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THURSDAY DECEMBER 5, 1872

THE COMETARY STAR-SHOWER

SOME months have now elapsed since an announcement by Mr. Hind informed astronomers that a well-known telescopic comet, first seen in the years 1772 and 1805, and rediscovered in 1826 by the astronomer Biela, of Josephstadt, in Bohemia, when it was first recognised as periodic, would make its nearest approach to the earth towards the close of this year; and its apparent place on successive nights was duly foretold, to assist them in their search for its existence. On the last two occasions of its expected returns, in 1859 and 1866, no signs of the missing comet were detected. The favourable circumstances under which it was expected to be observed, during its last approach to the earth in 1869, and the absence of any notice of its having been seen during the last two months of its anticipated reappearance in the present year, makes it hardly doubtful that, as an interesting study and examination with the most powerful modern telescopes, it has at length ceased to be any longer visible. When at its greatest brightness in the year 1805, it was seen by Olbers, with the naked eye, and in its subsequent returns, it was frequently attentively observed with the most powerful means and by the most expert astronomers. During its appearance in 1846 it was first distinctly perceived to separate into two portions, gradually receding from each other until they gained a greatest distance, which was estimated on that occasion at 157,000 miles. The two portions remained visible as two distinct comets at their next return in 1852, with a widened interval between them, which had increased to 1,250,000 miles. With nearly equal brightness, and with perfect cometary appearance, these two bodies travelled side by side, and journeyed together, doubtless, to separate still further from each other in their further circulations round the sun. Such is the telescopic history of Biela's comet. In the year 1818 a telescopic comet was discovered by Pons, the astronomer, at Marseilles, whose date of appearance, at least a year before the time of a punctual return, cannot have been a reappearance of Biela's comet, but the position of its orbit, as far as it could be calculated from the imperfect data that were obtained, are so similar to that of Biela's that its relation to that comet appears not improbably to be of the same kind as that which formerly connected together the two portions of the recently divided cometary pair, and the orbit and periodic time of this third comet probably differ but little from those of the principal comet from which it may fairly be presumed to have been derived. Such groupings of comets on nearly parallel courses appear to be distinguishable in the more remarkable cases, recently pointed out by Hoek, of some comets with hyperbolic orbits; and the revolution of more than one telescopic comet is thought to have been discovered in the same orbit with the periodically-returning comet of 1866, with which the meteor-current of the great November star-shower, at its recent return, was shown by Schiaparelli, Adams, and Oppolzer, to be in remarkable agreement. In a later letter to the *Times*, in August last, Mr. Hind pointed out the satisfactory coincidence of which Prof. Schiaparelli, the former coadjutor of Secchi, and now the able director of the Observatory at Milan, was the first discoverer, between the orbit of another comet of considerable brightness seen in 1862, and the course of the meteors of the well-known August star-shower, an unusually bright display of which was recorded shortly after the appearance of that comet in the following year. Another example of distinct resemblance between the orbit of a meteor current and that of a periodic comet was early discovered by the German astronomers Drs. Weiss and Galle in the case of the meteor shower of April 19-20 and the comet I, 1861, to which Prof. Kirkwood, of the State University in Indiana, U.S., has lately added the interesting observation that the earliest records of this meteor shower, as well as of a conspicuous star-shower annually visible about October 18-20, indicate a periodic time in their maximum returns, which corresponds, like that of the November meteor system and its attendant comets, to an ellipse whose major axis is very nearly the mean distance of the planet Uranus from the sun. The time has thus arrived when systematic observations of meteor showers may be regarded as an important auxiliary to astronomers in certain cases where the orbits of comets are intersected by the earth's path, by vying with the telescope in detecting the hidden courses of such comets as, by comminution or disbanding of their substance, have so lost their brightness, as at length completely to elude their search.

The probability that the orbit of Biela's comet is marked by a considerable meteor stream was first shown, almost simultaneously, by the two eminent directors of the national observatories at Vienna and Copenhagen, Drs. Weiss and D'Arrest. The meteor stream to which the comet appears in this instance to have given rise, was principally observed in Germany, France, Belgium, and the United States of America, in the years 1798, and 1838, occurring on December 6 and 7 in those years; and again by the astronomer of Münster, Dr. Heis, at Aix-la-Chapelle, on December 6, 1847. Either of the periodical returns of the comets, 1818, I., or of Biela's comets, it was found by Weiss and D'Arrest, would perfectly account for the dates of appearance of these meteor-showers, and for the observed direction of their radiation from a point of divergence between Cassiopeia and Andromeda. The situation of this meteor stream is such that the meteors enter the earth's atmosphere with almost the least possible speed, of about eleven miles per second, that meteors can have; while the Leonides, or meteors of November 14, penetrate it with a velocity which is about four times greater. The position of the orbit is also such that it undergoes very rapid changes by the attractions of the planets; so that, while encountering the earth on December 7 in 1798, the meteor particles, at the last visible return of the comet in 1852, must have extended across that point in the earth's course which it passed on November 28 in that year. A few meteors from the same radiant point were seen by the late Signor Zezioli, of Urbino, the most zealous contributor of shooting-star observations to Prof. Schiaparelli, on November 30, 1867, diverging from the indicated place. The probability that the shower formerly witnessed on December 6 and 7 has thus advanced with the node of the comet's orbit to an earlier date in November, is now fully corroborated by the conspicuous appearance of the same meteor-shower which has recently appeared. Had it, indeed, been possible to estimate exactly the motion of the comet's nodes during the interval since their previous return, the date on which the great meteor-shower observed on Wednesday last occurred, might have been accurately foretold. The Luminous Meteor Committee of the British Association requested observers to co-operate for its observation on the evenings of the 28th to 30th of last month, and to keep an occasional watch for its return from the 25th until the last day of November. The observations received from some of these observers are ample proofs of their success; and among the copious descriptions of the shower which have appeared by many expert astronomers throughout the kingdom, little can be desired to increase the extent or accuracy of the information which has been obtained. Should it, however, be observed that a star shower like that seen by Heis, and earlier observed on the 6th and 7th of December, is again visible on about the 5th of December in this year, its connection with the companion comet I., 1818, of Biela's comet, may become a matter of interesting deductions from such observations, and of further satisfactory investigations.

A. S. HERSCHEL

*FERMENTATION AND PUTREFACTION**

II.

IN the interesting inquiry into the life-history of mildews, a well-known one, abundant wherever organic matter, in a somewhat inert state, is exposed to damp, *Aspergillus glaucus*, may be taken as well as the *Mucor mucedo*. This consists in the first place of a mass of mycelium filaments, which are formed of delicate cells in chains, that is to say, the fibres are divided into series of true cells by diaphragms. The cells are full of protoplasm, at first showing a distinct nucleus, and afterwards a number of vacuoles containing water. The filaments grow at the ends, and new partitions there grow up—at first close together, and afterwards separating and becoming more distinct. Some of the filaments become spiral at the end and finally develop peculiar reproductive organs which will be noticed presently. *Aspergillus* frequently presents for long nothing but this spreading jointed mycelium, feeding upon the surface, and penetrating into the substance of organic matter, and rotting and burning it; producing water, carbon dioxide, sulphuretted hydrogen, various butyric compounds, and other products of decomposition, without developing any special organs of its own. In this state it is perfectly impossible to distinguish it from the mycelium of many other fungi. No doubt there are differences—there are marked differences from some mycelia, for instance those of the Mucors where the filaments are undivided—but most have divided filaments, and these organs are so small, so simple, and so variable, that it is next to impossible to appreciate the distinctive characters. Under favourable circumstances, in the light and air, *Aspergillus* rises into the form of a bluish mould. This under the microscope shows a multitude of one celled upright stalks, which form a kind of fur on the surface which it has attacked. Each of these stalks, which may be called *conidia-stems*, is dilated at the upper end, and from this dilatation there project, bristling all over the knob, a number of conical protuberances called *sterigmata*. Each sterigma becomes pointed towards its free end, and at length produces at the point a small round cell filled with protoplasm, which remains attached to the sterigma by a fine pedicel. Behind this cell, between it and the end of the sterigma, another cell then forms, and then another, until little chains of cells stand out free from the ends of the sterigmata; and as all these are of the same age, they are symmetrical, and of the same length. The farthest from the sterigmata are, of course, the oldest, and some of these soon get dry and ripe; so that an impalpable dust of these propagating buds or *conidia* is perpetually coming off, wafted by the slightest breath, or even by the imperceptible convection-currents from which the air is never free, from the surface of a mould patch. The conidia are buds capable of germination, of producing plants which go through the same course as their parent, but they are not reproductive products. At the ends of the spiral curls of the mycelium filaments at certain seasons, and under favourable circumstances, large bodies are produced by a form of conjugation in which cells are multiplied till they form a mass of considerable size of a bright yellow colour, called a *utricle*. Some of the cells composing the utricle become dissolved, while the greater number are developed into oval sacs or *asci*, in each of which eight spores are produced. These utricles are the true sexual reproductive organs. We have thus two kinds of spores—conidia, which are non-sexual buds, and asci-spores, the product of a form of sexual union. *Aspergillus* often bears conidia without utricles, and this is always the case when the fungus is badly nourished. It never, apparently, bears utricles without conidia. The appearance of the two modes of reproduction is so different, that the name *Aspergillus* was, until lately, restricted to mycelium bearing the conidia form of multiplication, while the utricle-bearing filaments and utricles were placed in another genus, *Eurotium*.

When sown, say on a solution of sugar or on any other suitable soil, the behaviour of the two kinds of spores is exactly the same. The spores send out tubes, which take the character of mycelium; and whose filaments in either case subsequently bear conidia or utricles according to circumstances.

Botrytis cinerea, a fungus specially abundant on decaying vine-leaves, produces conidia in elegant panicles, and a utricle which assumes such large proportions, and such a definite form, that it has been placed in the great genus *Peziza*, under the name of *P. fuckeliana*.

Not to multiply examples too much, I will briefly refer to a form, the life history of which is not yet thoroughly known—the mould which so often occurs in sour milk, though it is by no means confined to that station—*Oidium lactis*. The mycelium of *Oidium* is extremely like that of *Aspergillus glaucus*, having filaments divided into distinct cells by marked septa. From the mycelium long single shoots rise in the air, and give off chains of conidia; each shoot representing one of the sterigmata of *Aspergillus* with its progeny. *Oidium* attacks all kinds of fermentable substances, and consequently its conidia are frequently, almost constantly, met with in fœcal matter;

* From the Opening Address for the Session 1872-73 to the Botanical Society of Edinburgh, delivered on Nov. 14, by Prof. Wyville Thomson, F.R.S., President of the Society. Concluded from p. 62.

and, like many other innocent fungi, it has had the credit of producing the Asiatic cholera, and rejoices, among other synonyms, in the name of *Cylindrotænium choleræ*.

