional atmospheric conditions.

I next draw attention to the kind of change observed. To speak in the most general terms, any great change in one "ear" was counterbalanced by a change of an opposite character in the other; so that when one ear thinned or elongated, the other widened; when one was dim, the other was bright; when one was more "pricked" than usual, the other at times appeared to lie more along the curve of the fan and to form part of it. Another kind of change was in the fan itself, especially in the regularity of its curved outline and in the manner in which the straight sides of it were obliterated altogether by light, as it were, streaming down into the tail.

The only constant feature in the comet was the exquisitely soft darkness of the region extending for some little distance behind the nucleus. Further behind, where the envelopes of the tail were less marked, the delicate veil which was over even the darkest portion became less delicate, and all the features were merged into a mere luminous haze. Here all structure, if it existed, was non-recognisable, in striking contrast with the region round and immediately behind the fan.

Next it has to be borne in mind that the telescopic object is after all only a section, from which the true figure has to be built up, and it is when this is attempted that the unique character of this comet becomes apparent. There are no jets, there are no concentric envelopes; but, as I have said, in place of the latter, excentric envelopes indicated by the ears and their strange backward curvings, and possibly also by the fan itself.*

I prefer rather to lay the facts before observers than to state the conclusions to be derived from them, but I cannot help remarking that, supposing the comet to be a meteor-whirl, the greatest brilliancy is observable where the whirls cut or appear to cut each other; where we should have the greatest number of particles, of whatever nature they may be, in the line of sight; and not only so,

* By describing three parabolas on a card and spinning the card rapidly round a line not coincident with their common axis, I have been able to reproduce roughly the appearances figured last week and described above. —J. N. L.

but regions of greatest possible number of collisions associated with greatest luminosity.

It would be a comfort if the comet, to partly untie a hard knot for us, would divide itself as Biela's did. Then, I think, the whirl idea would be considerably strengthened. I could not help contemplating the possibility of this when the meaning of the "ears" first forced itself upon my attention.

The spectroscopic observations which I attempted, after the telescopic scrutiny, brought into strong relief the littleness of the planet on which we dwell, for a seven hours' rail journey from London had sufficed to bring me to a latitude in which the twilight at midnight was strong enough to show the middle part of the spectrum of the sky, while to the naked eye the tail of the comet was not so long as I saw it in London a week ago.

I had already in observations in my own observatory, with my 6¼ in. refractor (an instrument smaller than one of Mr. Newall's four finders!) obtained indications that the blue rays were singularly deficient in the continuous spectrum of the nucleus of the comet, and in a communication to NATURE I had suggested that this fact would appear to indicate a low temperature.

This conclusion has been strengthened by Sunday night's observations, and it was the chief point to which I directed my attention. The reasoning on which such a conclusion is based is very simple. If a poker be heated, the hotter it gets the more do the more refrangible—*i.e.* the blue—rays make their appearance if its spectrum be examined. The red colour of a merely red-hot poker and the yellow colour of a candle-flame are due, the former to an entire, the latter to a partial, absence of the blue rays. The colour, both of the nucleus and of the head of the comet, as observed in the telescope, was a distinct orange yellow, and this, of course, lends confirmation to the view expressed above.

The fan also gave a continuous spectrum but little inferior in brilliancy to that of the nucleus itself; while over these, and even the dark space behind the nucleus, were to be seen the spectrum of bands which indicates the presence of a rare vapour of some kind, while the continuous spectrum of the nucleus and fan, less precise in its indications, may be referred either to the presence of denser vapour, or even of solid particles.

I found that the mixture of continuous band spectrum in different parts was very unequal, and further that the continuous spectrum changed its character and position. Over some regions it was limited almost to the region between the less refrangible bands.

It is more than possible, I think, that the cometary spectrum, therefore, is not so simple as it has been supposed to be, and that the evidence in favour of mixed vapours is not to be neglected. This, fortunately, is a question on which I think much light can be thrown by laboratory experiments.

J. NORMAN LOCKYER

Mr. Newall's Observatory, Ferndene, Gateshead

P.S.—(By Telegraph.)—Wednesday night.—Sunday's observations are confirmed. The cometary nucleus is now throwing off an ear-like fan. Ten minutes' exposure of a photographic plate gave no impression of the comet, while two minutes' gave results for the faintest of seven stars in the Great Bear.

*THE FORMS OF COMETS**

I.

A FEW years ago astronomers studied comets almost solely to determine their movements. So little advance had been made in the study of the figures of these bodies, that M. Arago believed himself justified in stating in his "Astronomie populaire:"—"'I don't know' will still be the reply we have to make to questions asked concerning the tails of comets." If I venture to take as the principal subject of this lecture the researches which I have undertaken during recent years in this difficult subject, I hope to disarm criticism beforehand by at once declaring that the results contrast singularly, by their imperfection, with the degree of power and of certainty we admire in the other more ancient branches of astronomy.

The reason of this contrast is very simple. While planetary astronomy received the precious heritage of the science of the Greeks and the treasury of observations bequeathed by the highest antiquity, cometary astronomy finds in the archives of history observations travestied by superstitious terror. One of the strongest prejudices of previous centuries was that which attributed to the stars a mysterious influence on our destinies. And comets, by their unforeseen appearance in the midst of the familiar constellations, their monstrous heads, their gigantic tails, were calculated to inspire a sort of apprehension which judicial astrology, that long infirmity of the human mind, did not fail to interpret as menacing presages; and as catastrophes have not been wanting in every period of our history, the singular sophism, *post hoc, ergo propter hoc*, so natural to our poor logic, helped to confirm ten or twelve times in a century this miserable superstition.

Did a comet appear in the heavens, morning or evening, the astrologer had to be consulted. He did not go to work without rules; he had a complete classification of strange forms under which these heavenly bodies already had been observed, and to each form was attached a particular signification. Pliny has preserved this nomenclature for us: Hevelius, the learned *pensionnaire* of Louis XIV., faithfully reproduced it in the middle of the 17th century, in the fantastic figures of his *Cometographia*. And, certainly, everything was taken in the most literal manner: in a comet with a crooked, or straight, or multiple tail they traced, such is the power of imagination, a gigantic sabre, a lance, or a fiery bolt, a burning torch or a dragon hurling upon an entire country the plague, rebellion or famine. Figs. 1 and 2 are indications of this idea taken from the "Theatricum cometicum" of Lubienitzki. The first comet, in the form of a blazing torch, indicates very clearly by the direction of its tail the flames which will consume the neighbouring town; the second, a veritable dragon, whose tortuous folds the artist has reproduced, threatens France and Ireland from the seven points of its tongue of fire.

These specimens will suffice; there is no use in producing similar statements and similar pictures; at the most we can barely find here and there in the theories which were then formed some traces of the truth.

Astrology thus stifled real observation until the beginning of the seventeenth century. This may now appear strange to us, but there is no doubt of it. The astronomers of those times, so near in time to ourselves, and already so bold with the universal *renaissance* of the human mind, were almost all to some extent astrologers. Kepler himself, one of the glorious fathers of modern astronomy, was obliged by the duties of his office as Imperial Astronomer both to draw the horoscope of the war of the Pope against Venice, and to give to his powerful but too-straitened patron, the Emperor Rodolph II., an opinion on the comet of 1607, which appeared to be menacing Hungary. Besides, Rodolph counted much then upon his alchemist to find the gold necessary to pay his army; while his general, the Duke of Friedland, the celebrated Wallenstein, never failed to consult the heavens, always by the help of Kepler, who has preserved for us his horoscope.

But already, from the time of Tycho Brahé, astronomy had commenced to place a hesitating foot in the domain of comets, from which she was soon to drive astrology. Until then men had lived, upon the faith of

* A lecture by M. Faye delivered at the "Soirées Scientifiques de la Sorbonne." Translated from *La Revue Scientifique*.

Aristotle, in the thought that comets were not celestial bodies, but mere sublunary meteors; and now it was discovered, by substituting observation for the word of the master, that they journeyed far above the orbits of Mercury and Venus, without being in the least incommoded by the crystalline spheres of the firmament in which the old astronomy incrusted its planets and stars. From the time of Newton comets were at last embraced,

FIG. 1.

so far as the movement of the nucleus was concerned, in the theory of attraction, and consequently in planetary astronomy, with this single difference, that they described around the sun ellipses enormously elongated, almost parabolic, instead of ellipses almost circular, like the planets. Then astronomers observed carefully the successive positions of these nuclei, and calculated their orbits, but without attending to the figure of the

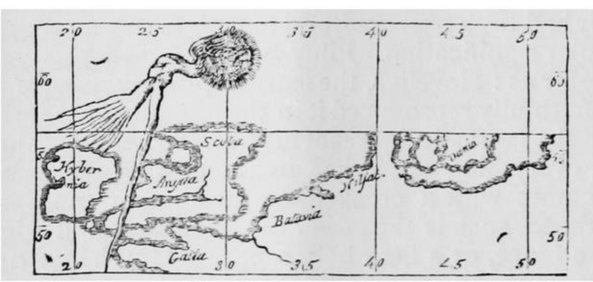


FIG. 2.

comets themselves, although the invention of the telescope must have already revealed a number of curious phenomena which escaped the naked eye. During this period astronomers restricted themselves to representing the comet by a small circle, the centre of which alone was of importance, for there was the centre of gravity to which the laws of Kepler applied, and the calculation of the elements of the orbit. As to the tail, which attracted

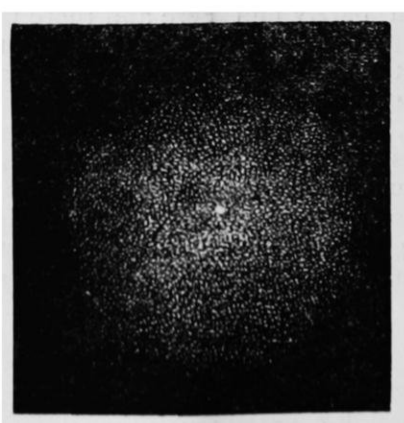


FIG. 3.

no attention, they figured it very simply by some feathery traces attached to the nucleus. In all this there is nothing to attract attention now, any more than the dragons of the astrologers. It was no longer now a superstitious prejudice which took from astronomers the desire to closely examine the facts; it was a preconceived idea, an elevated idea, no doubt, but too absolute, according to which the only force to be regarded in the celestial spaces was attraction. At bottom it was vaguely felt that the figures of comets were irreconcilable with this ruling hypothesis; and this was sufficient, for the eye was brought to bear by preference upon the subject the most attainable by the reigning theories.