In solutions containing sugar we often find a multitude of round or oval cells, precisely resembling the cells which I have already described in other fungi; a delicate membrane surrounding a mass of protoplasm, with one or two water vacuoles; each cell is about $\frac{1}{100}$ mm. in diameter; the cells are in twos or threes, or frequently run together in strings, like a breaking up chain of gemmules of a *Mucor*. These are the well-known *Saccharomyces cerevisiæ*, the yeast fungus. In multiplying, which they do with extraordinary rapidity, these yeast cells throw up irregularly from the surface one or more buds, much as other fungi produce conidia. These separate, and in turn multiply in the same way; but the last stage in the development of this fungus is one which brings it into the regular series of ascomycetous fungi, the formation of regular asci or utricles, which correspond exactly with the asci of *Aspergillus*. These contain four to eight spores, which, when placed under favourable circumstances, vegetate in the ordinary way. It is after the sprouting of fresh yeast has taken place for some time in a fermenting solution, and has become languid, that the formation of asci begins, and we can produce them artificially by taking yeast out of a solution of sugar, and placing it upon the surface of a fresh vegetable, such as a slice of carrot. From yeast we pass to a series of very nearly-allied forms, which, as we shall see hereafter, perform a somewhat different function, the difference altering their value prodigiously in human economy. In sour wine and beer, in the process of the manufacture of vinegar, and wherever we have what is called the acetous fermentation, minute bodies swarm in the solution which closely resemble yeast, differing chiefly in the smaller size of the cells. Sometimes these appear in pairs, sometimes single, and sometimes as little vibrating jointed rods. The best known, and perhaps the most mischievous, are the mould fungus of sour wine, *Mycoderma vini*, and the "mother of vinegar," *Mycoderma aceti*. These are called *Mycoderma* because the cells are entangled in a sort of slimy film.

From these we pass to another class of bodies scarcely distinguishable from them morphologically, but usually even still more minute, which are universally spread wherever putrefactive decomposition is going on, *Bacteria* and *Vibriones*. These and the lactic acid, and butyric acid yeast-fungi cannot, however, so far as we at present know, be ranged with the *Ascomyceti*, but must be placed in another group, for which the term *Schyzomyceti* has been proposed parallel with the Nostocs among Confervoids.

Having thus given a very brief sketch of the morphology of this singular group of beings, I should wish to make one or two general remarks. In the first place, with De Bary, I would exhort you to remember that these beings whose morphology we have been discussing, although they are very small, are nevertheless *plants*, each going through its own life-history, and presenting at different periods, and in connection with the performance of the different functions of its life, definite forms like every other plant. You know how to think about peas and beans, oats and rye-grass, and after sowing a crop of peas you never go and watch it, wondering whether it will come up peas or barley. You never watch the growth of a turnip, expecting to find it gradually turning into a carrot; and you never set aside a bowl of gruel and wait till acorns come in it, and wonder whether, if they do come, they will sprout into cabbages or hedgehogs; and yet there are slight difficulties in the study of the plants which we have been describing which have led men apparently otherwise well instructed to write reams of trash, gravely advocating absurdities of essentially the same order. These difficulties are in the first place that these plants are extremely minute, and their investigation requires great skill in manipulation, and great practice. Again, they are enormously abundant, and their multiplying germs of all kinds are so minute and all-pervading that it requires the utmost experimental dexterity to separate them, to sow them, and still more to exclude them. If we attempt to select and sow one species, ten to one the seed is mixed with the seeds of a multitude of weeds, and if during the process we allow the most indirect and instantaneous communication with the open air, instantly the enemy sows tares among our wheat, and one of these, probably more vigorous than the others, in the course of an hour has cut short its weak struggle for life. Then the form of these plants requires very careful study—some parts of them, such as the universally diffused mycelium, are undistinguishable in different species; and so are the gemmules, conidia, and spores examined singly. It is often only when the entire "fructification" is present that distinguishing characteristics exist which one can grasp. Then there is another difficulty—most of these plants present some form of the singular phenomenon of pleomorphy; perhaps not more so than other plants, but slight differences in form tell greatly in such simple and critical organisms. They present different forms at different periods of growth, and under slightly different circumstances. It is therefore not the appearance of the particular mould-fungus at any one time which we have to consider, but its life history. In this, however, as in all other such cases, we must apply the ordinary rules of experience and common sense. A plant of rhubarb, pink and clear, drawn up and forced in a can, is very unlike the same plant grown outside, with great green leaves and giving off a multitude of multiplying buds from its root crown; and without some little knowledge and experience it would be difficult to identify either of these with the plant in the autumn in its reproductive stage, shooting up its stately axis with its myriad of white feathery flowers. The difficulties in studying the small fungi are very great, but a few men, not perhaps very many, are capable of dealing with such difficulties, and by the application of the methods and reasoning of such men as De Bary, Pasteur, Lister, Burdon Sanderson, and Hartley, men trained in skilful investigation and accurate thought, the wild misconceptions which have lately gathered about the whole subject are fast passing away.

I will now turn for a few minutes from the morphological to the physiological part of the question, from the researches of M. De Bary to those of M. Pasteur.

These active little scavengers, the microscopic fungi, live upon and in, spread their mycelium over and through, and flourish on the surface of decaying vegetable and animal matter; but it is not the decay which produces the fungi, it is the fungi which produce the particular form of decay.

When a mildew is growing in the ordinary way in the free air on the surface of a liquid containing sugar, or on the surface of a plant, it absorbs oxygen from the air, and combines the oxygen thus absorbed with carbon, the product of the decomposition of the matter on which it is growing, so that by this ordinary process of burning, carbon dioxide and water are set free, while at the same time putrefaction is kept up in the substance attacked. If protein compounds be present, then ammonia, sulphuretted hydrogen, and other substances are likewise set at liberty, making the putrefaction more offensive. The fungus is, in this case, feeding upon the organic matter, and breathing the oxygen just like an animal. It cannot decompose carbonic acid if it be freely supplied with this gas. Without any other source of carbon, it does not increase. The relation of fungi to the other substances required for their growth is still uncertain. It has been supposed, and experiment seems to favour the opinion, that fungi can assimilate the nitrogen of ammonia and nitric acid, and even that they can absorb and assimilate the nitrogen of the air. I should think this very doubtful. It would seem most probable that in their relation to their surrounding sources of nourishment, their reactions are the same as those of animals and of the pale parts of the higher plants.

Pasteur has shown that the same plants which, when growing fully exposed to the air and liberally supplied with oxygen, produce putrefaction, will, when partially or wholly excluded from the air, and deprived of a full supply of oxygen, produce fermentation—that is to say, will induce and keep up a set of changes resulting in the production, not of carbonic acid and water, but of alcohol, or of acetic, butyric, or lactic acid.

The *rationale* of this process proposed for acceptance by Pasteur is singularly beautiful, and will, if correct, cause a great change in our ideas of the vital relations of these lower living forms. He believes that ferments are living beings with this special property—that they can perform all their vital functions without being in contact with free oxygen gas; that they can take the oxygen which is necessary for their respiration, and for other changes in the organic matter upon which they are feeding, from organic compounds containing oxygen, such as sugar; that they can decompose and burn these, and in doing so induce in a large quantity of fermentable material the conversion of sugar into alcohol. Pasteur cites the following experiment:—

If we half fill a flask with a fermentable liquid such as a solution of sugar, and having taken all care to exclude all other germs, sow on its surface some spores of *Mycoderma vini* or *Penicillium glaucum*, the fungus grows and flourishes on the surface, feeding on the organic matter in the solution, absorbing oxygen from the air, and throwing off carbon dioxide. In this case no alcohol is produced. If we now shake the flask, the film of fungus sinks through the liquid, and for a time there is no further change; but after resting a little, if the temperature be kept up, bubbles of carbon dioxide begin to rise from the fungus, which continues to grow, although more slowly. Fermentation sets in instead of putrefaction, and alcohol is produced in sensible quantities. The one great change which has been produced in the circumstances of the fungus is that it has now been almost wholly excluded from contact with free oxygen, while in its former condition it was bathed in it. Upon this change, according to Pasteur, depends its now acting as a ferment instead of inducing putrefaction.

A ferment, then, is a living body which is special in this respect; that it is capable of performing all the functions of its life apart from free oxygen; it can assimilate directly oxygenated matters such as sugar, and derive from them the requisite amount of heat, and it further can produce the decomposition of a much greater weight of fermentable matter than the weight of the ferment in action. Pasteur has found that ferments such as yeast lose their fermenting power— that is to say, the amount of organic matter decomposed diminishes and approaches the weight of the ferment employed—exactly in proportion to the amount of free oxygen supplied.

Pasteur has also shown, and this is one of the most curious results of his investigations, that the same fungus does not incite or maintain the alcholic, the acetic acid, the lactic acid, or the butyric acid fermentations; but that these changes are produced by different species, nearly allied but distinguishable from one another under the microscope; the specific differences between them extending to this strange difference in their powers of nutrition or respiration which induces different reactions in a fermentable fluid.