Leaving aside the rude drawings of the six-tailed comet of 1744, by Chézeaux, and those which Messier made by rule and compass, we must come down to the two Herschels before we find trustworthy observations on the form of comets; the beautiful drawings of the comets of 1811 and 1835 are even now of use to science. Astronomers had at last learned, from the example of Olbers and Bessel, the high importance of these phenomena, which reveal to us more than a new world, since they tell us of a new force in the universe. At present the figure of comets has become the subject of the most earnest research, and the drawings of the beautiful comet of Donati (1858) which I am about to show you will give you an idea of the change which, in this respect, has taken place in the minds of astronomers. I can confidently vouch for their fidelity, for, while Bond was executing these drawings at the Cambridge (U.S.) Observatory, by means of a telescope of great power, I followed the same body at Paris with the first telescope which Foucault constructed on his new system, and it appears to me while looking with you on these drawings of Bond, as if I still had that wonderful comet before my eyes.

I shall endeavour first to give an exact idea of the successive metamorphoses which comets present during the course of their appearance, taking as a type a comet which has been perfectly studied—that of Donati. Let us remember that these bodies describe around the sun ellipses extremely elongated, of which the sun occupies the focus; that the point nearest the sun is called the *perihelion*, while the most distant point (in a truly parabolic orbit this would be infinite) is called the *aphelion.* Unlike the planets, which describe orbits almost circular, and remain always at nearly the same distance from the sun, comets, in general, come to us from regions much more distant than the most remote planets; but they only become visible, even to the telescope, in the part of their orbit which is nearest to the sun. After their passage at perihelion, their distance from the sun becomes greater and greater, and soon they cease to be visible. I do not believe that any comet has been seen beyond the orbit of Jupiter. It is assuredly not on account of their smallness that they thus escape our notice in regions where the most distant planets, Saturn, Uranus, and Neptune, shine so clearly with the light which they borrow from the sun; this is because the rare and nebulous matter of comets reflect much less light than the solid and compact surface of the planets of which we speak, much less even than the smallest cloud of our atmosphere.

When they are seen far from the sun through a telescope, they appear like rounded nebulosities, but vaguely defined, presenting at the centre a condensation sufficiently marked, which is called the *nucleus;* it is this nucleus, more brilliant than any other part, whose position astronomers observe. Fig. 3, representing Donati's comet at the time of its discovery, June 5, 1858, gives a sufficient idea of the aspects of all comets when they are at a great distance from the sun.

At a later period, when the comet is approaching its perihelion, it sensibly lengthens out in the direction of the radius vector, *i.e.* in the direction of an imaginary line which would join the comet and the sun; but then the bright nucleus is no longer found in the centre of the figure, but is situated excentrically on the side nearest to the sun, as is shown in Fig. 4.

Later still, the tail is formed, and is developed more and more, like an opened fan, while the nucleus shines with a more vivid brightness. The comet becomes visible to the naked eye as in Fig. 5.

This tail is always away from the sun. At its origin, near the nucleus, it lies in the prolongation of the radius vector; at a greater distance it is curved backwards, as if it met with some resistance which hindered it from following completely the path of the nucleus. The bent axis of this tail is, however, always situated in the plane of the orbit, and this simple fact accounts for the many varieties of aspect presented to our eyes by these cometary appendages. Comets with straight tails appear such only because the eye of the observer is in the plane of the axis of the tail, *i.e.* in the plane of the orbit. When the earth, in consequence of its annual motion, is carried from this plane, the curvature of the tail becomes manifest; it becomes more and more pronounced as the comet, seen at first edgeways, so to speak, shows itself more and more on the flat, like a scimitar, to the observer.

When the comet, describing the descending branch of its orbit, reaches perihelion, these phenomena acquire their full development. But when it recedes from the sun, describing the ascending branch of its immense parabolic trajectory, the tail diminishes, disappears, and gives place to a mere elongation. Soon it again assumes the spherical form; the nucleus, which has gradually lost its brightness, is indicated only by a slight condensation of light at the centre of a globular mass entirely similar to that which was first seen. Finally this rounded nebulosity disappears.

Upon what scale do these phenomena take place, the immediate cause of which is evidently located in the sun? What may be the dimensions of these nebulosities, of these brilliant nuclei, of these curved tails? These dimensions are assuredly formidable. The comet of 1843 had a tail of 60,000,000 leagues, nearly double our distance from the sun. On the sky that tail was drawn like an immense dash of a brush of 65 degrees of angular amplitude. The tail of the famous comet of 1811 was only 40,000,000 leagues: but, on the other hand, the head alone of the comet (250,000 leagues in diameter) was nearly as large as the sun.

As to Donati's comet, its dimensions were more modest; its nucleus was 1,000 leagues in diameter, and the head only about 13,000; the tail was only about 14,000,000 leagues in length. I had the curiosity to estimate approximately the volume of this small comet, and I found, supposing that the thickness of the tail is equal to its breadth, its volume was a thousand times greater than that of the sun. As in reality the tails are flattened, it will perhaps be necessary to reduce this figure by half. There remains enough to show us that our terrestrial globe, so little beside the sun, is only a point in comparison with these gigantic bodies.

But, on the other hand, everything proves to us that these bodies contain very little matter in so enormous a volume. A characteristic which is special to them, and which assuredly belongs neither to the planets nor to their satellites, is their almost absolute transparency. The stars are seen through the tail of a comet as if the tail did not exist; they can be seen even through the head, much more dense and more brilliant than the tail. It was for long a question whether the nucleus, at least, of a comet would not be opaque and solid like a planet; but, after examination by the most powerful telescopes, it has always been found to be formed of nebulous layers, more and more dense, always permeable by rays of light. This very simple and altogether characteristic fact leads us, by itself, to think that cometary matter must be of extreme rarity, for a mist of some thousands or even of some hundreds of metres in thickness suffices to hide the stars, while a thickness of from 10,000 to 15,000 leagues of cometary matter scarcely lessens their lustre. Desiring to fix our ideas on this subject, I calculated the mass of Donati's comet, and found that it equalled at least that of a sea of 100 metres in depth, and 16,000 square leagues of superficies. This mass is only a fraction, almost imperceptible, of that of the earth. It was almost entirely concentrated in the head of the comet and around in the nucleus; even supposing it uniformly distributed over the whole volume of the tail, there will be found, for the mean density of that appendage, only a value incomparably more feeble than the density of the void approached by our pneumatic machines. But it is not to this rare gaseous residue that we must compare the matter of comets; it will resemble

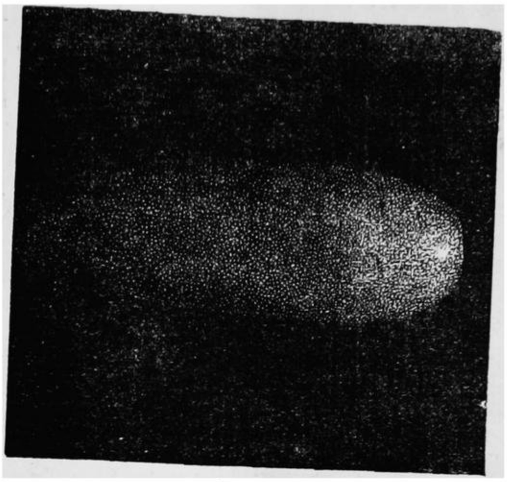


FIG. 4.

rather those impalpable grains of dust which dance in the air, and which are disclosed to us by the smallest ray of solar light penetrating a darkened chamber.

Although comets show us matter rarefied to such an extent that a celebrated physicist, M. Babinet, could with considerable justness call them "visible nothings" (*riens visibles*), do not, however, imagine that their contact with our earth would be without inconvenience. If the nucleus of our comet had directly encountered the earth, with its mass of 25,600 millions of millions of kilogrammes, and its relative speed of seventeen leagues per second (seven for the earth and ten in an opposite direction, for this retrograde comet), the actual energy of the shock would be enormous; I calculated that its transformation into heat would immediately generate fifty-one million *calories* per square metre of the hemisphere which sustained the shock. It would be enough to shatter, dissolve,

FIG. 5.

and volatilise a part of the solid crust of our globe. No living being could survive such a catastrophe. Happily the probability of such an encounter is excessively small; and, indeed, the most remote geological ages do not bear any traces of such an adventure. We cannot, however, forget that meteors and shooting stars, perhaps even the aerolites which bombard us so regularly every year and every day of the year, have probably the same origin as comets, and result from a mass of analogous materials which are decomposed in penetrating our solar world.

(*To be continued.*)

THE FLYING MAN

THE fatal experiment made by M. de Groof at Cremorne Gardens could not possibly have led to success. The possibility of directing an apparatus in the air by any mechanical contrivance, without actually using the lifting power of gas, is out of the question, and we do not wish to enter into a discussion on that point. But several interesting problems may be examined *à propos* of the inquest held by the coroner on the death of the unfortunate man.

De Groof's wings, irrespective of their motive power, may be regarded as two imperfect parachutes intended to diminish his rate of falling, and, if kept horizontal, prevent it increasing above a certain rate. It remains to see if their surface was large enough to keep that velocity within reasonable limits. The wings of De Groof were 30 ft. by 4 ft.; but being irregularly shaped, we may suppose the surface of each was 100 sq. ft., or in round numbers 200 sq. ft. for the two. The weight of the machine not being far from 4 cwt. if we include the man, we may say in gross numbers that each square foot had a kilogramme to support, which is more than ordinary; the parachute maker taking 1 kilogramme for each square metre, which is about ten times smaller.

But to ascertain if the velocity, although being larger than under ordinary circumstances, was really dangerous we must go to the formulæ established by General Didion and quoted by Poucelet—

$$R = 1{\cdot}936\ (A\ 0{\cdot}036 + 0{\cdot}084\ v^2)$$

Under the above circumstances, R the rate of falling is always inferior to the value of x given by the equation

$$10 = 1{\cdot}936\ (0{\cdot}036 + 0{\cdot}084\ x^2)$$

x being obviously enough the velocity for which $R =$ to the weight pressing on the unit of surface. When the motion is such the velocity cannot be increased. If we make the calculation it is easy to see that the velocity is about 7 metres per second, almost = the fall from 3 metres to the ground. It is large, but not too large for a practised jumper, if he were clever enough to keep his balance, which is not very easy, it must be confessed.

Experiments on parachutes show that great oscillations always take place if the experimenters have not placed a small hole in the centre of their parachute, which increases stability at the expense of resistance. The motion of the wings, if they are working together, would very likely render the same service to the occupant of the machine, as they prevent the accumulation of the air. Unfortunately, to keep them working evenly is a difficult matter, requiring not only force of muscle but great presence and firmness of mind. The so-called *queue* or rudder was a useless encumbrance. A man working hard with his two hands, fighting for his life, cannot be expected to attend to direction with his legs attached to a rudder. The lifting power of the wings must have been very small indeed, although diminishing in some respects the rate of falling; but it is not easy to understand how a calculation may be made of the amount of mechanical power exerted in each stroke. The question must be left open for future examination.

W. DE FONVIELLE

NOTES

A CIRCULAR has been issued by the Hon. Local Secretaries of the Belfast meeting of the British Association, calling attention to the numerous objects of interest, natural and mechanical, with which the town and neighbourhood of Belfast, as well as the county of Antrim, abounds. The whole Province of Ulster is full of objects of the highest interest to the admirer of natural scenery, to the geologist, the naturalist, and the antiquarian; and many of its most interesting localities, such as the Antrim Coast, the Giant's Causeway, the Mourne Mountains, Lough Neagh, the Round Towers of Antrim and Drumbo, are within an easy distance of Belfast. The local secretaries state that a large number of the hotels will be open to members of the Association at the usual charges, and that a list of persons willing to let rooms has been prepared. We sincerely hope that this time there will be no complaint to make on the score of accommodation. Conveyance to Belfast can be obtained from any part of the country at very reasonable rates.

THE Right Hon. Lord O'Hagan will preside over the Section for Economic Science at the meeting of the British Association.

A MEETING of the General Council of the Yorkshire College of Science was held at Leeds on the 17th inst. The Council proceeded to the election of the Professor of Geology and Mining, and the Professor of Physics and Mathematics. The vote of the Council was unanimously given to Mr. A. H. Green, M.A., late Senior Fellow of Gonville and Caius College, Cambridge, as Professor of Geology; and Mr. A. W. Rücker, M.A., Fellow of Brasenose College, Oxford, as Professor of Physics and Mathematics. Prof. Green for the last five years has held the appointment of Lecturer on Geology at the School of Military Engineering at Chatham. Prof. Rücker in Oct. 1871 was appointed Demonstrator in the Physical Laboratory of Oxford University under Prof. Clifton. The appointment of the Professor of Chemistry will be made on Friday. The Council recorded a cordial vote of thanks to Sir A. Fairbairn for his liberal offer of 2,000*l*., provided that the sum of 60,000*l*. was placed in the hands of the treasurer, and resolved to take the necessary steps for raising the required amount.

AT King's College, London, the Chair of Zoology and Comparative Anatomy, vacated by the resignation of Prof. T. Rymer Jones, F.R.S., has been filled by the election of Mr. A. H. Garrod, Fellow of St. John's College, Cambridge, and Prosector to the Zoological Society. The Chair of Materia Medica and Therapeutics, vacated by the resignation of Prof. A. B. Garrod, M.D., F.R.S., has been filled by the election of Dr. E. B. Baxter, Medical Tutor to the College.

THE prospectus has just been issued of a company to establish an aquarium for London, close to Westminster Abbey.

A BALLOON experiment to test a steering apparatus is soon to be made under the auspices of the authorities at Woolwich.

NORTHUMBERLAND, in Pennyslvania, on the Susquehannah, the place where Dr. Priestley was buried, has been selected by Americans as the spot at which all chemists are invited to gather on August 1 next, the hundredth anniversary of the discovery of oxygen by the illustrious philosopher. An address is to be delivered over his grave. This proposition of Dr. Bolton has met with a cordial response from a large number of chemists. Prof. Henry, of the Smithsonian Institution, proposes to be present with some of the original apparatus of Priestley from the Smithsonian collections. August 1 falling on Saturday, the meeting will be called for the day previous. A programme will be soon issued by the committee in charge.

THE Governing Body of Christ Church, Oxford, have voted the sum of 100*l*. per annum for five years in aid of the Biological Department of the Museum.

THE New Falcons Aviary in the northern part of the Zoological Society's Gardens beyond the canal has just been completed, and is now tenanted by a fine series of the Diurnal Birds of Prey, principally exotic. Amongst them are examples of several rare species, such as the Red-backed Buzzard (*Buteo erythronotus*), the Laughing Eagle (*Herpetotheres cachinnarus*), and the Malayan Crested Eagle (*Spizaetus caligatus*). Amongst the less-known European species are a pair of Bonelli's Eagles, a pair of Red-footed Falcons, and an Eleonora Falcon.

M. DOURNEAU DUPRÉ, a French explorer of the Sahara, has been killed by marauders on the way from Ghadames to Rhat. French colonists are making great progress in opening through the desert a road to Senegal by Timbuctoo and Niger; but Algerian refugees are their most determined opponents. The prospect of introducing water from the Mediterranean into the Chott has created a sensation in the colony and is very likely to lead to new efforts in desert exploration.

M. DE LESSEPS' scheme for making an inland sea in Algeria seems to have excited great alarm in some of the French journals. It is feared that the resulting evaporation will have a bad effect on the climate of France, one journal going so far as to suggest a return of the glacial epoch!

WE have just received the first two parts of a new monograph on the *Trochilidæ* or Humming Birds, by M. E. Mulsant, the well-known coleopterist, and the late M. E. Verreaux.

THE second series of the superb work "On the Butterflies of North America," by Mr. William H. Edwards, has just been commenced with the appearance of Part I. and with the promise of even greater beauty and excellence than the one recently closed. The illustrations, as in the preceding series, were drawn by Miss Mary Peart, who has made a specialty of this branch of art, and coloured at the establishment of Mrs. Bowen, of Philadelphia. The work bears the imprint of Hurd and Houghton, New York.

WE understand that Lieut. Cameron's journal, giving an account of his journey from Unyanyembe to Ujiji, has arrived in this country. He passed over a new route, to the south of that traversed by Capt. Burton, and north of Stanley's; and has thrown much light on the geography of the southern half of the Malagarazi drainage area. He has obtained several latitudes, and took a series of hypsometrical observations; but his most important work has been the final settling of the questions respecting the height of lake Tanganyika above the sea; and the latitude and longitude of Ujiji. Lieut. Cameron has recovered, at Ujiji, a most important map drawn by Dr. Livingstone, of the unknown country between Mikindany and Lake Nyassa, without which the record of the great explorer's discoveries would be very incomplete. Lieut. Cameron found the country between Unyanyembe and Ujiji in a more dangerous and unsettled state than ever. Mirambo and an independent body of runaway slaves were in complete possession of the route; and, though they would not molest an English officer, no Arab caravan or body of negroes could have passed. The insurgents attack and drive back all such parties, and the people would destroy all their food rather than give it to them. Lieut. Cameron's labours, first in his gallant attempts to succour Livingstone, then in furnishing aid to the explorer's servants, who brought down his body and effects, and finally in pressing onwards, in the face of great dangers and privations, to recover the journal and map at Ujiji, are deserving of the admiration of his countrymen. He is now on the verge of new discoveries, and resolved to achieve them; and we trust there will be a liberal response to the appeal for funds. Subscriptions to the Cameron Expedition Fund are received by Messrs. Ransom and Co., 1, Pall Mall East.

IN a paper in Petermann's *Mittheilungen* (Heft vii. 1874) by Dr. Joseph Chavanne, of Vienna, on "The Arctic Continent and Polar Sea," the author deduces the following conclusions from the data furnished by recent expeditions, and which he carefully discusses:—1. The long axis of the arctic land-mass (which probably consists of an island archipelago separated by narrow arms of the sea, perhaps only fjords) crosses the mathematical pole; it thus bends round Greenland, north of Shannon Island, not towards the north-west, but runs across to 82° or 83° N. lat. in a northerly direction, proceeding thence towards N.N.E. or N.E. 2. The coast of this arctic continent is consequently to be found between 25° and 170° E. long. in a mean N. lat. of 84° and 85°, the west coast between 90° and 170° W long. in a latitude from 86° to 80° 3. Robeson Channel, which widens suddenly north of 82° 16′ N. lat., still widening, bends sharply in 84° N. lat. to the west; Smith Sound, therefore, is freely and continuously connected with Behring Strait. Grinnell Land is an island which probably extends to 95° W. long., south of which the Parry Islands fill up the sea west of Jones's Sound. 4. The sea between the coast of the arctic polar land and the north coast of America is traversed by an arm of the warm drift-current of the Kuro Siwo, which pierces Behring Strait, and thus at certain times and in certain places is free of ice, allowing the warm current to reach Smith Sound. 5. The Gulf Stream gliding between Bear Island and Novaya Zemlya to the north-east washes the north coast of the Asiatic continent, and is united east of the New Siberia Islands with the west arm of the drift current of the Kuro Siwo. On the other hand, the arm of the Gulf Stream, which proceeds from the west coast of Spitzbergen to the North, dips, north of the Seven Islands, under the polar current, comes again to the surface in a higher latitude, and washes the coast of the arctic polar land, the climate of which, therefore, is under the influence of a temporarily open polar sea; hence both the formation of perpetual ice, as well as excessive extreme of cold, is manifestly impossible. 6. The mean elevation of the polar land above the sea diminishes towards the pole. 7. The sea between Spitzbergen and Novaya Zemlya to Behring Strait is even in winter sometimes free of ice, and may be navigated in summer and autumn. 8. The most likely routes to the pole are:—first, the sea between Spitzbergen and Novaya Zemlya; and second, the sea north of Behring Strait along the coast of the unknown polar land.

A NEW geological survey of the State of Pennsylvania has been ordered, and the bill providing for it has passed the Legislature and has received the signature of the Governor. Money for three years has been voted. Prof. J. P. Lesley, of the University of Pennsylvania, has been appointed Geologist-in-Chief.

THE programme of arrangements for the thirty-first annual meeting of the British Archæological Association is just out. The meeting will be held at Bristol in the week between Aug. 4 and 11, under the presidency of Mr. K. D. Hodgson, M.P. Excursions will be made to various places of interest in the surrounding district. Among the papers to be read at the evening meetings are the following:—On unpublished historical documents at Bristol, by W de Gray Birch, Hon. Palæographer; and On the records of Merchant Adventurers, by Mr. J. de Haviland.

WE learn from the Report of the Radcliffe Observer that the number of transits observed from July 1, 1873, to July 1, 1874, is 3,093; and the number of zenith-distances, 4,101. The number of stars observed in the same interval is 1,585. Coggia's comet has been observed four times on the meridian and four times with the heliometer. With the heliometer, in addition to a small selected list of double stars which have been observed as usual, a series of ten measures of the equatorial and polar diameters of Jupiter has been made, and the diameter of Uranus has been measured several times. These observations have been made chiefly by Mr. Bellamy. The volume containing the results of observations for 1871 is complete and ready for distribution. This volume contains a catalogue of 1,331 stars; [illegible] observations of the sun, 51 observations of the moon, 25 of Mercury, 18 of Venus, and 14 of Mars; a catalogue of 21 double stars, of which several have been observed repeatedly; 11 measures of the equatorial and polar diameters of Mars with the deduced apparent ellipticity, and diameter at mean distance; 8 occultations of stars by the moon, with the equations deduced from the occultations; and, finally, a considerable list of shooting-stars observed chiefly by Mr. Lucas. Considerable advance has also been made in the reductions for 1872-73.