In the course of the foregoing remarks we have digressed widely from our text, the ripening and rotting " Duchesse d'Angoulême " pears; but, before concluding, let us for a moment recur to them, and see how far the facts and theories which I have brought before you are applicable to the considerations from which we started—their ripening and their decay. This ripe pear, during its early growth, was green. The cells in its outer layer contained chlorophyll, and contributed their quota to the shaking asunder of the elements of carbon dioxide and water under the influence of light—to the nutrition of the pear tree. Its inner pale cells grew, amply supplied with food from the elaborated sap, and with oxygen suspended in the percolating fluids and passing through the many ducts. Thus at that period growth was going on, and neither fermentation nor putrefaction. Sugar, starch, and various substances were then laid down in the cells, and when the pear had acquired its full growth, the connection with the tree was cut off, but the surface of the fruit remained still freely exposed to the air. A considerable quantity of sugar is now decomposed in the interior of the fruit, and the result is the production of a trace of alcohol and certain ethers—the development of the flavour of the pear; but shortly the outside softens by the ordinary production of water and carbon dioxide in contact with the oxygen of the air, the pear loses flavour again, and commences to decay. M. Bérard has shown that if a ripening fruit be placed in an atmosphere of carbon dioxide no such softening occurs. The changes are much less rapid, the inner cells of the pear act as a ferment, and while carbon dioxide is still given off it is now at the expense of the sugar, and a large quantity of alcohol is the result. M. Pasteur tried this experiment with four dozen " Monsieur " plums taken nearly ripe from the tree; twenty four of these were placed in an atmosphere of carbon dioxide, and after several days, during which time they seemed quite firm and fresh, they gave to analysis 0·50 grammes of absolute alcohol, and a corresponding quantity of sugar was destroyed; the other twenty-four were left in contact with the air, and had became soft, watery, and sweet. It is the active vitality of a living plant, which consists of materials very suitable for their consumption, which prevents its being attacked by these promoters of putrefaction and fermentation. Our pears, after burning their substance for a time without any new supply, become weak, and fall an easy prey to their persecutors. The moment the soil is free there is no want of seed. I need not reopen the old question and repeat that every breath of air is full of it. It is said that if you want a thoroughly good pasture, the best way is to fallow your ground and leave it for thirty years. During that time you will have over it a battle-royal for life. Every possible kind of seed will come to it from the four winds of heaven, and for a time it will be a wilderness of weeds; but soon the good old law begins to work, and the weak go to the wall, and the fallow bears a close sward of native British grasses. The same takes place in our pear, only what takes thirty years in a field is compressed into thirty hours, and probably before a much longer time has elapsed, its surface is enveloped in a luxuriant microscopic jungle of *Mucor stolonifer*. WYVILLE THOMSON

THE FINDING OF LIVINGSTONE

How I found Livingstone in Central Africa. By H. M. Stanley. (London: Sampson Low, Son, & Co.)

MR. STANLEY'S bold march from Zanzibar to the Tanganyika, and his perfect success in meeting with and relieving the greatest of our modern travellers precisely at the right moment, will ever form one of the happiest and most romantic pages in the story of African exploration.

Remembering the watchword of his mission, "Go and find Livingstone," and that this, not the discovery of new countries, was his great object, it seems almost invidious to notice that Mr. Stanley's journey must take a minor place among African travels of exploration, adding little to our knowledge of the exact geography of the continent. The path which he traversed is for the most part a frequented caravan route, running parallel to, and occasionally touching, the lines passed over and described by Burton, Speke, and Grant. Without the basis given by the labours of these explorers, Mr. Stanley's work would have had but small value, since he himself has not made a single observation of position or of elevation, and the compass-bearings contained in some parts of his book are not in any way checked for magnetic variation. Still, very considerable portions of Mr. Stanley's route pass through lands hitherto untrodden by Europeans, some parts even unvisited by Arabs, and of these he is undoubtedly the discoverer.

Three frequented caravan routes lead from the coast near Bagamoyo towards Unyamyembe, and of these Mr. Stanley chose the most northerly and direct, the others having been traversed by Burton, and Speke and Grant. In following this new line, Mr. Stanley has been able to mark out more clearly than the former travellers the separate basins of the Kingani and the Wami rivers of the coastland; and he points out the important fact that the latter might be navigated with ease by light-draught steamers for a distance of 200 miles inland from the port of Whinde at its mouth.

At the base of a spur of the Rubeho mountains, the edge of the high plateau of Eastern Africa, the unexpected scene of a walled town presented itself. This was Simbamwenni, the capital of Useguhha, and the recently-built stronghold of an usurper, "another Theodore on a small scale"; "the houses in the town are eminently African; the fortifications are on an Arabic-Persic model; well-built towers of stone guard each corner; four gates are facing each cardinal point, and, set half-way between the several towers, permit ingress and egress to the inhabitants."

Beyond the mountains which face the coastland, Mr. Stanley's route converged in the dry region of Ugogo to that of Burton and Speke, and hence to Unyanyembe he passed over their track. Arrived at Tabora in Unyanyembe (the name Kazeh, applied to this capital by Burton, appears to be now unknown), Mr. Stanley found the whole country to westward overrun by the gangs of Mirambo, the turbulent chief of Ugoweh, a place some 60 miles north-west of Tabora. This chief sternly refused passage to the Arab traders unless they would aid him in a warfare he was about to wage against the Sultan of the Wanyamuezi in Unyanyembe. After taking part in an ill-directed and unsuccessful attempt to dislodge the obstructive Mirambo, Stanley determined to strike out for himself a new path outside the disturbed region. In carrying out this resolve he led the way, in a semicircular track of more than 200 miles, through the forest countries of Utakama, Ukonongo, and Ukawendi, first south, then west and northward to where he again fell in with the ordinary trade route. The whole of the geography of this detour is new and interesting, and it forms the chief portion of the discoveries which are particularly Mr. Stanley's own.

The path chosen lay round the southern tributaries of the Malagarazi river, the largest known tributary of the Tanganyika, and along the water-parting between this basin and that of the Rungwa river farther south, which Mr. Stanley affirms to be also an influent of the lake, flowing through the marshy plain called Rikwa (the Rukwa lagoon of Burton and Speke). The direction of flow of the Rungwa is a most important point, since it had been suggested as probable that the Tanganyika might have its outflow through this marshy country to the Lufiji river on the east coast. This theory appears now to have no foundation.

Passing over the arrival at Ujiji, and the most fortunate conclusion of Mr. Stanley's direct mission in meeting the great traveller there, the next perfectly new portion of this journey is that in which Livingstone and Stanley together explore the head of the Tanganyika.* "We found that the northern end of the lake was indented with seven broad bays." "The fourth bay (at the head of which was the delta of the Rusizi), was about three miles in depth, and penetrated half a mile farther inland than any other." "Soundings indicated 6 ft., and the same depth was kept to within a few hundred yards of the principal mouth of the Rusizi." "We ascended about half a mile, the current being very strong (from six to eight miles an hour), and

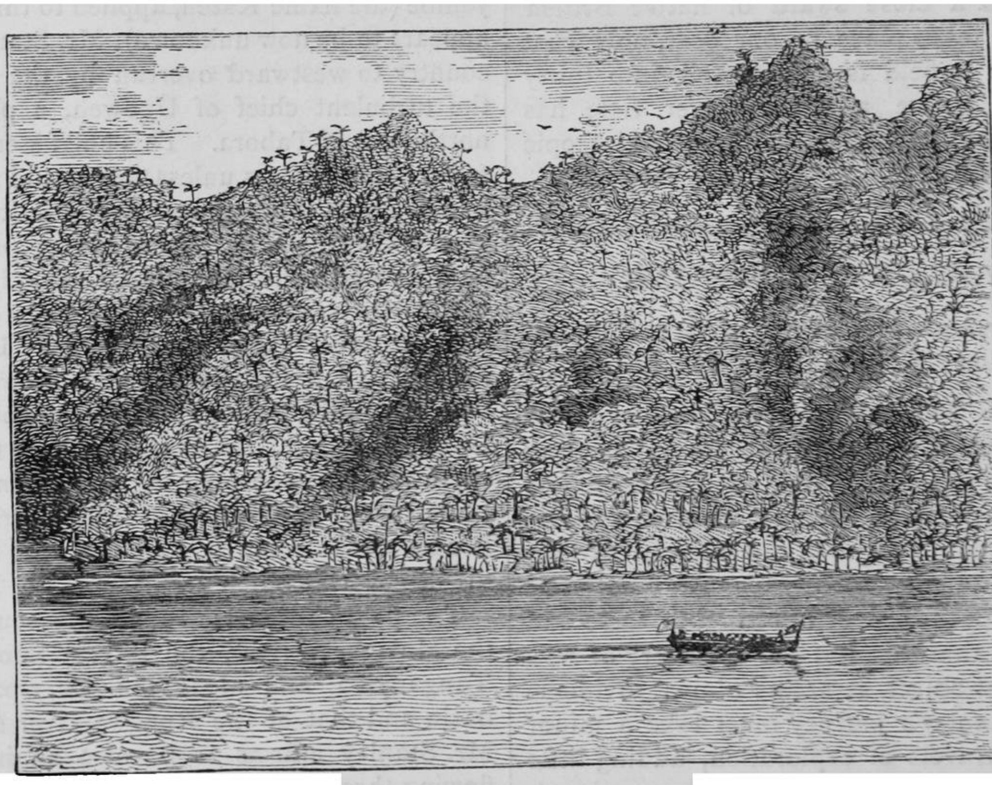
* Mr. Stanley prefers the spelling Tan-gan-ika.

about ten yards wide, and very shallow. The question, 'Was the Rusizi an effluent or an influent?' was settled for ever."

Much, if not the whole credit of this discovery, the most valuable geographical point of the journey, is due to Mr. Stanley, who suggested to Dr. Livingstone the desirability of its examination and the completeness of the circumnavigation of the head of the lake, along with the presence there of the most experienced of African travellers, leave no possible doubt remaining. The view first taken by Burton and Speke is amply confirmed, and the Tanganyika has certainly no outlet at its northern end.

When approaching Ujiji, Mr. Stanley heard a sound as of distant thunder in the west, and on asking his guides if it were thunder he was told that it was Kabogo, "a great mountain on the other side of Tanganika, full of deep holes into which the water rolls," "Many boats have been lost there; The sound of the thundering surf which is said to roll into the caves of Kabogo was heard by us, therefore, at a distance of over one hundred miles away from them." This story, in which Mr. Stanley himself does not appear to place much confidence, has suggested a possible outlet of the Tanganyika to the Lualaba system by subterranean rivers through the mountains which enclose the lake on the west; but, besides the extreme improbability of such a phenomenon, it is to be remembered that Livingstone, in coming to Ujiji from the Cazembe's territory, must have passed close to these dreaded caves, and would not have gone by them without exploring, or at least hearing of their existence. It is not recorded that Mr. Stanley consulted Livingstone on this subject.

A remarkable fact, which, taken in connection with our knowledge of the insignificant drainage to the Tanganyika, seems to lend still further confirmation to the view first expressed by Burton that "the Tanganyika, situated like the Dead Sea, may maintain its level by the balance of suppl



View on Lake Tanganika.

and evaporation," is Mr. Stanley's observation of a clearly marked high-water line of the lake on the rocky slope of a promontory south of Ujiji. "This went to show that the Tanganyika, during the rainy season, rises about 3 ft. above its dry season level, and that during the latter season evaporation reduces it to its normal level." On the contrary supposition of the existence somewhere of a considerable outflowing river from Tanganyika, it is difficult to account for such a rise and fall in a lake of upwards of 10,000 square miles in extent.