We would draw special attention to the Catalogue of the Anthropological Collection lent by Col. Lane Fox for exhibition in the Bethnal Green Museum. Only Parts I. and II. have been yet published, and these are almost entirely occupied with Weapons, which are divided into various classes, the lists under the various classes, or rather the contents of the various screens on which the specimens are arranged in the museum, forming the subjects of dissertations by Col. Lane Fox, who endeavours to trace out the probable origin and development of the various kinds of weapons. The principles which have guided Col. Lane Fox in making and arranging his valuable collection, he pointed out in his paper read at Bethnal Green on July 1, an abstract of which will be found in our last number, p. 217. He has abandoned the mere geographical arrangement, and adopted a principle as scientific, and we hope as productive, as that which obtains in natural history. A student of anthropology going carefully over Col. Lane Fox's collection at Bethnal Green, with this catalogue in his hands, would find himself both interested and instructed to a degree that it would be difficult to attain anywhere else.

We rejoice to see from the tone of the replies to questions in the House of Commons on Monday by Mr. Disraeli and Lord Henry Lennox, that Government is conscious of how poorly housed some of our scientific collections are, and seems really disposed to take steps to remedy the evil. Mr. Disraeli said, in reply to a question concerning the Patent Museum, that it is not the only public institution which is suffering from want of space and of suitable accommodation. "That is now a crying grievance with respect to all our public buildings, collections, and offices. In regard to the Patent Museum, however, I am aware from a communication which I have received from my noble friend the First Commissioner of Works, that the matter is at present engaging attention." Lord Henry Lennox confirmed this by subsequently stating that he intended to propose to Her Majesty's Government a scheme which, if it were agreed to, would enable him to offer the Patent Museum suitable accommodation in the southern block of the International Exhibition buildings.

Mr. John Murray has in the press a memoir of Sir Roderick I. Murchison, based upon his journals and letters, with notices of his scientific contemporaries, and a sketch of the rise and progress, for half a century, of Palæozoic geology in Britain, by Prof. Archibald Geikie, LL.D., F.R.S., &c. It will be illustrated with portraits, and will be published in two octavo volumes.

Mr. Karl Trübner, of Strasburg, has recently published one part of a geological map of the neighbourhood of Heidelberg, the work of Drs. Benecke and Cohen. We especially draw attention to the fact that contour lines are given faintly marked in red. The other part, and the letter-press description, will not be ready till next year.

M. Cailletet, in studying the compressibility of gases, has been led to investigate the resistance which glass tubes oppose to pressure. In one experiment a tube 21·7 in. long, and 0·7 in. diam., was crushed by an outside pressure of 77 atmospheres, while half that pressure sufficed to break it when exerted on the interior.

The Geologists' Association has organised a lengthened excursion to the Cotteswold Hills, May Hill, and the Severn Valley, extending from Monday last, July 20, to Saturday, July 25. The head-quarters is at Cheltenham. Judging from the programme this excursion promises to be one of great interest; the directors are Dr. Thomas Wright, F.G.S., Mr. J. Logan Lobley, F.G.S., Mr. W. C. Lacy, F.G.S., and the Rev. W. S. Symonds, F.G.S.

The first volume of the United States Commission of Fish (8vo, 899 pp., 38 plates and 3 maps) has been recently issued from Washington. In addition to reports of proceedings there are given arguments for and against protective laws, the natural history of some of the most important food-fishes; catalogue of marine algæ of southern New England; and papers on physical characters, invertebrate animals, &c., of different districts.

Following the report of the Inspectors of Salmon Fisheries in England and Wales, that from the Inspectors in Ireland has just been issued, containing statistics concerning not only the salmon fisheries, but the deep-sea and coast fisheries as well. It is difficult, from the form of the report, to give any general idea of the condition of the salmon fisheries, but they appear to be slightly increasing in productiveness. The same complaints are made in Ireland as in England of the dangers from pollutions, and from the want of passes over the weirs. But the inspectors do not appear to have done anything to remedy either of these evils. The oyster fisheries are in a decaying state, and the beds licensed to private persons are almost unproductive; naturally better situated than England for the production of oysters, it seems a great pity that Ireland should not yield a large number of these molluscs, if proper care were only taken, and a little energy and capital expended in improving the beds. The herring fishery for the year was less than in 1872, while the mackerel fishery was nearly double; pilchards, however, are almost unutilised, though the mass of wealth in the waters is sufficient to make an industry that would rival that of the Cornish fisheries. If the inspectors could put a little energy into the matter and the people be made to see their opportunities, the fisheries of Ireland might be the richest in the world.

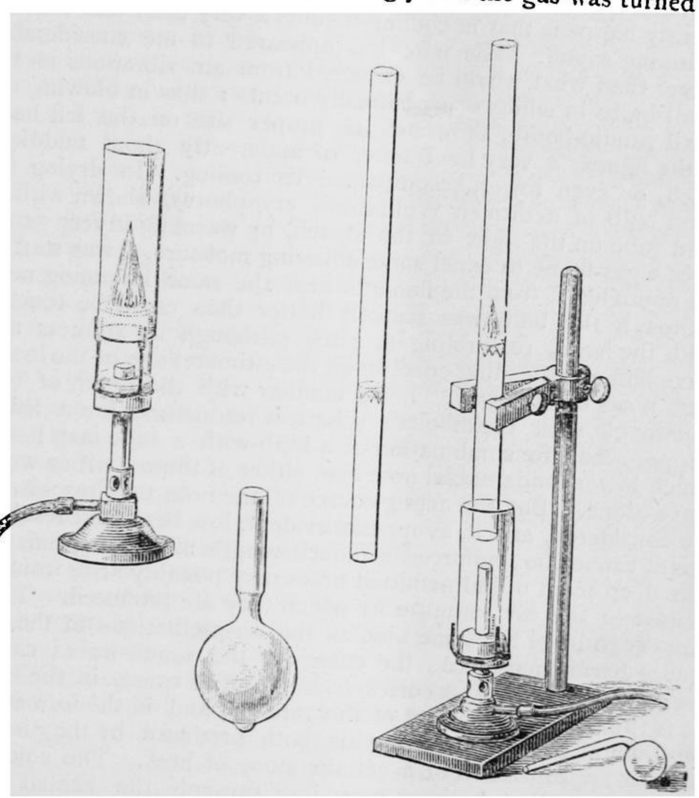
There appears a prospect of good coal being shortly made available for consumption in Japan. The largest of the coal-fields of Japan, that of Takosima, has come into possession of the Japanese Government, and it is hoped that an increased outlay of capital will produce satisfactory results.

The *New Quarterly Magazine* for July contains, among other articles, an essay On birds and beasts in captivity, by Archibald Forbes, and an interesting paper by Mr. Evershed, On habit in plants and power of acclimatisation, in which, *àpropos* of the present state of the question of sewage farming, he remarks:—"It is a serious drawback to the profits of sewage cultivation that only certain plants are disposed to consume so much liquid as is offered to them under that system of management. Cereals are not drinkers to any large extent, and will not suddenly change their habits. They have enough to do to swallow the ordinary amount of wet which prevails in our climate, being naturally partial to rather drier countries like South Russia, Poland, and Spain."

The additions to the Zoological Society's Gardens during the past week include three Giraffes, (*Camelopardalis giraffa*) from Upper Nubia, purchased; two Passerine Owls (*Glaucidium passerinum*), European, presented by Mr. C. W. Tait; a Reeves' Muntjac (*Cervulus reevesi*), born in the Gardens; a Slow Loris (*Nycticebus tardigradus*), from the Malay region, deposited; a Coati (*Nasua nasica*), brown variety, and a Spotted Cavy (*Coelogenys paca*) from South America, purchased; two Bronze-winged Pigeons (*Phaps chalcoptera*) and an Olive Weaver Bird (*Hyphantornis capensis*), hatched in the Gardens.

VIBRATIONS OF AIR PRODUCED BY HEAT

DURING the past session an interesting experiment was made by some students of the College of Physical Science, Newcastle-on-Tyne, engaged in their practical course of chemistry in the laboratory, sufficiently striking and remarkable to secure it, I have little doubt, a short notice among the records of a scientific journal. While testing the inflammable properties of the explosive mixture of air and coal-gas proceeding from the mouth of an unlighted Bunsen-burner, and observing its flame kindle and flashing back along a glass tube, it occurred to one of the students and to the chemical demonstrator, Mr. Haigh, to check the flame in its descent by inserting a piece of wire-gauze in the tube. On reaching the wire-gauze the flame rested there, as they expected; not silently, however, but bursting to their surprise with remarkable clearness and loudness into the peculiar singing strain of the chemical harmonicon. Mr. Haigh made several experiments on the flame with tubes of different sizes, which, if more immediate engagements had not prevented me from pursuing them, it had been my intention to have varied, and to have examined them more completely. In the form in which it first presented itself, a convenient and easily intelligible arrangement of which is here sketched, it appears, however, to offer all the attractions and the remarkable strength and variety of singing properties with which it seems to be abundantly endowed. A cylindrical lamp-glass mounted with a cork and wire-triangle on a Bunsen-burner serves to shield the mouth of the tube from draughts of air, and to preserve a steady flow of the entering gas. The tube is first lowered over this and lighted at the top; by raising it gradually sufficient air soon enters with the gas below to make the flame waver on the top of the tube, and finally descend to the wire-gauze, where it then burns most vociferously, especially if the wire-gauze is placed at the best position in the tube to produce some of its harmonic notes. The highest notes are sounded when it is above the middle, or even near the top of the tube, and the lowest when it is not far from the bottom of the tube; the stronger draught arising from the long column of heated air, which soon greatly assists the sound, appearing in the latter case to favour the production of notes of the deeper pitch. A glass tube about 2 ft. long and nearly 1 in. in diameter inside furnished a very powerful note, the wire-gauze being placed a short distance below the middle of the tube. By bending down the edges of a square or circular piece of wire-gauze over the flat end of a round ruler so as to fit the tube correctly, all passage of the flame between it and the tube is prevented, but when, as quickly happens with the increasing heat and updraught of the tube, the agitation of the flame grows more and more intense, it at length red-heats the wire-gauze, and passing through it lights the Bunsen-lamp below. A very instructive illustration is thus afforded of certain conditions in which the security of Davy-lamps in a fiery atmosphere can no longer be assured, where a sufficiently quick draught, or in this case the pressure of continued vibrations, carries the flame against the meshes of the wire-gauze until they are ignited. In one case danger arises of the wind carrying the flame of one side of the interior of the lamp over to the other side, which it red-heats; in the present case the vibrations carry the flame back upon itself. If in the former case a red-heated Davy-lamp is not turned round quickly to face the draught, explosion does not always follow; but in this case the current of explosive gas is immediately presented to the heated gauze, and not having undergone any previous combustion it is of course quickly kindled. On the other hand, another source of insecurity of safety lamps when exposed to sudden vibrations, or to the shock produced by a fall, is well shown, when it sometimes appears to happen, if the flame flutters very strongly, that it strikes through the wire-gauze without red-heating it, and lights the lamp below. This may, however, have occurred from imperfect fitting of the wire-gauze to the sides of the tube, and it would be interesting to repeat it if possible with precautions for making the surrounding junction quite secure. A lighted Davy-lamp suspended by wire in a tin tube 3 ft. or 4 ft. long and wide enough to admit it easily, through which a stream of coal-gas mixed with air was passing made the tube hum very loudly, but no explosion followed, perhaps because it was not found possible to produce in the lamp a sufficiently violent agitation of the flame. A remarkable example of the ease with which the wire-gauze flame excites the notes of even very short, wide-mouthed tubes can easily be shown by inserting a well-fitting piece of wire-gauze 1 or 2 in. from the lower end of a straight lamp-glass, as shown in the sketch, and supporting this a few inches above an unlighted Bunsen jet. When the gas is lighted on the top of the wire-gauze and the heat of the glass chimney becomes sufficient to increase the draught, which may also be adjusted by varying the gas supply to the glass, its shrill treble note is sounded at once with overpowering loudness. The sensitiveness of the wire-gauze flame to acoustical impressions was, I believe, demonstrated very recently by Prof. Barrett, by many new and striking experiments on the depression of its luminous cap or top in obedience to the voice and to other sounds; and I have been assured both by Prof. Tait and by Prof. Marreco that the use of the smokeless wire-gauze burners, common in laboratories before the introduction of Bunsen's lamps, for exciting the hoarse music of singing flames in tubes of large calibre has long been familiar to them as a thoroughly effective means of reproducing the chemical harmonicon with common coal-gas. The easily inflammable nature of well aërated coal-gas combined with the conducting and quenching power of wire-gauze on flames which it supports, supplies an obvious explanation of the responsive vibrations of the flame to any description of rhythmical surrounding agitations and impulses. I was not, however, prepared for an equally remarkable and peculiar property of heated wire-gauze to the above, which, like the last experiment, was also shown to me by Mr. Haigh in some of his trials of the sounding tubes. When the flame had been sounding strongly and the gas was turned off



to extinguish it, instead of ceasing immediately the musical note continued for a considerable time, sometimes even gaining a little in strength before it died away, the tube then appearing to have the power of intoning spontaneously without the presence of any visible exciting cause. That the source of these prolonged vibrations is the heat communicated to the wire-gauze, which enables it to expand the air by impulses in the tube as the ascending current gradually passes through its meshes was confirmed by a variety of experiments, all pointing to this origin of the sound as its real explanation. It happened on one occasion, when the flame passed through the gauze, lighting the Bunsen-lamp below, and leaving the gauze red-hot, that on putting out the lamp the after-note sounded so long and loudly as quite to equal, if it did not even surpass what had just been emitted by the flame. To reproduce the same note it is in fact only necessary to red-heat a wire-gauze diaphragm inserted a few inches above the lower end of a pretty wide glass tube over a Bunsen-flame, and to remove it from the lamp, when the gravest note of the tube will immediately be sounded with all the strength and purity that can be desired. Somewhat coarser wire gauze than that used for the singing-flame succeeds the best, as, besides being more easily red-heated by the Bunsen-flame, it furnishes a larger store of heat to the ascending air-current, which, in passing through its meshes, produces the singing sound. If the tube is raised quickly, the draught through it being thus checked it stops, and as soon as it is brought to rest it begins to sing again; by lowering it quickly the note is much strengthened, as it is also by turning on an unlit gas-jet under it, and especially by swinging the tube round horizontally, the lower end foremost through the air, which increases the draught and the strength of the note most considerably. The note is silenced when the tube is held at rest inverted, or horizontally, but it begins again as soon as the tube is restored to its erect position. A closely twisted coil of thin platinum wire was compressed in the tube in the place of the wire gauze, and was made red-hot over the Bunsen-flame, which was then extinguished, and the gas again turned on immediately, causing the platinum wire to continue to glow by catalytic action. As long as its red-heat continued, the musical sound of the tube also continued to be produced. A glass tube 2 ft. long by 1¼ in. in diameter, stopped near one end with platinum wire-gauze, to the centre of which a small piece of spongy platinum is fastened, performs in this way over an unlighted gas-jet, when started by preparatorily heating the platinum gauze, for any length of time. Although unable to do so over ordinary coal-gas, yet it is very probable that over hydrogen (as a heat below redness is sufficient to maintain the sound) a tube thus fitted with pieces of platinum sponge laid upon wire-gauze would start and continue to sound by itself.

When a glass bulb is blown at the end of a glass tube it frequently happens that in cooling it emits a very clear and distinct humming sound. The note has appeared to me considerably graver than what would be expected from air vibrations in the small bulbs in which it occasionally occurs; thus in blowing the small candle-bomb, shown of its proper size on the left hand in the figure, a very loud note, of apparently about middle C pitch, or even lower, accompanied its cooling. In drying the glass bulb of a broken Wollaston's cryophorus, shown with its bent tube on the right in the sketch, by warming it very gently over a gas-flame to expel some adhering moisture, I was startled on removing it from the flame to hear the same humming note, although the bulb was scarcely hotter than could be touched with the hand, resembling in pitch (although its softness may have had a misleading effect upon the estimate) one of the lowest bass notes of an organ. Being familiar with the depth of tone obtainable with Helmholtz's spherical resonators, I am led to suppose that the combination of a bulb with a tube may have a much lower fundamental note than either of those cavities would have alone. But the acting source of the note requires also to be considered, and if, as appears evident, low beats and resultant tones cannot be reinforced without strengthening their primaries, the deep pitch of bulb-emitted notes may possibly arise from the nature of the air impulses by which they are produced. These appear to be of the same kind as the air-oscillations in the hot-gauze harmonicon. As the energy of the sound-waves cannot be produced without a corresponding motive cause, in the latter it is the ascending current of the rarefied, and in the former the in-draught of the contracting air, both produced by the dissipation or appropriation of a certain store of heat. The cold air entering the hot bulb or ascending through the heated wire meshes, expands in doing so, recoils upon itself, and throws the air column of which it forms a part into vibrations, which continue as long as the flow of air and heat together continue to support the motion. The rapid succession of explosions of the gas-flame harmonicon are, in fact, reproduced; the expansive force of the small puffs or explosions that produce the sound being merely derived from a limited stock of sensible heat, instead of from a constant supply of heat of combustion. Considering the volume and duration of the sound long after the wire-gauze has ceased to be visibly red-hot, the energy of the effect produced by the heated gauze seems to be out of all proportion to its magnitude; but the effects of the mechanical transformation of heat are, as is well known, always sufficiently startling, and sometimes even prodigious when the conditions under which it takes place are at all favourable to the process of the transformation.

I was not aware, when writing this description, that musical sounds produced by heating glass bulbs had been examined so long ago as the beginning of this century, as described in Prof. Tyndall's work on Sound, by the late G. De la Rive, who obtained them by boiling water in thermometer bulbs. The vapour in its passage along the tube is condensed, and by the collapse that accompanies its contraction throws the air column in the tube into vibration; this action is thus exactly the opposite of what occurs when fresh-blown strongly heated glass bulbs are allowed to cool, the expansion, instead of the contraction, then giving the necessary impulse. I am also disposed, since reading Prof. Tyndall's description and explanation, to ascribe the low note of the warmed cryophorous bulbs to the escape of aqueous vapour from it in the manner of De la Rive's experiment, rather than to the influx of cold air into the bulb to which I attributed it at first.

It is well known that at a nodal point of a vibrating air-column there is no oscillation, but alternate expansion and contraction of the air, while in the middle point of a vibrating segment the opposite is the case. Neither of these places is accordingly a suitable one for the combined air-pressures and oscillations to take place, which in a sounding flame or at a heated diaphragm can never occur separately or independently of each other, the strength of each little puff or explosion depending at once upon the direction and amount of the contributing oscillation; the position of the heating cause must accordingly be between the ventral and the nodal points. It is the same with the air-currents that excite the vibrations of a flute, railway whistle, common bird-call, or organ-pipe; the oscillations and throws of pressure of the air at the embouchures are not only simultaneous, but they must also be so related to each other that an inward oscillation accompanies increase of pressure, since a part of the blast is then thrown into the air-column and compresses it. From an easy law connecting together the changes of pressure with the motion of the air at any point of a stationary air-wave, it appears that in these instruments, exactly as in the hot-bulb, or in the hot-gauze and gas-flame harmonicon, the ventral point (as far as a true one exists) is not at the embouchures of the wind-instruments, nor at the heating and cooling points of the several kinds of heat-sirens or harmonicons, but outside of them in such a position as to place the exciting air-puffs between the nodal and the ventral point. Prof. Tyndall has truly pointed out in his sound lectures that whenever stationary undulations are kept up against friction, as when a stretched string is kept in uniform vibration by the hand, the nodal points are not absolutely stationary points, but present a little oscillation. It is equally true that the string does not remain accurately parallel to itself where it ought to show true ventral points, and accordingly resists a hand applied there to keep up its oscillations with a certain force; but this resistance is weak, and it acts through a wide excursion, while near the nodal points the necessary efforts of the hand are greater and exerted through very small displacements. In intermediate positions the nearer the string is held to a nodal point, and the smaller its excursions, the stronger must be the jerks given to it by the hand to keep up its oscillations. In air-instruments (including the harmonicon and flute) the jerks of the hand correspond to the explosive force of the small admitted puffs of air, depending in heat-harmonicons on the intensity of the heat or combustion, and also on the quantity of the matter burned or heated in the successive puffs; and in wind-instruments no doubt principally on the pressure and perhaps to some extent also on the quantity of the admitted blasts. According to the position of the embouchure (including a flame-jet or a heated gauze under the expression) in the vibrating segment of a wave of resonance, its beneficial action in maintaining the air-wave will be evoked or suspended in obedience to the particular conditions that exist in the air-wave at that point; the only absolute requirement for its activity being that entanglement of a fresh supply of blast must coincide with a moment of rising pressure at that point of the air-wave. This is easily accomplished in wind-instruments, the large excursions of the air at the embouchures ensuring a plentiful introduction of the entering wind-puffs at the proper time; the action in this case is quite free from complication, as without considering the small gains of pressure periodically given by the blast as it flows inwards, and a small suction that it exercises (to which I believe that Mr. Hermann Smith is the first to draw attention in his excellent communication on this subject in NATURE, vol. x. p. 101), as it retreats, nothing prevents the to-and-fro displacements at the mouth of an organ-pipe from so deflecting the current of the air-blast inwards and outwards as constantly to apply its useful energy to the best effect. Inward motion of air towards a node is accompanied by rising and outward motion by falling pressure, and as the losses of both of these kinds of energy are properly renewed by the blast in entering or retreating, the resonance of the wind-instrument is kept up. The friction and loss of energy in high harmonics is probably much greater than in graver notes, and, the air-excursions being also smaller, it is perhaps on this account that a stronger blast or a nicer direction of it by the mouth-piece is found necessary to produce and to maintain them. In heat-harmonicons the action is less simple, the alternations of pressure as well as the oscillations of the air determining the admission of the entering puffs. To judge from the position in which a singing-flame sounds best in a chemical harmonicon, a certain "lead" like that used in admitting steam to the cylinder of a steam-engine is necessary for the flames to exert their expansive force, the gas perhaps not instantly igniting on its emergence from the jet; and this "lead" the mere oscillations of the surrounding air are unable to supply; but in the position which the jet occupies in the tube, the air-pressures, which return at periods answering to a half stroke of the flame before the oscillations, precipitate its development and enable it to exert its pressures at the proper times. The proportion of lead given to the flame increases as it approaches the middle of the tube, where only the variations of pressure act upon it, while at the lower end of the tube it is commanded entirely, like the air-blast of an organ-pipe, by the oscillations of the air. It is perhaps thus that a wire-gauze flame burning at the foot of a lamp-glass sounds so vociferously, because stationary alternations of pressure in the lower part of the tube cannot affect the transmission of gas through the gauze, while the extensive oscillations there produced have perfectly free action in extinguishing and replenishing the flame. By using a piece of thin glass connecting-tube about 4 ft. long, held vertically over an unlighted Bunsen jet, on lighting the gas escaping at the top, and carefully raising the tube so as to allow the flame to descend very slowly, it may be made to pause in its descent at the successive ventral points corresponding to the harmonic divisions of the tube, sounding the note of the section of the tube above it as it comes to each point of rest. On lowering the tube it ascends, stopping and singing at some higher point of rest, depending apparently upon the less instantaneous inflammability of the gas. With some difficulty, and by shielding the lower end of the tube as much as possible from draughts, the flame was sometimes made to drop quickly within a few inches of the bottom of the tube, stopping always at the same place and sounding there for a moment the lowest note of the tube, when by the strength of its vibrations it was either rapidly extinguished, or else lighted the Bunsen lamp below. The notes sounded by these means were, however, not nearly so loud and effective as those obtained when the gas-flame was held at its stationary points by making it come to rest upon wire-gauze.