The occasional descriptions of landscape throughout the volume are exceedingly graphic; for example, the descriptions of the forest scenes in the newly traversed region of Ukonongo (p. 322) or of the park-like and pastoral country of the coast slope (p. 167). With such an appreciation of the great landscape features of the changing belts of country through which he passed, it is to be regretted that the pictorial illustrations of Mr. Stanley's book should, with so few exceptions, be devoted to personal incident. As in many books of travel, so here, a ship, a wild boar, an elephant, or a house, form the subject of the majority of the pictures, the real scenery of the country being thrown in only as a background to these objects, drawings of which may be readily obtained at home.

It is also a matter of regret that the chief map accompanying the volume does but scant justice to the observations recorded in its pages; a much more detailed representation of the routes might have been given. We look in vain, for example, for the position of Mount Kibwe, which is frequently mentioned as one of the highest peaks of the mountains of Usagara, and which is the subject of perhaps the best illustration in the book. Again, "Mukondokua had been reached after three hours' march direct west from Misanza," but upon the map these places are shown relatively north-west and south-east; Imreras, a chief settlement in Ukawendi, and the objective point of Mr. Stanley's return-route from the lake with Livingstone is not to be found. The spellings of map and book are frequently at variance.

Two chapters of geographical and ethnological remarks may have some value to the student, but do not appear to add much to the exhaustive descriptions of Burton in his "Lake Regions."

Mr. Stanley gives very minute and apparently accurate descriptions of the various fishes of Tanganyika, and these are accompanied by a page of elaborate drawings. It is unfortunate, however, that some of the fishes to which the same names are applied by Burton and Stanley do not agree in their dimensions; thus, the *Mvoro*, according to Burton, is "a long bony variety, in shape like a large mackerel;" whilst Stanley's *Mvuro* is a "thick fleshy fish, 18 inches long and 15¼ inches round the body."

The excellent chapter on the organisation of the expedition, in which Mr. Stanley gives to future explorers the benefit of his anxious study of the requirements of the expedition at starting, the native currency, quantities of cloth, beads, and wire necessary for the journey, the hire of native porters, and such like, deserves the highest commendation; and the truth of his remark that "however stay-at-home people may regard the merits of his book, the greatest praise and the greatest thanks will be bestowed upon it by travellers who may succeed me in East Africa" is already on the point of being verified.

OUR BOOK SHELF

Nachträge zu der Schrift über Inschriften und Zeichen in lebenden Bäumen, sowie über Maserbildung. Von Prof. H. K. Göppert. (Breslau: E. Morgenstern.)

PROF. GÖPPERT published in 1869 in the *Jahrbuch des Schlesischen Forstvereins* some observations on the singular inscriptions and other marks found within the stems of living trees, to which the present pamphlet is an appendix. The original tract was illustrated by four lithographic plates, and in this publication we find two more, illustrating the mode in which injuries to the wood become entirely covered over and concealed by the subsequent formation of cambium and growth of bark. The visitor to the British Museum will observe some very curious instances of this phenomenon in the botanical department, which possess the additional interest that the exact period is known when the inscriptions were made, and consequently the age of the subsequent overgrowth can be determined.

Des Préparations Microscopiques Tirées du Regne Végétal, et des différents procédés à employer pour en assurer la conservation. Par Johannes Grönland, Maxime Cornu, et Gabriel Rivet. (Paris: F. Savy. London: Williams and Norgate.)

OF the 75 pages of which this book consists, only the last 25 properly relate to the subject which is indicated by the title; all the rest are occupied by descriptions, of a very detailed and apparently accurate kind, of apparatus and various accessories to microscopic work, such as all but the most inexperienced are necessarily perfectly familiar with. A classification and account of the various kinds of turntables fills 8 pages at the beginning; diamonds and scalpels are afterwards treated of, with the method of sharpening the latter. A simple plan of mounting needles for dissection, which consists in inserting their blunt ends into the pith cavity of pieces of fresh twigs cut of the proper lengths, and then allowed to dry, and consequently shrink tightly upon them, will, no doubt, be found useful. The handles, however, for crochet-needles which are sold at berlin-wool shops achieve the same end by a simple mechanical contrivance. The triangular needles, by the way, mentioned by the authors, are known in England as glovers' needles, and are kept by some instrument-makers. Microtomes are discussed very minutely: they are, no doubt, very useful; but excellent sections are habitually made by those who use no contrivance of any kind. Imbedding in stearine is recommended in the case of Rivet's most ingenious section cutter; but when this is done it will be found that, with a little practice, the instrument can be quite dispensed with. It will hardly be worth while, therefore, for any one who wishes seriously to work at vegetable histology to expend 28 fr. upon it. A good hint is to coat the object to be cut with a thick solution of gum-arabic, which is to be allowed to quite dry before putting it into the melted stearine. By this expedient, when the section is thrown into water as soon as cut, the stearine is said to detach itself, and gives no further trouble. The manufacture of a slide and covering glass (pronounced *slïade* and *coveur*) requires an explanation of 16 pages. It is, perhaps, a doubtful compliment to find only the mechanical side of English microscopy getting any recognition. It may possibly be all we deserve; still, no serious worker in England would waste his time in carrying out the directions given here for cutting, trimming, and polishing the edges of glass slips, which can be so easily purchased ready-made. Directions for making preservative solutions form the last chapter, and these are probably of some value. A medium prepared by adding 4 to 5 parts (by weight) of glacial acetic acid to 100 parts of distilled water, with which 2 parts of chloroform have been agitated for some time, is stated to preserve the endochrome of minute algæ without contraction, and to have the enormous merit, when vegetable tissues are worked with, of absorbing bubbles of air. Another liquid, composed of 75 parts of water saturated with camphor, an equal quantity of distilled water, and 1 part of glacial acetic acid, is recommended in the warmest terms for the preservation of fresh water algæ. A great deal still remains to be done in the methods of vegetable histology. No one in England has probably as yet tried perosmic acid for plant tissues; and staining, which has proved so important an aid to animal histologists, never enters into the minds of the authors, even to the extent of mentioning the familiar carmine; much less the solution employed by Hanstein for colouring the cell-wall, consisting of equal parts of rosaniline (magenta) and aniline-violet (mauve) dissolved in alcohol.* Schulz's process for demonstrating the "intercellular substance" characteristically concludes what the authors have to say. On the whole, any person wishing to practise the preparation of vegetable microscopic objects merely as a matter of business on a large scale, will find it useful to possess this book.

W. T. T. D.

LETTERS TO THE EDITOR

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

Ipecacuanha Cultivation at Kew

I HAVE just received No. 158 of NATURE, containing Prof. Owen's letter "On the National Herbarium." In that letter Prof. Owen quotes several sentences relating to ipecacuanha cultivation in India from my last report for the official year ending March 31, 1872, on the Calcutta Botanical Garden, with the object of substantiating an insinuation of bad cultivation at Kew. He does not, however, quote the whole of what I wrote about ipecacuanha in the report referred to, and the result is, that a

* Bot. Zeitung, 1868, p. 708.

casual reader of his letter would form the impression that, but for Edinburgh, ipecacuanha would not have been introduced into India, and that, consequently, the Kew establishment cannot be relied upon for the dissemination of useful plants among the British possessions abroad, which is, I imagine, one of "the works and applications for which a nation provides and supports its collections of living plants."

My report having been quoted with such an object, I wish to state that the success of ipecacuanha cultivation in India had been practically settled before any of the plants propagated at Edinburgh had arrived in that country. In the year 1866, and long before Government had begun to show any official interest in the matter, Dr. Hooker sent an ipecacuanha plant to the Calcutta Botanical Garden, the offspring of which, in Sikkim, amounted, in the month of September, 1871, to nearly 400—quite a sufficient number to a sure a successful start to propagation on a large scale. The subsequent arrival in India of considerable supplies from Edinburgh has, indeed, made assurance doubly sure; but the fact remains that to Dr. Hooker is India indebted for the first beginning of this important cultivation.

If the establishment at Kew stood in any need of a testimonial as to the valuable assistance rendered by it in the introduction into India of plants of economic or horticultural interest, it would not be difficult to furnish a list sufficient to fill a good many columns of NATURE of the names of plants and seeds sent—many of them quite unsolicited—from Kew to Calcutta within the last ten years, to go no farther back.

GEORGE KING,
Superintendent Calcutta Botanical Garden

Nice, Nov. 26

The Great Meteoric Shower

As you will most probably have received from many other correspondents a general description of the magnificent spectacle on last Wednesday evening, I will confine my remarks principally to those observations which bear directly on the most important point at issue, viz., whether this meteor stream can be identified with the well-known comet of Biela. Having searched, during the autumn, on every available occasion for a glimpse at the approaching comet, and the almost unvarying cloudiness of the early morning sky having rendered even the negative value of the observations well-nigh useless, I read with delight the prediction of Dr. Weiss, and felt the greatest interest in its fulfilment.

Immediately I had noticed that a meteoric shower was in progress on the evening of the 27th, I directed the two assistants of the observatory, who have had considerable experience in tracing the paths of meteors during the last few years, to devote their whole attention to the accurate determination of the radiant point. In the meantime, with the assistance of three of the students of the philosophy class and of the meteorological assistants of the observatory, I noted the rate per minute, the velocity, direction, magnitude, &c., of the falling bodies.

The Radiant was found to be on the line joining γ and 51 Andromedæ, and twice as far from 51 as from γ. This gives as the R.A., 26° 37′, and N. Decl. 43° 48′, agreeing very well with the prediction.

The Epoch is somewhat in advance of that predicted; but this cannot be wondered at, as the comet has not been seen since 1852, and, in three complete revolutions round its orbit, it could scarcely have been expected not to have been subjected to considerable unknown perturbation, either from planets whose masses are imperfectly known, or perhaps from some neighbouring meteor-stream.

The time of the maximum was about 8h. 10m. P.M., but the numbers did not much diminish before 9 P.M., G.M.T Between 8h. 47m. 30s. and 9h. 0m, the computer of the observatory counted 512, which gives 40 per minute for one observer, and therefore at least 100 per minute invisible. From 9 to 10 o'clock, at which time the sky became clouded, and remained so till morning, the mean rate was about 53 per minute, and almost constant from minute to minute, though varying much during each minute. At certain moments they were exceedingly numerous. Thus, at 9h. 19m. nine appeared at the same instant at a point near β Andromedæ.

A very peculiar feature of the display was the parallel motion of many stars that became visible at the same time. Thus, at 9h. 16m. five burst out close by γ Andromedæ, and travelled eastward together; at 9.25 four went together from γ Andromedæ to the Pleiades.

More than nine-tenths of the meteors were very faint, and the larger ones seldom attained to any very considerable magnitude. Most had tails; the almost invariable colour being a white star with a greenish-blue trail. The tails of those falling S.E. were observed to bend somewhat towards the E., and to be straight only during the first half of their path. The ratio of the numbers falling S.E., to those falling N.W., was as 3 to 2, but this excess may in part be accounted for by the position of the Radiant. More of the larger meteors went S. than N., and more W. than E. The track of the larger bodies rarely, if ever, exceeded 50°, and their velocity was very noticeably less than that of the 13th and 14th November shower, as might be expected, if their absolute velocities are comparable, the Radiant for November 27 being so far removed from the apex of the earth's way. S. J. PERRY

Stonyhurst Observatory, Dec. 1

ALTHOUGH it is probable that you will reeeive full accounts of the meteoric shower of Wednesday, November 27, yet the following notes, imperfect though they be, may have some interest. I was prevented by indisposition from observing it myself, but the numbers were noted by Captain Brinkley, grandson of the great astronomer, and his sons:—

"Mr. Charles B., at 3 P.M., observed a bright meteor; Capt. B., at 4.35, another; at 5.20 the young men came in to announce an extraordinary display; and Capt. B. noted 34 in 1m. 30s.; Capt. B., looking north at 5.40, marked 95 in 5m.; Mr. John B., looking south at same time, marked 147 in 5m; the radiant point was a little S.E. of the zenith; Mr. J. B, at 9, marked 26 in 1m.; Capt. B., at 12, marked only 7 in 5m. Many were large, and left trains."

It was remarked that the night was unusually light, while clear. A very thick fog appeared before the dawn of Thursday.

Castleknock, Dublin, Nov. 29 T. R. R.

A FINE display of shooting stars was observed here on Wednesday, 27th inst. I first noticed them at 7.20 P.M., Greenwich time, and watched them till about 8, when the sky became obscured. They were occasionally seen again till 9.30. When first observed they appeared to radiate from the zenith, and to be more numerous towards the north-west and south-west; many passed over the constellation Cygnus. A. W. SCOTT

St. David's College, Lampeter, Nov. 30

DURING the recent star-shower, my attention was given especially to observations connected with the flight of individual meteors. As on many previous occasions in the presence of rare natural phenomena, I was keenly mortified with the deficiency of my own scientific training; but I send a few gleanings, if perchance a useful grain can be found amongst them. The brightness obviously increased with the distance traversed, but in many cases no increase of brightness was perceptible for the first third of the course. The extinction was not instantaneous but only very rapid, the distance traversed towards extinction being perceptible though very small; perhaps because the velocity seemed to diminish as the brightness increased. The train in many instances was forked, being brightest on its edges, the luminosity of which lasted for some time after the intermediate space was dark. This seems incompatible with the hypothesis that the train is a mere optical result, or that the brightness of the train arises, as in lightning, from incandescent particles of the atmosphere. In one or two instances the brightness of the train was granular, resembling the light of a partially resolved nebula, or of the Galaxy. In a few instances the paths of the meteors appeared to show remarkable deflections. One, notably, at 6h. 25m., close to Vega, resembled an "S" drawn out nearly straight.

The course of a body passing with great velocity though an elastic medium tends to follow the direction of least resistance. It is only in poetry that

"The lightning falls with never a jag."

And though, as compared with that of electricity, planetary velocity is small, say twenty miles per second, yet this error in a very attenuated atmosphere would produce an intolerable amount of resistance right ahead.

Looking for deflections arising from this cause I saw, or fancied I saw, some very remarkable ones, such as no rules of foreshortening or perspective would account for.

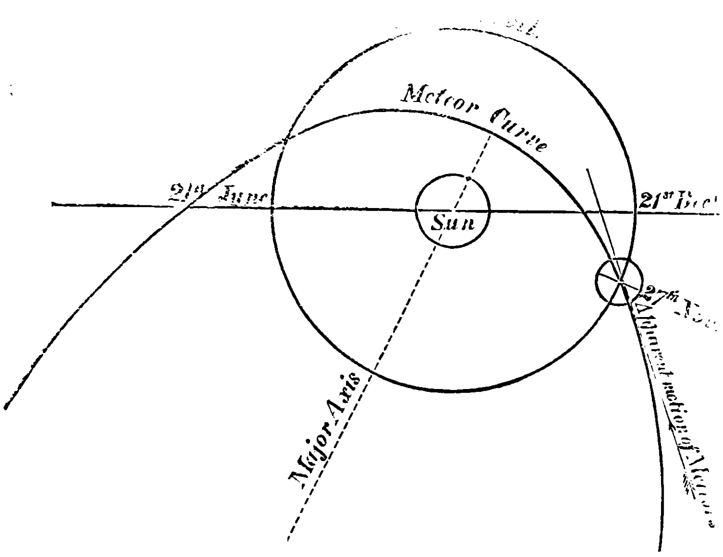
Rainhill, Dec. 2 HENRY H. HIGGINS

I HOPE last night, Nov. 27, was generally clear. It was so here, and we were treated to the most splendid meteoric shower that I have ever seen. I went out quite by chance into my garden at 7 P.M., and saw it in its full glory. I counted in a very few minutes 500 meteors, and then lost count, there being far too many to count all. On several occasions I saw as many as twelve in the sky at once: their radiating point seemed to be about ξ Cassiopeiæ, and from that point they floated in every direction—north, south, east and west. At that time, Cassiopeia being immediately above one's head, the effect was magnificent.

Malpas, Nov. 28 EDMUND V. PIGOTT

ON the 27th inst. a very fine display of meteors was observed here, which continued from about 5 P.M. to a late hour.

During 20 minutes of casual observation I counted 70 meteors —viz., from 7.45 to 8.5 P.M. One or two very fine ones were observed, one of which, having a northerly direction, left a luminous trail lasting for about 15 seconds. The radiating point



was situated about 10° to S. and E. of the zenith. The apparent velocities varied considerably, no doubt due to the angle at which each meteor was seen. The appearance of the tails also varied, some giving a quiet steady light, others wavy or sparkling; reddish sparks appear to have been observed. At 9.35 I counted 11 in 2 minutes.

I have constructed the annexed diagram from my rough observations. W. J. M.

Glasgow, Nov. 29

A VERY fine shower of shooting stars was observable at Boltsburn, Rookhope, in Durham, on Wednesday night (27th inst.). I first noticed them about half-past seven, when they were very numerous; their directions were chiefly downward, towards nearly all points of the horizon. The radiant point seemed to be situated near the Great Bear, but of this I could not make myself perfectly satisfied. They varied much in magnitude and length of track. Some of the larger ones left a streak of reddish light on their track, which lasted a second or two. About eight o'clock I counted, in fifteen minutes, 600, which came within my field of vision from a doorway having a southerly exposure. The regularity of occurrence was such as to approximate closely to 200 during each five minutes. How long the phenomenon continued in the latter part of the night I had not the opportunity of ascertaining. JOHN CURRY

Rookhope, Durham, Nov. 29

THE following are the observations which I was able to make on the great shower of meteors on Wednesday last:—

The first which I saw was at 5.25 P.M. Between 5.35 and 5.50, 150 were counted by one observer in the sky towards N.E. At 6.26, in four minutes, five observers counted 310. At 6.40, in two minutes, five observers counted 316. At 8.37, with a hazy cloud to N., six observers, in five minutes, counted 553. At 8.45, in fifteen minutes, one observer counted 528 while facing S.E.

A very few, among so many, left visible streaks of light after the meteor itself had disappeared, fifteen seconds being the longest time any of them remained visible. They appeared to radiate from a point a little to the south of μ Cassiopeia, many in the vicinity of that star having courses of less than a degree in angular measurement.

Towards 10 P.M. clouds covered the greater part of the sky, so that only unusually brilliant meteors could be seen; they were, however, again visible, but in decreased numbers, at 11.30.

Birkenhead, Nov. 29 G. H. H.

A VERY well sustained shower of meteors was observed here and at many other stations in the early part of Wednesday evening last, Nov. 27. Unfortunately, however, the weather was very unfavourable for observation at this city, and but very few of the meteors constituting the "shower" came under my notice. The first shooting star was noticed at 5h. 50m. It was a very brilliant one, and must have equalled Venus when at her *maximum*. This meteor passed down the northern sky near Dubhe, in Ursa Major, and left sparks in its flight. Very soon afterwards—at about 5h. 55m.—four other bright meteors, succeeding each other very rapidly, were visible. The most remarkable fact in connection with them was the great coincidence in their apparent courses among the stars. They all *appeared* to diverge from a point westward a few degrees from Polaris, and passing downwards became extinct in Ursa Major. At 6h. 5m. I commenced a careful watch of the sky in conjunction with a friend, and during the interval from that time until 6h. 30m. seventy-four additional meteors came under our observation. At 6h. 30m. the sky was much overcast, and though all the stars were invisible, yet for a short time subsequently I saw several flashes of light in some portion of the heavens, which must have been originated by the bursting of meteors of considerable magnitude. During the time that I was enabled to witness the appearance of meteors, the sky was very much obscured by clouds and mist which rendered nearly all the stars imperceptible. I could, however, faintly see Polaris, Vega, α and β Persei, δ and α Cassiopeiæ, and γ Andromedæ, and was enabled from the paths of the various meteors seen, to find the exact situation of the radiant point. This was situated at a place between Perseus and Andromeda, and about 5° north of the brilliant star Almaach (γ) in the latter constellation. This is at Right Ascension 1h. 56m. Declination 46° North. I saw several meteors in close proximity to this point. They had very short paths. I also noticed two meteors which were apparently quite stationary, and after brightening disappeared. The largest that were seen passed between Ursa Minor and Ursa Major, and several were also noticed in the neighbourhood of α Lyræ (Vega). No shooting stars were seen in the western sky, as it was overcast. I did not notice any trail of light after the disappearance of any of the brightest meteors, nor did I hear any noise as of an explosion, subsequently to the extinction of any one of them. I principally directed my attention to the accurate determination of the radiant point, and to the numbers of meteors visible.