I am indebted for almost all of the foregoing experiments to Mr. Haigh, who was very skilful in suggesting and devising modifications of them, leading to the immediate conclusions regarding the mode of their production to which they appear most distinctly to conduct. Other occupations have hitherto prevented me from attempting to extend and to examine them as thoroughly as they seem to deserve; but the field of research presented by the study of harmonic flames does not yet appear to be nearly exhausted, and the repetition of the above experiments by others will perhaps throw more light upon the doubtful questions with which they are still to some extent surrounded, enabling, it may be, the many significant and easily-recognised features of singing flames to be produced with even more than their present ease and certainty.

A. S. HERSCHEL

SCIENTIFIC SERIALS

THE *Geological Magazine*, July.—In this number Mr. J. Croll commences an article On the physical cause of the submergence and emergence of land during the glacial epoch, which is to be continued. As far as it goes it is concerned with the conceptions we have of the thickness of continental ice. An attempt is made to estimate the thickness of the great antarctic ice-cap, about which "observation and experience to a great extent may be said to be a perfect blank." The condition of the interior of the antarctic continent is inferred from the little that we know of Greenland. The diameter of the ice-cap being taken at 2,800, the thickness at the centre is given at the lowest at 6 miles, reckoning a quarter of a degree only as the slope of the upper surface. Mr. Hopkins has recorded that he found one degree the least slope on which ice will move. An ice-cap of only 6 miles in thickness is to many an unfamiliar idea, and "few things," Mr. Croll writes, "have tended more to mislead geologists in the interpretation of glacial phenomena than inadequate conceptions regarding the magnitude of continental ice."—The other original articles are On the dawn and development of life on the earth, by H. Woodward, F.R.S.—Notes on carboniferous monomyaria, by R. Etheridge, jun.—The geology of the Nottingham district, by Rev. A. Irving.—There are two letters on the glaciation of the south-west of England, by Dr. Mackintosh and H. B. Woodward.—Mr. Mallet writes that he does not see how he can be charged with "misapprehending" Mr. Scrope in the discussion on the nature of volcanic heat, and asks that as he has reduced his own views to clear definition (Phil. Trans., vol. i. 1873) Mr. Scrope will do the same.

Bulletin de l'Académie Royale des Sciences, &c., de Belgique, No. 5.—M. Van Beneden contributes the first part (65 pp. in length) of a paper entitled "On the original distinction between the testicle and the ovary; the sexual character of the two primorial layers of the embryo; the morphological hermaphrodism of an entire 'individual'; an essay on the theory of fecundation." The "essay" opens with an introduction in which reference is made to Huxley's first pointing out that the organism of Zoophytes, Medusidæ, Polyps, Siphonophora and Hydroideæ consists essentially of two layers, endoderm and ectoderm, and also to other writers who have studied the relationships of endoderm and ectoderm in various aspects. The second part contains the history and bibliography of the subject, and the third (50 pp. long) describes the author's researches on *Hydractinia echinata*, made during a lengthened visit to Ostend. He first describes the characters which the male and female reproductive zooids have in common, and carefully details his methods of preparation. The microscopic description of the female and then of the male zooids or gonosomes is given in much detail, illustrated by plates. He arrives at the following conclusions:—The ovaries are developed entirely from the epithelial layer of the endoderm. Up to the time of maturity they remain entirely surrounded by the elements of the endoderm. The testicle and spermatozoa are developed from the ectoderm. The female sporosacs contain rudimentary testicular organs, and male sporosacs a rudimentary ovary. From a sexual point of view the ectoderm and endoderm have an opposite signification. If it is true that special organs have resulted from specialisation of function following division of labour, then we must believe that originally the whole ectoderm performed the male sexual function and the endoderm the female. The ectoderm is the animal and male layer, the endoderm the vegetation and female. Fecundation consists in the union of an egg, the product of the endoderm, with the product of the ectoderm, which brings chemical compounds of "opposite polarity" into union. The new individual is formed at the instant the elements of "opposite polarity" unite just as a molecule of water is formed by the union of atoms of hydrogen and an atom of oxygen.—M. Henry contributes papers on chloral and chlor-ethylic ethers, &c.—M. F. Plateau has sent in a communication on the digestion of insects, which is to be published in the memoirs.

Bulletin de la Société d'Anthropologie de Paris, t. vii.—In the seventh volume of this journal M. Hamy gives us the results of his examination of M. Janneau's officially conducted investigations into the anthropology of Cambodia. He begins by endeavouring to define the meaning attached to the three words, "Moi," "Kha," and "Penang," which have hitherto been used in Annamite, Laolian, and Kmer almost indiscriminately to indicate the wild tribes of the hills. By the first of these we must understand the negro tribes occupying the oriental chain of the Cambodian range; in the second a people not unlike the yellow races of Laos; and in the third the tribes in whom the flat-faced non-Caucasian type is strongly marked. The Cambodians themselves distinguish between races, known as Kuoi, who, they say, are the primitive people of the land but not savages, and the Rodé, the former being employed in the extraction of the ores of Kompong Svai, and the latter in the breeding and care of horses, while both are exempt from the yoke of slavery which presses heavily upon nearly all the other tribes. In the Cambodian language M. Janneau thinks he can trace evidence of identity with many of the primitive forms of the roots of the mother-tongue of the Indo-European languages. The Aryan name "Rama" appears among the ancient regal titles of Cambodia, and while the Sanscrit "Ramayana" includes the Cambodians amongst the offspring of the immaculate cow, Cabala, the people themselves have from the most remote antiquity made the cow the object of special adoration.—The question of the depopulation of certain districts, more especially in the Polynesian and other Australasian insular groups, has lately attracted especial attention among the members of the Anthropological Society of Paris. The Gambier Islands, which in

1838 had 2,000 inhabitants, had in 1872 only 650. M. Leborgne shows, however, that although alcoholism does not exist in these islands, where fevers and smallpox are unknown, rheumatic, neuralgic and nephritic affections are not uncommon, whilst phthisis and scrofulous degeneration are attended by a frightful mortality, which seems to point to the injurious results of consanguineous unions. M. Broca is disposed to attribute the gradual diminution of the Polynesian and other analogous peoples to the moral action of certain depressing influences to which savages are exposed when they find themselves brought suddenly in contact with civilised men. The very contact of civilisation seems to exert in and for itself a destructive action on their physical nature. M. de Quatrefages considers, in a separate paper, the same question in reference to the general diffusion amongst the Polynesian races of tuberculosis, which was not observed by the early discoverers, but has now attained such dimensions that its presence could scarcely escape the notice of the least observant travellers. In the universality of its destructive action on all the Australasian islands, M. de Quatrefages sees another and most incontrovertible evidence of the unity of the entire race.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, June 15.—In this number is commenced a review by Herr Fritsch of M. Poëy's "New Classification of Clouds," published in the *Annales Hydrographiques*. After insisting on the importance to sailors, farmers, gardeners, and others, of a knowledge of clouds with a view to prediction, M. Poëy has remarked how few observers have recorded the kind of cloud, the shape, rate of movement, course, and change of direction or shift, which differs with the height at which it floats. The ideas of men who have busied themselves with clouds, from Aristotle to Maury, are commented upon and criticised. Lamarck was the first to divide clouds into classes, and Howard's system, which followed independently a year later, differed but slightly in the main from that of the French naturalist. The stratus of Howard he regards as nothing but a fog, and the cumulo-stratus as a cumulus. His own fracto-cumulus resembles Lamarck's "attroupés," and his pallio-cirrus and pallio-cumulus, determined by observation in the Antilles, replace the nimbus of Howard. The sub-divisions of Admiral Fitzroy, based merely upon quantity, lead to error. As to the stratus, the first mistake arose from its being described as a mist by Howard himself, and the next from his followers raising the thin streak of fog to the dignity of a cloud. For Kämtz says of the cirro-stratus, that when seen at the zenith it appears to be made up of a number of cloudlets, but near the horizon like a long and very narrow streak. This cloud might therefore be confused with the stratus as represented, especially as both are common at sunrise and sunset. This error, namely, making the stratus anything but a fog, has been followed in all publications since 1815, including one of Kämtz in 1840, and the plates of Schübler, of the Smithsonian Institution, of Maury, and of the French Ministry of Marine (see NATURE, vol. ix. p. 163).

Reale Istituto Lombardo. Rendiconti : t. vii. fasc. vi., March.—The following papers are contained in this number :—In hydraulics there is a paper by M.E. Lombardini, On floods and on the inundation of the Po in 1872.—In experimental physics, Prof. Rinaldo Ferrin contributes a paper On the reversal of the current in Holtz's electric machine.—Prof. Alfonso Corradi contributes a paper to the history of medicine on certain unpublished writings of Morgagni.—Tome vii. fasc. vi., April, contains the following papers :—In the section of mathematical and natural science there is an anthropological paper by Prof. Cesare Lombroso, On tattooing amongst criminals in Italy.—In chemistry there is a note by Prof. Egidio Pollacci, On the action of sulphur on earthy carbonates, particularly on calcium carbonate as relating to geology and agriculture.—In mechanics, Prof. Giuseppe Bardelli contributes a mathematical note entitled "Researches on the moment of inertia."