It may be considered remarkable that such a comparatively small number of shooting stars should have come under observation at this city. The facts are, that, owing to the extremely cloudy state of the atmosphere, only an exceedingly small proportion of the meteors which actually existed were seen. During the whole time of observation—*i.e.*, from 5h. 50m. to 6h. 30m., a period of 40m.—it was very cloudy and misty, and but few of the brighter stars were visible, and these were hardly discernible. Under these circumstances, then, it is evident that only the brighter class of meteors could have been perceptible, while the smaller ones, which constituted the great majority of those seen at other stations, must have been utterly invisible. From these facts, I believe that no meteor less in apparent brightness than a second-magnitude star was seen here. Under more favourable atmospheric conditions, no doubt, the meteor shower would have been a grand spectacle from this place, and have equalled in intensity the display as described by other observers at different stations.

It does not seem improbable that the recent exhibition of November meteorites was originated by the earth passing through the node of the periodical comet of Biela. It has been discovered quite recently that an analogy exists between the orbits of comets and meteoric showers; but in reference to this interesting part of the subject I would, however, without occupying further space, direct attention to a paper by Prof. Alexander S. Herschel, which appears in the monthly notices, R. A. S., vol. xxxii. No. 9.

Several correspondents describe an aurora borealis visible on the 27th; and it may be appropriate to note here that a very brilliant display was witnessed at Bristol on the 24th, at about 3 A.M. It was very intense at that time. On the previous and subsequent nights lightning was very frequent, and meteors more numerous than usual. WILLIAM F. DENNING

Bristol, Nov. 30

THERE was a magnificent meteor-shower here on the evening of Wednesday last, the 27th. My attention was first called to it about half-past five o'clock, and I watched it at intervals until about seven, when the sky became overcast with clouds. It really was a shower, and no mistake, the sky at times quite sparkling with meteors. Their point of origin appeared to be in the neighbourhood of Cassiopeia, and their general direction towards the west and north, though several radiated to the east and south. Some, after becoming invisible, as if passing behind some intervening cause, suddenly emerged in all their brightness and then suddenly vanished. The streak left behind was in some instances a continuous, smooth line, in others the appearance was that of a row of sparks strung together. The finest meteor, and the one of longest duration, that I noticed became visible near Cygni, and continued its course to a point a little to the south of Vega. It resembled a small rocket. On the following evening the sky was too overcast to make observations. THOMAS FAWCETT

Blencowe School, Cumberland, Nov. 30

THE splendid meteor-shower of November 27 was well seen at St. Andrews. My attention was not called to it until after the meteors had begun to decline in frequency; but they were still at about 8h. 30m. G.M.T., so numerous as to give considerable confidence in assigning their radiant point, about which they were seen shooting out in all directions. I saw at least two, whose paths were foreshortened almost to a luminous point. These appeared very close to the radiant near two stars in the right foot of Andromeda, which in the maps of the Society for the Diffusion of Useful Knowledge are numbered 51 and 54, or in about R.A. 25°, N. Decl. 48°. The sky became overcast; but about 11h. 30m., meteors were still falling in directions which confirmed my previous estimate of the position of their radiant. The sky was again clear at 1h. 30m. A.M., but I saw no more meteors.

I have since seen, in a table by Schiaparelli, from observations by Zerzioli, 1867-69, and under the date November 30. a radiant point in R.A. 17°, Decl. 48°, which agrees closely with that which I have ventured to assign to the remarkable shower of November 27. W SWAN

St. Andrews, Nov. 30

Metamorphosis of Insects

THE description of the development of the Lepidopterous wings, and the illustrations which were included in my lecture on Insect Metamorphosis, were taken from Landois' admirable essay in Siebold and A. Kolliker's *Zeitschrift* (1871).

Nov. 25 P. MARTIN DUNCAN

PRIZES OF THE FRENCH ACADEMY OF SCIENCES

AT its annual public meeting on Nov. 25 last the French Academy of Sciences awarded its prizes for the years 1870 and 1871. M. Faye gave a brief introductory address, in which he touchingly alluded to the misfortunes to science arising from the late war, to the various preparations for the forthcoming transit of Venus, the metric commission, and other matters of scientific interest. It is on account of the war that at this annual meeting the Academy had to award prizes for two years, namely, for 1870 and 1871. The list of prizes was as follows:—

Competition of 1870. 1. The Grand Prize in the mathematical sciences this year was offered for a paper on the modification which light undergoes in its mode of transmission and in its properties, in consequence of the movement of the luminous source and the movement of the observer. This prize was not awarded, but a bonus of 2,500 francs was given to M. E. Mascart.

2. The Poncelet Prize was awarded to M. C. Jordan for his treatise on Algebraic Substitutions and Equations.

3. The Dalmont Prize was gained by M. Maurice Levy for his four memoirs on (1) Running Water, (2) The Pressure of Earths, (3) The Interior Movements of ductile Solids, (4) Curvilinear Co-ordinates.

4. The Lalande Prize in Astronomy to Mr. Huggins, for his Discoveries on the Physical Constitution of Stars, Nebulæ, Planets, and Comets. The Commissioners for this prize speak in the highest terms of Mr. Huggins' discoveries, declaring that they mark a brilliant epoch in this new branch of science.

5. The Montyon Prize in statistics, to M. A. Potiquet for his work entitled, "L'Institut de France, &c.;" and honourable mention was made of M. A. Thévenot for the agricultural part of his work entitled "General Statistics of the Canton of Ramerupt," and to M. A. Castan for his memoir on the Influence of Temperature upon Mortality in the City of Montpellier.

6. The Jecker Prize.—MM. Clermont, Gal, and Grimaux, each obtained, by way of bonus, the sum of 1,700 francs for their works on Organic Chemistry.

7. The Barbier Prize was awarded to M. Personne for his Researches upon Chloral.

8. The Desmazières Prize to M. de Notaris for his work entitled "Epilogo della Briologia Italiana"; while honourable mention was made of M. C. Roumeguère for his work entitled "Cryptogamy Illustrated; or, History of the Natural Families of the Acotyledonous Plants of Europe."

9. The Thoré Prize to M. J. C. Schiödte, for his work upon the Metamorphoses of the Coleoptera.

10. The Bordin Prize, for the Comparative Anatomy of Annelids, to M. Léon Vaillant for his works on that subject.

11. The Savigny Prize was divided between M. Issel for his work entitled "The Malacology of the Red Sea" (Italian), and Mr. MacAndrew for his researches into the Malacologic Fauna of the Red Sea.

12. The Bréant Prize. The reward of 5,000 francs, the whole of the annual interest of the legacy, was divided between M. Grimaud (of Caux), for his Researches concerning the Transmissibility of Cholera, and M. Thalorzan, for his work entitled "New Origin of Asiatic Cholera." Honourable mention was made of M. Bourgogne, jun., for his work entitled "Cholera Epidemic in the Communes of Condé, Vieux-Condé, Fresnes, and Escaupont, during the year 1866."

13. The Chaussier Prize, to M. Tardieu, for his works on Legal Medicine.

14. The Montyon Prize in Medicine and Surgery. Two prizes of 2,500 francs were awarded—(1) To MM. Lancereaux and Lackerbauer for their treatise on Pathological Anatomy; (2) To Dr. Chassagny, for his work entitled "Method of Continued Tractions. The forceps considered as an agent of prehension and traction." Bonuses of 1,200 francs were given—(1) To MM. Colze and Feltz, for their researches into Infectious Maladies, &c.; (2) To M. Jousset, for his experiments upon the Poison of the Scorpion; (3) To M. Decaisne for his memoirs upon the Temperature of Sick Children, and on the influence of Alimentation upon the composition of Female Milk; (4) To M. Despies, for his work on Ulceration and the Ulcers of the Neck of the Uterus. The works of M. V Fumouze upon the Spectra of Absorption of the Blood of M. Bergeret, on the Changes of the Urine, and of Bile in various Diseases, were honourably mentioned.

15. The Godard Prize was awarded to M. C. Mauriac for his work entitled "Essay on the Reflex Symptomatic Neuralgias of Blenorrhagic Parastatitis."

16. The Montyon Prize, in Experimental Physiology, to M. J. Raulin, for his Chemical Studies on Vegetation.

17. The Montyon Prize, for a paper on Unhealthy Occupations, was awarded to M. Guibal for his System of Ventilation applied to the Airing of Mines.

18. The Gegner Prize to M. Duclaux.

19. The Tremont Prize to M. Leroux, who will hold it for three years.

20. The Laplace Prize was obtained by M. H. B. N. Bea-

iron, who held the first place in the Polytechnic School in 1871, and who has entered the School of Mines.

1871.

1. The Poncelet Prize, in Mechanics, to M. J. Boussinesq.

2. The Lalande Prize in Astronomy to M. Borelly for the Discovery of the Planet Lomia.

3. The Montyon Prize in Statistics to M. E. Cadet, for his work on "Marriage in France." Honourable mention was given to Dr. Ely for his work on "The Army and the Population."

4. The Jecker Prize in Chemistry to M. Schutzemberger for his works on Organic Chemistry.

5. The Barbier Prize in Botany to M. Duquesnel, for his memoir on "Crystallised Aconitine."

6. The Bordin Prize for a paper on "The part played by Stomata in the Functions of Leaves," was not awarded, and is withdrawn from competition; but a bonus was given to M. A. Barthelemy.

7. The Desmazières Prize was not awarded either, but a bonus of 500 francs was given to M. Husnot for various works on the Cryptogamic Flora of Martinique.

8. The Bréant Prize.—A sum of 5,000 francs, the whole annual interest of the legacy, was awarded to M. Chauveau for his experiments upon Virulent Virus and Maladies.

9. The Montyon Prizes in Medicine and Surgery.—Two prizes of 2,500 francs were awarded—(1) To M. Grehant for his Physiological and Medical Researches on the Respiration of Man; (2) To M. Blondlot, for a series of memoirs concerning the disputed questions of Medicine, Chemistry, and Physiology. Three sums of 1,500 francs each were awarded—(1) To M. Bérenger-Féraud for his work entitled "Treatise on the Direct Union of Osseous Fragments in Fractures;" (2) to M. Duclout for his work entitled "Account of three cases of Vesico-vaginal fistula," &c; (3) To M. Leon Colin for his Treatise on Intermittent Fevers. Honourable mention was made of (1) M. Raimbert, (2) M. Bucquory, (3) M. Hajem, (4) MM. Krishaber and Peter.

10. The Godard Prize to Mr. J. Jolly for his work on Cancer of the Prostate; honourable mention being made of M. Puech.

11. The Montyon Prize in Experimental Physiology was divided between M. Chantran for his Observations on the Natural History of Crabs, and M. A. Gris for his Memoir on the Pith of Ligneous Plants. Honourable mention was given to M. Mehay for his Essay on Beet-Root Sugar, and a bonus to MM. Chéron and Gonjon for their Researches on the Functional Properties of the Nerves and Muscles during the intra-uterine life.