Fünfzigste Jahresbericht der Schlesischen Gesellschaft für Vaterländische Cultur (1872). This Society has its head-quarters at Breslau, and, according to the present report, numbers 443 acting, 32 honorary, and 108 corresponding members. It is at present under the presidency of Dr. Göppert. The account of proceedings, now before us, attests considerable vigour and industry during the year. In the department of natural science, perhaps the most important paper is that of Prof. Cohn, giving the results of his observations on Bacteria, and their relation to putrefaction and contagion. Dr. Roemer reports on some bone-remains of rhinoceros found in the Trachenberg; and Dr. Göppert traces the history of the elk in Silesia.—The family of the Cirratulides is described by Prof. Grube; and we also find accounts of a collection of Javan birds, and Transcaucasian insects in the Society's museum, and of plant-eating Cetacea.—Dr. Poleck discusses the experimental bases of the so-called modern chemistry.—Prof. Cohn's report in the botanical section is of considerable length. We may note in it Dr. Stenzel's paper, On the Riesengebirge as a limit of vegetation. He finds that about thirteen species of phanerogam and cryptogram vascular plants belong only to the Silesian side, and about as many only to the Bohemian side of the range. The entire number of plant species in that highland region is estimated at about 200, so that about an eighth finds its limit at the watershed of the range.—There is also an instructive paper by Prof. Göppert, On the relation of the plant-world to weather.—Dr. Schröter communicates a list of the fungi he has met with at Rastatt during a four years' residence; and Dr. Göppert reports on the fungus collection in the museum of the Botanical Garden in Breslau.—Descriptions of flora of the Grünberg and other localities in Silesia are furnished by various observers.—The Society has a section specially devoted to horticulture, and the report on this, presented by M. Müller, contains a good deal that will be found of value by the practical gardener.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, June 24.—John Evans, F.R.S., president, in the chair.—The following communications were read :—New Carboniferous Polyzoa, by Prof. John Young, and Mr. John Young, Hunterian Museum, Glasgow University (see NATURE, vol. ix., p. 456).—On *Palæocoryne* and other polyzoal appendages, by Prof. John Young and Mr. John Young, Hunterian Museum, Glasgow University.—The steppes of Siberia, by Thomas Belt. The author described the portion of the Siberian steppes traversed by him as consisting of sand and loam. The best section seen by him was at Pavlodar, where he found 1 ft. of surface-soil, 20 ft. of stratified reddish-brown sand, with lines of small gravel, 8 ft. of light-coloured sandy silt, 15 ft. of coarse sand, with lines of small pebbles and one line of large ones, and 6 ft. of clayey unlaminated silt, with fragments of the bed-rock in its lower half, the bed-rock being magnesian limestone much crushed at the top. The generally accepted marine origin of the great plain was said to be negatived by the absence of sea shells in its deposits, whilst *Cyrena fluminalis* occurs in them. The author regards them as deposits from a great expanse of fresh water kept back by a barrier of polar ice descending far towards the south. In its greatest extension this ice-barrier would produce the crushing of the bed-rock ; and as it retreated, the water coming down from the higher ground in the south would cover a continually increasing surface.—On the microscopic structure and composition of British Carboniferous dolerites, by S. Allport.—Additional remarks on boulders, with a particular reference to a group of very large and far-travelled erratics in Llanarmon parish, Denbighshire, by D. Mackintosh.—Note on the Bingera diamond-fields, by Archibald Liversidge.—Remarks on the working of the molar teeth of the *Diprotodon*, by Gerard Krefft, F.L.S. ; communicated by the president. In this paper the author criticised a figure of the lower molars of *Diprotodon*, published by Prof. Owen, on the ground that the teeth are represented in it in an unabraded state, and stated that when the last tooth breaks through the gum the first of the series is always worn flat. He also remarked on the peculiar modification of the premolar in the genus *Diprotodon*.—Descriptions of species of *Chætetes* from the lower Silurian rocks of North America, by Prof. H. Alleyne Nicholson, F.R.S.E. In this paper the author accepted the union of *Chætetes* and *Stenopora* made by Milne Edwards and Haime, and stated that *Monticulipora* D'Orb. and *Nebulipora* McCoy, also seemed to him to belong to the same generic group, for which he proposed to employ the name *Chætetes*.—On the composition and structure of the bony palate of *Ctenodus*, by L. C. Miall ; communicated by Prof. P. Martin Duncan, F.R.S.—Notes on a railway section of the Lower Lias and Rhætics between Stratford-on-Avon and Fenny Compton, and on the occurrence of the Rhætics near Kineton and the Insect-beds near Knowle in Warwickshire, and on the recent discovery of the Rhætics near Leicester, by the Rev. P. B. Brodie.—The resemblances of ichthyosaurian bones to the bones of other animals, by Harry Govier Seeley, F.L.S. In this paper the author endeavoured to give precision to the term ichthyosaurian by analysing the characters of the Ichthyosaurian skeleton into the resemblances which it presents to skeletons of other vertebrates. Ichthyosaurian characters are subdivided into Mammalian, Avian, Crocodilian, Chelonian, Lacertilian, Cameleonian, Rhynchocephalian, Ophidian, Urodelan, Piscine, Plesiosaurian, Dinosaurian, Dicynodont, and Labyrinthodont. By thus classifying the characters it is anticipated that the affinities of the Ichthyosaurian type may be rendered evident.—The resemblances of Pleiosaurian bones with the bones of other animals, by Harry Govier Seeley, F.L.S. This paper is an attempt to make a similar analysis of the Plesiosaurian skeleton.—On the tibia of *Megalornis*, a large struthious bird from the London clay, by Harry Govier Seeley, F.L.S. The author considered that the skull named by Prof. Owen *Dasornis* might, if it belonged to a bird, be referred to *Megalornis*; but he detailed considerations which led him to suggest that *Dasornis* may possibly be a fish.—On cervical and dorsal vertebræ of *Crocodilus cantabrigiensis* Seeley, from the Cambridge Upper Greensand, by Harry Govier Seeley, F.L.S.—On the base of a large Lacertian skull from the Potton sands, by Harry Govier Seeley, F.L.S. This specimen was interpreted by the author as the anchylosed basioccipital and basisphenoid of a Dinosaur. The author did not regard the specimen as giving support to Prof. Huxley's hypothesis of the Avian affinities of Dinosaurs.—A section through the Devonian strata of West Somerset, by Harry Govier Seeley, F.L.S.—On the pectoral arch and fore limb of *Ophthalmosaurus*, by Harry Govier Seeley, F.L.S. After some remarks on the structure of the pectoral arch in *Ichthyosaurus* the author described parts of a skeleton discovered by Mr. Leeds in the Oxford clay, on which he founded the genus *Ophthalmosaurus*.—The glacial phenomena of the Eden Valley and the western part of the Yorkshire Dale district, by J. G. Goodchild; communicated by H. W. Bristow, F.R.S. This paper is a continuation, in a northward direction, of the investigation of glacial phenomena which formed the matter of a paper lately read before the Society by Mr. Tiddeman, and published in the Society's journal.—Geological observations made on a visit to the Chaderkul, Thian Shan range, by the late Dr. F. Stoliczka. In this paper the author gives an account of the geology of the district traversed by him in his journey from near Kashgar to Lake Chaderkul on the Russian frontier, a distance of about 112 miles, his route lying among the southern branches of the Thian Shan Range. Three principal ridges were crossed. The first, or "Artush ridge," consisted of newer Tertiary deposits of bedded clay and sand, mostly of a yellowish white colour. These "Artush beds" were traced by the author for a distance of 22 miles. The southern slopes of this range were covered with gravel from 10 to 15 ft. thick, which passes into a conglomerate with a thickness of about 200 ft. The second, or "Kokan range," is formed on the southern side of old sedimentary rocks, whilst the northern is occupied by newer Tertiary deposits and basaltic rocks, the former consisting of shales and limestones, in which the author found some fossils, inducing him to refer them to the Trias. These are succeeded by some dark-coloured shales, slates, and sandstones, dipping at a high angle to the north. On the denuded edges of these the new Tertiaries rest, consisting of sandstones interstratified with basaltic rocks. These latter increase in thickness till just beyond Kulja an old "somma" is reached, with perpendicular walls rising to a height of 1,500 ft. above the river. The cone of the volcano has disappeared by subsidence. The third ridge, "Terek-tagh," consists of old sedimentary rocks, chiefly limestones.—Note upon a recent discovery of tin-ore in Tasmania, by Charles Gould.—Note on the occurrence of a Labyrinthodont in the Yoredale rocks of Wensleydale, by L. C. Miall; communicated by Prof. Huxley, F.R.S. The author briefly describes a specimen, discovered by Mr. W. Horne, of Leyburn, in the Lower Carboniferous Rocks there, comprising casts of five bones. He considers that these bones belong to an animal of higher rank than any known fish, and thinks that the Lower Coal-measures of Glasgow, with *Loxomma*, may be of earlier date than the Yoredale Rocks.—Geological Notes on the route traversed by the Yarkund Embassy from Shahidulla to Yarkund and Kashgar, by Dr. F. Stolickza. The author described the rocks observed by him along the course of the Karakash river and through the Sanju pass as chiefly metamorphic, and very highly inclined, until near Yám sedimentary rocks rest unconformably on the schists. These are probably Palæozoic. Later rocks occur near the camp Kiwáz, some resembling the rocks of the Nahún group, and underlain by deposits containing Carboniferous fossils. At Sanju coarse grey calcareous sandstones and chloritic marls of Cretaceous age occur. True Löss occurs in some of the valleys.—The hematic deposits of Whitehaven and Furness, by J. D. Kendall.—Notes on the Physical Characters and Mineralogy of Newfoundland, by John Milne. Notes on the Sinaitic Peninsula and north-western Arabia, by John Milne.—Giants' Kettles at Christiania, by MM. W. C. Brögger and H. H. Reusch; communicated by Prof. Kjerulf. The authors first refer to the popular notices about giants' kettles, and describe in detail a number of these pits, which were examined and emptied near Christiania. They then mention the theory concerning their origin. From their own facts and reading they conclude that many of these remarkable pits were made at the bottom of "Moulins" during a glacial period, when the locality was covered with ice on the scale of existing ice in Greenland. The contents of these pits are traced to their parent rocks, which are higher up towards the great valley of Gulbransdal, in which glacial phenomena abound. They are inclined to conclude that moraine matter was washed off the glacier-ice from time to time, and left in the pits at last.