12. The Montyon Prize for Works, &c., bearing on unhealthy occupations. Of this, 2,500 francs were awarded to M. Goldenberg for the methods adopted by him for securing the healthiness of his Manufactories. A bonus of 2,000 francs was given to Mdlle. C. Garcin and to M. Adam for their Automatic Sewing Machine; and a similar sum to M. Louvel for his process of preserving grains *in vacuo*.

13. The Tremont Prize was awarded in 1869 to M. Le Roux, who holds it for three years.

14. The Laplace Prize was awarded to M. L. A. E. Sauvage, dux in 1870 of the Polytechnic School, and who has entered the School of Mines.

MRS. SOMERVILLE

MARY SOMERVILLE (born Fairfax), long ago known for her scientific researches and long well known for her popular and educational scientific works, died in the neighbourhood of Naples, where she has lived for some years, on Friday, November 29, aged nearly 92 years, having been born on December 26, 1780. She belonged to a good Scotch family, her father having been the late Vice-Admiral Sir William George Fairfax, was a great reader, learned Euclid surreptitiously while quite a girl, and at the same period got up a knowledge of Latin in order to be able to read Newton's *Principia*, and was educated at a school in Musselburgh, near Edinburgh.

Her first important contribution to science was made in 1826, when she presented to the Royal Society a paper on the magnetising powers of the more refrangible solar rays, the object of which was to prove that these rays of the solar spectrum have a strong magnetic influence. This paper led to much discussion, which was not set at rest till the researches of Riess and Moser showed that the action upon the magnetic needle was not caused by the violet rays.

Mrs. Somerville's first work of any extent was her "Mechanism of the Heavens" (1831), written at first at the request of Lord Brougham, as one of the series of publications by the Society for the Diffusion of Useful Knowledge. As, however, the work was on too large a scale, and, according to Sir John Herschel, to whom the MS. was submitted, as it was written for posterity, and not for the class whom the society designed to instruct, it was published as an independent work, eliciting from all quarters the highest encomiums, especially as being the work of a woman. It was founded to some extent on La Place's treatise, though the authoress exercised her own judgment in the acceptance or rejection of his theories.

Her next work "On the Connection of the Physical Sciences," was published in 1834, and was referred to by Humboldt as "the generally so exact and admirable treatise."

In 1848 appeared the work by which, perhaps, she is most generally known, her "Physical Geography," which, along with some of her other works, has passed through many editions, been reprinted frequently in America, and translated into several foreign languages. Notwithstanding the numerous works on the same subject that have since appeared, Mrs. Somerville's book still holds place as a first authority, even with the initiated.

In 1869 appeared her last work, "On Molecular and Microscopic Science," which, to quote a writer in the *Edinburgh Review*, "contains a complete conspectus of some of the most recent and most abstruse researches of modern science, and describes admirably not only the discoveries of our day in the field of physics and chemistry, but more especially the revelations of the microscope in the vegetable and animal worlds." The fact that Mrs. Somerville was close on her 90th year when she published this work, in which is contained a *résumé* of the most interesting results of recent scientific investigations, may give one some idea of the undying vigour and clearness of her mind, as well as of her intense love of science.

So long ago as 1835 Government recognised Mrs. Somerville's great merits, by bestowing upon her a literary pension of 300*l.*; and in the same year she was made an honorary member of the Royal Astronomical Society, the only other lady on whom this honour was conferred having been Miss Caroline Herschel. The Geographical Society awarded Mrs. Somerville the Patron or Victoria Medal in 1869, and about thirty years earlier the Fellows of the Royal Society subscribed for her bust, which was executed by Chantrey, and now adorns the Society's library. She certainly deserved all the honours she obtained, for during her long life she has done very much to raise the standard of scientific text-books, and to spread among general readers the accurate results of scientific research.

Dr. William Somerville was his wife's second husband, her first husband having been Captain Greig, a naval officer, fond of mathematics, and who took pleasure in giving his wife instruction in his favourite subject, thus probably giving her mind a bent towards science which has led to important results.

NOTES

ONE of the most cheering Ministerial outcomes that we have read for a long time is to be found in Mr. Gladstone's speech, on Tuesday, at the Society of Biblical Archæology, an outcome which indicates, we take it, on the part of the Government, that the lamentable condition of research in England has at length forced itself upon them, and that the policy which has done such an infinity of harm, and the fruits of which we are reaping, is at length to be reversed. In the speech to which we refer Mr. Gladstone said :—" I do not at all deny that many fields of inquiry have been so much widened and deepened of late years, that it is both becoming and proper for the Government from time to time, according to circumstances and occasions, to take part in, and give encouragement and assistance to, those things, many of which indeed cannot be prosecuted without that assistance." The paper read at the meeting to which we refer was one by Mr. G. Smith on a Chaldean account of the Deluge which he has recently deciphered. This communication was of such high importance that we hope to be able to refer to it at length next week.

THE next meeting of the British Association for the Advancement of Science will be held at Bradford, not on September 19, 1873, as was fixed at the Brighton meeting, but for the convenience of many who have objected to the date, a fortnight earlier than that time. The Vice-Presidents appointed are Earl Rosse, Lord Houghton, Mr. W. E. Forster, M.P., and the Mayor of Bradford (Mr. Thompson). At Bradford an executive committee of sixteen persons, and also a larger general committee have, as usual, been appointed to prepare for the next meeting of the Association, and a public subscription, which is not to be less than 4,000*l.*, has been opened, for the purpose of defraying the estimated expenses in connection with the visit of the Association to the town. Of this sum 1,500*l.* will be required for the erection of a temporary building as a reception room. At a meeting held the other night 1,000*l.* were contributed on the spot, including 250*l.* by the Mayor.

AT the recent second M.B. examination at the University of London, the Scholarship and Gold Medal in Medicine were awarded to Mr. B. N. Dalton, of Guy's Hospital, the Gold Medal in Medicine to Mr. W. Ottley, of University College, the Scholarship and Gold Medal in Obstetric Medicine to Mr. Robert Eardley Wilmot, of King's College, the Gold Medal in Obstetric Medicine to Mr. W. C. Greenfield, of University College, the Gold Medals in Forensic Medicine to Messrs. M. Harris, of Guy's Hospital, and W. Ottley, of University College.

THE Brakenbury Natural Science Scholarship at Balliol College, Oxford (80*l.* per annum for four years), has been awarded to Mr. R. B. Don, of Clifton College. No fewer than four other scholarships in Natural Science have already been gained during the present year by boys from Clifton College, viz., two at St. Peter's College, Cambridge, one at Christ College, Oxford, and one at Magdalen College, Oxford.

VICE-CHANCELLOR BACON has decided that the conditions of the legacy under which sums of money were left by the late Mr. James Yates to endow the Professorship of Mineralogy and Geology at University College, and to found a Professorship of Archæology at the same college, have not been fulfilled, and that the legacies have therefore reverted to the heir-at-law of Mr Yates.

IN accordance with the anticipation we have already expressed, Dr. Macalister has been chosen to fill the newly-founded chair of Comparative Anatomy at Trinity College, Dublin. Dr. Macalister continues to hold the Professorship of Zoology in the University of Dublin.

MR. J. A. WANKLYN has, according to the *Chemical News*, become a candidate for the Chemical Prælectorship at Cambridge.

MR. E. G. PITT has been appointed Medical Officer of the south district of St. George's-in-the-East.

MR. BASS has presented Derby with 5,000*l.* towards the erection of a free library.

A MADAME DE PERINOT has left to the French Academy of Sciences a legacy of 20,000 francs for the foundation of a prize, to be awarded every two years, for the purpose of assisting astronomers and encouraging astronomical researches.

THE two Actonian prizes of 105*l.* have been awarded by the Managers of the Royal Institution to the Rev. George Henslow and to Mr. B. Thompson Lowne, for " Essays on the Theory of the Evolution of Living Things."

THE Baroness Burdett Coutts' prize for the best essay on the Isochronism of the Balance-spring was divided by the adjudicators equally between Mr. Palmer, of Leominster, and Mr. Moritz Immisch, of Regent Street, neither taking precedence of the other.

IT is satisfactory to learn that 116 citizens of New York have lately tendered to Mr. B. Waterhouse Hawkins an expression of their sympathy with him in his grief at the loss of his models of the gigantic fossil reptiles of North America, which were broken to pieces and carted off as rubbish by order of certain unenlightened officials of the public parks, as mentioned in NATURE some time ago. Mr. Hawkins has presented some casts of the pelvic and other bones of *Hadrosaurus* (one of the most interesting of these restorations) to the Museum of the Royal College of Surgeons.

THE new Medical Microscopical Society will meet at 8 P.M. on December 6, in the college dining hall, St. Bartholomew's Hospital, to sanction rules, elect officers, and receive names of intending members, &c.

MESSRS. L. REEVE and Co. announce a new and important part of Bentham and Hooker's "Genera Plantarum" at the commencement of the new year. It will include Dipsacaceæ, Valerianaceæ, Compositæ, and Rubiaceæ.

WE have received from Mr. Quaritch, of Piccadilly, a list of very valuable books he has for sale from the libraries of the late Dr. Robert Wright, F.R.S. late of Madras, of the late Prof. Babbage, of the late Mr. G. R. Gray, F.R.S. of the British Museum, and the library of an architect.

THE official Report of the Proceedings of the Meteorological Conference at Leipzig in August last will appear in the Journal of the Austrian Meteorological Society, and is now in the press. A translation is being prepared by Mr. Robert H. Scott, and will be issued under the authority of the Meteorological Committee as soon as possible after the appearance of the German original.

WE have received the first number of the *Telegraphic Journal*, whose expected appearance we announced some time ago, and to judge from the prospectus to the first issue, it promises to perform good services to the scientific and industrial department with which it is connected. From one paper we learn that the total number of marine cables laid is 213, measuring 43,783½ miles.

WE have received from the United States Government copies of their official tri-daily weather-map and bulletin, containing the result of meteorological observations taken simultaneously at about eighty stations.

WE learn from the *Photographic News* that Dr. Vogel, the President of the Berlin Society for the Advancement of Photography, and instructor in the art at the Royal Industrial College, has been made a Professor. Thus we have the first instance of the appointment of a Professor of Photography, and we heartily join the German photographers in their congratulations on the chair being so worthily filled. Dr. Vogel is about to publish a photographic dictionary.