Geologists' Association, July 3.—Henry Woodward, F.R.S. president, in the chair.—On the deposits now forming in British seas, by G. A. Lebour, F.G.S. The author limited his present task to a brief description of the principal constituents of British sea-bottoms, with particular reference to their distribution and its causes. The materials are of mechanical, chemical, or organic origin.—*Rock-bottoms.* In some places no deposit occurs, the bare rock being left. The largest of these bare spots, in British seas, occurs in the western half of the Channel Valley. Their distribution is directly connected with that of currents, and this is strikingly proved by their being limited to no relative depth; for, in the Channel, their range extends entirely across the valley. Another bare area exists at the point where the Atlantic cable enters the yet deeper region of the Atlantic ooze in 500 fathoms water. The specimens brought up by the sounding instruments from such places consist of weathered and rotten stone, pointing to chemical rather than mechanical disintegration, even where powerful currents are present.—*Marine deposits.* These consist chiefly of sand, with occasional islands of clay, mud, gravel, and shell detritus. The broader the sea the greater the proportion of sand: thus the North Sea bottom is especially a sandy one, though towards the centre the sand becomes muddy over a considerable region. Sandy bottoms also largely prevail in the north-western seas and on the west coast of Ireland; but south of Ireland a large expanse of pure mud and muddy sand extends in a south-easterly direction.—*Organic deposits.* In the Channel the shell deposits attain their greatest development as regards British seas. There they form two long, occasionally broken lines, following at a short distance the English and French shores, and forming at the outer mouth of the Channel a vast shell bank. These deposits actually cross the broad sea-valley partly over and considerably to the west of the spread of bare rock previously mentioned. Beyond the ocean valley which lies between the Hebrides and the Rock-hall reef, there occurs a fish bank more than three miles in length, affording us an inkling of the manner in which some of our long-fossilised fish-beds may originally have been accumulated.—*Fluvio-marine deposits.* The Thames, Seine, and Tay form mud banks in a sandy sea. The submarine delta of the former has the shape of a triangle, of which the apex points seawards; that of the Seine is also triangular in outline, but the apex points landwards. Such submarine deltas can only be recognised when the materials of which they consist are distinct from those forming the prevailing sea-bottom. Although much of the above materials are at present incoherent, especially the sands, it is not probable that the larger features of the sea-bottoms are liable to important changes, whilst the surrounding geographical conditions remain unaltered. The same agencies, which sweep certain spots, have heaped-up material elsewhere, and the relative form of both covered and uncovered portions of the sea-floor is preserved by them. The points of the greatest violence of current action are shown by the bare rock patches, whilst the intermediate stages of agitation are represented by coarse shingle, sandy gravel, sand, and finally patches of mud or clay supervene, which, to a certain extent, indicate centres of calm.

Entomological Society, July 6.—Sir Sidney Smith

Saunders, president, in the chair.—Prof. Westwood exhibited specimens of *Haltica aurata*, which he had found to be very injurious to young rose-leaves. Also, a portion of a walnut attacked by a Lepidopterous larva, probably a Tortrix; but he was unable to name the species, as it produced only an ichneumon. It was the first instance he had known of a walnut being attacked by an insect in this country. Mr. F Moore stated that he had on one occasion reared *Carpocapra splendana* (a species that usually feeds on acorns) from a walnut.—Prof. Westwood made some remarks on the Yucca moth (*Pronuba yuccasella* Riley), of which some fifty specimens had been sent to him, in the pupa state, by Mr. Riley; but he had succeeded in rearing only three. He exhibited a drawing of a portion of the insect, showing the extraordinary form of the palpi, which was especially adapted for collecting the pollen, with which it impregnated the female flowers. He directed attention to a full description of the insect and its habits by Mr. Riley, in the sixth Annual Report of the Insects of Missouri.—Prof. Westwood also exhibited some bees which had been sent to him from Dublin, having been found attacking the hives of the honey-bees. They were smaller than the honey-bee, and black, and he considered them to be only a degenerated variety of *Apis mellifica*. He suggested the probability of their being identical with the "black bees" mentioned by Huber.—Mr. Champion exhibited *Amara alpina* and other beetles from Aviemore, Invernesshire.—The Secretary exhibited some specimens of a Dipterous insect which had been found in the larva state in an old Turkey carpet. The larva was very long, slender, and serpentiform; it was white and shining, and had something the appearance of a wire worm, but much longer, and without feet. The name of the insect was not ascertained.—Mr. Bond exhibited specimens of *Argas pipistrellæ* parasitic on a bat, and also some *Acari* from a small species of fly; both were from the Isle of Wight.—Mr. Boyd exhibited specimens of *Thecla rubi* from St. Leonard's Forest, differing in certain points from the ordinary type.—Mr. Wormald exhibited a collection of butterflies sent from Japan by Mr. H. S. Pryer.—Mr. W. Cole exhibited some galls of a species of *Cecidomyia*, found in West Wickham Wood.—Mr. F. Smith exhibited some earthen cocoons found on wet mud at Weymouth by Mr. Joshua Brown. They proved to belong to a Dipterous insect (*Machærium maritimum*), one of the *Dolichopidæ*.—Mr. S. Stevens exhibited specimens of *Asopia nemoralis* from Abbot's Wood, Lewes, and other Lepidopterous insects.—Mr. Butler exhibited a copy of a very rare (if not unique) book, which had recently come into the possession of Mr. E. W. Janson, entitled Lee's "Coloured Specimens to illustrate the Natural History of Butterflies" (London, 1806). He could not find that it had been quoted in any synonymic catalogue, and it contained coloured drawings and diagnoses of nineteen species of butterflies.—The Rev. H. S. Gorham read descriptions of species of Endomycid Coleoptera not comprised in his catalogue, "Endomycici recitati." Also, Some remarks on the genus *Helota* (*Nitidulidæ*), of which he described a new species from Japan.—Dr. Sharp communicated a supplementary paper On some additional Coleoptera from Japan.—Prof. Westwood communicated Descriptions of new species of *Cetoniidæ*, principally from the collection of Mr. Higgins.—The President announced that the library of the Society would remain for another year at 12, Bedford Row, and it was hoped that by that time some more permanent and suitable place would be obtained for it.—Part III. of the Transactions of the Society for 1874 were on the table.

Paris

Academy of Sciences, July 13.—M. Bertrand in the chair. The perpetual secretary announced the death of M. Angstrom, and the president made some remarks expressive of the regret of the Academy at the loss they had sustained. The following papers were read: Observations relating to M. Tacchini's last note and to the recent memoir of M. Langley, by M. Faye. The author gave an extract from Langley's memoir, showing that this observer accepted, with certain restrictions, the cyclone theory of sun-spots. On chemical actions other than metallic reductions produced in capillary spaces, by M. Becquerel. This is a continuation of the author's researches in electro-chemistry. Observations on the subject of the establishment of an inland sea in Algeria, by M. de Lesseps.—Memoir on the chronological classification of geological formations, by A. E. B. de Chancourtois. On some applications of Abel's theorem to curves of the second degree relative to the elliptic functions, by M. H. Leauté. On the observation of a phenomenon analogous to that of the "*goutte noire*," by M. Devic.—Observations on the obstacles to be opposed to the attack of vines by Phylloxera, a letter from M. Bourgeois to M. Dumas. The writer made four propositions relating to (1) the direct destruction of the insects; (2) the preservation of isolated stocks; (3) the preservation of a field of vines not attacked; and (4) treatment of a field partially attacked. Several members made remarks on the same subject. M. Elie de Beaumont suggested the use of snow.—Note relating to the *viriel* of M. Clausius, by M. F. Lucas.—Note relating to the theory of osculatory surfaces, by Mr. Spottiswoode.—Remarks on the pyrheliometric observations of Pouillet, a reply to the criticisms of M. Faye, by M. Duponchel.—On chemical achromatism, by M. Prazmowski. This was a note descriptive of the construction of the photographic objective to be used by M. Janssen for photographing the solar disc.—Second note on the electric conductivity of ligneous bodies, by M. Th. du Moncel.—On indications furnished by conjugate thermometers *in vacuo*, by M. Marié-Davy.—Qualitative research on arsenic in organic and inorganic substances, by MM. Mayençon and Bergeret. The authors have devised a new plan for detecting arsenic (depending upon the action of arsenetted hydrogen on mercuric chloride), which possesses extreme delicacy.—Action of heat on the isomers of anthracene and their hydrides, by M. Ph. Barbier. The author has extended his investigations to the following substances:—the two ditolyls, ethylene and diphenyl mixed, and benzyltoluene. Fritzsche's phosene appears to have been a mixture of anthracene and phenanthrene.—New experiments on human locomotion, by M. Marey.—New experimental researches on inflammation and mode of production of leucocytes of pus, by M. J. Picot. Action of salts of biliary acids, by MM. V. Feltz and E. Ritter.—Observations on the first phases of development of *Pelobates fuscus*, by M. G. Moquin-Tandon. These phases are in the main identical with those of the common toad.—Analyses of the samples of wine exhibited at the exhibition of the Pavillon du Progrès, by M. Ch. Mène.—On globular lightning, by M. Gaultier de Claubry. This was a description of some of the effects of the thunderstorm which broke over Paris on Thursday the 9th inst.

BOOKS RECEIVED

American.—Baird's Annual Record, 1873.—Proceedings of the Boston Society of Natural History, vol. xvi. part ii.—Field Ornithology, comprising a Manual of Instruction for procuring, preparing, and preserving Birds, and a Check List of North American Birds: Dr Elliott Coues, U.S.A. (Trübner).—The Birds of Florida, Part iii.: C. J. Maynard (Ipswich, U.S.A.).—Bulletin of the Buffalo Society of Natural Science (Warren & Co., Buffalo).—Circles of Deposition of American Sedimentary Rocks: J. S. Newberry.—Theory of Arches: Prof. W. Allan (Van Nostram, N.Y.).—My Visit to the Sun: or, Critical Essays: Laurence S. Benson (J. S. Burton, N.Y.).—Annual Report of the Trustees of the Museum of Zoology, Harvard, Camb. U.S.A. for 1873.—Birds of Western and North-Western Mexico: G. A. Lawrence (Boston Natural History Society).—The Organisation and Progress of the Anderson School of Natural History (Welch, Biglow & Co., Camb. U.S.A.).—Sea Fisheries of the South Coast of New England: Spencer and Baird (Washington).—The Vertebrate Animals of Vineyard Sound: A. E. Verrill and S. J. Smith (Washington).—First, Second, and Third Annual Reports of the United States Geological Survey of the Territories for 1867-69 (Washington).—Geological Survey of Ohio, vol. i. Palæontology (Columbus).—Reports of the Geological Survey of Missouri, 1855-71 (Jefferson City).—Reports of the Geological Survey of Missouri Iron Ores and Coalfields, 1872 (N.Y.).—Atlas to Geological Survey of Missouri (N.Y.).

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