WE learn that Part xi. of "Reliquiæ Aquitanicæ" is in the press. This serial work, descriptive of the Caves of Perigord and their contents, has been interrupted of late by the death of M. E. Lartet and the disturbances in France. The executors and friends of the late Henry Christy are proceeding with the work as expeditiously as possible, but do not expect to produce quite as many parts as originally contemplated.

THE *School Board Chronicle* tells us that an international college such as appears to have been the ideal of Mr. Stuart Mill has existed for some time in the Canton of Zurich. This is the Institution Breidenstein, in which there are at present as many as eighty-eight pupils, representing fourteen different nations from the two hemispheres. These scholars speak nine different languages between them.

WE have received the last three numbers of the *Horological Journal*, and, judging from its contents, it seems well calculated to accomplish one of its chief purposes, to spread a knowledge of the scientific principles upon which the art of watch and clock making is founded. It well deserves the support of all those for whose benefit it is intended.

CONSIDERABLE changes, says the *Quarterly Meteorological Journal*, are in progress in the meteorological organisations of various countries. In France, M. Jules Simon has reversed the action of the Imperial Government, and placed the entire meteorological system under the Observatory of Paris. The Observatory of Montsouris, which C. Ste.-Claire Deville had established with much care, has been placed under the Observatory, and most of the meteorological work of the latter establishment has been transferred to it. The *Bulletin International* is now dated from Montsouris, but the series of observations at the Paris Observatory has not been suspended. M. C. Ste.-Claire Deville has been appointed Inspector-General of all the French Meteorological Stations, except those in connection with the telegraphic system. In Denmark, Captain N. Hoffmeyer has been placed at the head of the newly organised Institute. In Sweden, the intention of the Government to establish a central Institute in Stockholm in the year 1873 is announced, and the Observatory at Upsala is to be the central station. In Berlin arrangements are reported to be in progress for the founding of a more complete meteorological organisation than that now existing, which is of old date, and is in connection with the Statistical Bureau.

Harper's Weekly announces the death, at Reading, Pennsylvania, at the age of fifty-six, of Mr. William M. Baird, a gentleman who was much interested in natural history, and especially in ornithology. Mr. Baird, while residing at Carlisle, Pennsylvania, commenced in 1838 a collection of the birds of the county, in which he was assisted by his younger brother, Prof. S. F. Baird, of the Smithsonian Institution; and the two carried on their labours in common for many years, during which time they published conjointly descriptions of two new species of small fly-catchers discovered by them in the vicinity of Carlisle, as also a list of the birds of Cumberland County. Having adopted the profession of the law, Mr. William Baird was obliged to give up his active labours in ornithology, and the work was continued by his brother, who, on receiving an appointment in connection with the Smithsonian Institution at Washington, carried to it the conjoint collection, which formed, in a measure, the basis of the magnificent series of North American birds in the institution, and which has served as the material for so much research on the part of naturalists in America and other countries.

ON November 26, the first Annual General Meeting of the National Union for improving the Education of Women of all classes was held at the rooms of the Society of Arts, Lord Lyttelton in the chair. The two principal resolutions were that "the meeting, feeling the inadequacy of the supply of good schools for girls, pledges itself to promote the establishment of such schools, and also to aid all measures for extending to women the means of higher education beyond the school period of life; and that the meeting, feeling the necessity of thorough training for teachers, and of some recognised test of their efficiency, pledges itself to promote measures for the attainment of those objects." The grand principle upon which the Union is founded, is "that the human faculties and intellect have been impartially given, and belong in equal degree to both men and women."

WE notice that a new method of lighting gas has been invented by Mr. J. Billington Booth, of Preston, the working of which was shown by him the other night in that town. By this method the whole of the street lamps can be lighted simultaneously from any distance. The apparatus constituting the invention, the *Preston Chronicle* tells us, looks like a moderately-sized globular inkstand of glass, surmounted by a tube of the same material, with a metallic top; by screwing off the burner it can be very easily attached to any lamp, chandelier pipe, or ordinary gas-jet. The base or globular portion is filled with a deep red-coloured liquid, so cheap that three pennyworth will serve the lamp for a year. Over the liquid and within the glass tube there is a plate of zinc, with a piece of graphite or gas coal, and between these and a thin coiled platinum wire, fixed over the cup of the general vessel, into which a gas-burner is inserted, galvanic communication is obtained. Ignition is thus effected: A pipe is screwed to the top of the gaspipe; pressure on the gas in this pipe causes a simultaneous depression upon the chemical solution which occupies a lower level in two side tubes; the gas occupies the vacuum caused by the displaced liquid, and then ascends to a chamber connected with the burner, while the displaced liquid is pressed into two side-tubes effecting contact with the zinc and graphite, and generating galvanic activity. This is communicated to the platinum wire, and excites its catalytic power; the wire being then exposed to the ascending jet of gas, immediate ignition takes place.

AN invention by Mr. J. A. H. Ellis, of Boston, U.S., is described in the *Industrial Monthly*, by means of which, it is said, enormous amount of heat wasted in exhaust steam is profitabl utilised. The method consists in passing the exhaust steam from an ordinary steam-engine through the tube of a boiler filled with the bisulphide of carbon (which boils at 110° Fah.), in the same way that smoke and the products of combustion are passed through a steam-boiler filled with water. The result is, according to our authority, that the bisulphide boiler will be rapidly heated up to 212° Fah., the resulting vapour being able to keep an engine going, and do a large amount of work, if the supply of exhaust steam is sufficient. By this means one large steam-engine might keep not only itself going, but supply the necessary power to a number of neighbouring small ones, the latter being thus able to dispense with fire and all attendance. The *Industrial* says the method is actually at work at Fitchburg, Massachussetts.

FROM the *British Medical Journal* we learn that at the last examination in anatomy held at the University of Berlin, two candidates alone, amongst the thirteen who presented themselves, obtained the notice "good." One of these was a Japanese medical student called Sasumi Satoo. The intellectual labour and the amount of perseverance necessary to gain this success will be appreciated when it is known that in November 1869, the time when Sasumi Satoo was sent by his father to Berlin, he did not even know the German characters. The first five months he applied himself exclusively to the study of German, and he acquired in the remaining six months the knowledge of all the subjects, including Latin, which were required for the first examination. The father of Sasumi is the principal physician to the Mikado, and enjoys in Japan great celebrity as an operator.

THE BIRTH OF CHEMISTRY

V

The Alchemists.—Origin of Alchemy.—Hermes Trismegistus.—Greek MSS. on Alchemy.—Their probable authorship and age.

WE speak here of the alchemists almost for the first time, and we must now turn our attention to the origin and growth of their dogmas, and to their work. We have already seen that the word χημεία is first found in the Lexicon of Suidas, and that he defines it as "the preparation of gold and silver." He further tells us, under the same heading, that the books on the subject were sought for by Dioclesian and burnt, lest the Egyptians should become rich through their knowledge of the art, and should thus be able to resist the Romans. Now, the people who professed a knowledge of the art of making gold were called *alchemists*. The word *alchemy*, as we have previously shown, consists of a Coptic root united with an Arabic prefix, and signifies the *hidden* or *obscure art*. Alchemists were those who practised this mysterious art. We can well understand why the professors of such an art should maintain the utmost secrecy; to divulge such magic would be to make all men equally rich; hence it was necessarily a hidden art. Neither did the books on the subject avail much, for they are filled with some of the most incomprehensible nonsense that ever was written. Yet the literature of the subject is enormous. The volumes on alchemy in our large libraries are to be counted by the hundred. In 1602 Zetzner published, in Strasburg, a "Theatrum Chemicum," containing more than a hundred tracts on alchemy, selected from various notable authors. A century later Mangetus published his "Bibliotheca Chemica Curiosa," in two large folios, containing a hundred and twenty-two alchemical treatises. We have previously given the titles of a few Greek MSS. on alchemy. The list has been extended to eighty-three. Arabic and Persian MSS. on the subject are not uncommon. There are treatises in Spanish, Italian, German, Dutch, and English on alchemy, and, more numerous than all, treatises in Latin, in every large library. Let us endeavour to get from the tangled mazes of this hieroglyphical literature some idea of alchemy, and of its influence upon chemistry.

We are, perhaps, puzzled at the outset to comprehend how any one man, much less thousands of men, could have deluded themselves with the belief in the possibility of transmuting one kind of matter into another:—crude lead, or tin, or mercury, into weighty, lustrous gold. But this was not the greatest wonder of the age. At the time when alchemy arose, and throughout the period during which it most flourished, the belief in theurgy, witchcraft, necromancy, and magic of all kinds was rife among all classes; and surely it was less wonderful to change lead or tin into gold, than to call up the spirit of one's ancestor, or to confer perpetual youth upon a nonagenarian! It is, for wonderment, as compared with the greater magic of the day, as the process for the conversion of benzine into aniline compared with spirit-rapping; or as a demonstration of specific inductive capacity compared with a manifestation of psychic force. Alchemy was considered to be perfectly rational not two centuries ago, and was among the lesser forms of magic, inasmuch as it did not require the influence of supernatural causes.

The growth of the idea is not difficult to trace. The ancients had persistently asserted the change of one element into another. Thales, as we have seen, evolved the ten thousand forms of nature and kinds of matter, from water, Anaximenes from air, by successive transmutation. Aristotle, whose physical views were accepted without question by the alchemists, had endeavoured to show by clever argument that, if you transfer a quality of water to fire, you obtain air; while if you transfer a quality of earth to air, you get water; and so for fire and earth, and that from these elements all things proceed. This was readily accepted by Middle Age thinkers. The alchemists reasoned, plausibly enough:—if fire becomes air, air water, and water earth, why may not one kind of substance formed from these elements be changed into another kind of substance of somewhat the same nature, and certainly more similar than air and water, or water and earth? Why may not lead, compounded of these elements in certain proportions, be changed into gold, compounded of these elements in certain other proportions? There have been falser modes of reasoning than this in the history of science.

Let the ancient Greek theory of the transmutation of the elements be once literally accepted, and the alchemical belief in transmutation follows naturally; it is a minor application of the major proposition. There is nothing to wonder at in this; the human mind seldom moves by fits and starts; an essentially new mode of thought and new form of belief is rare, and many apparently new dogmas are united with older dogmas in the closest manner, and are in fact direct emanations from them. Such was the alchemical idea of transmutation. Admitting the possibility of the process, a man would naturally ask himself "What do I most desire to make?" What in this world procures the greatest amount of happiness, and of power?" For what have men slaughtered each other by the thousand in open war, or singly and secretly in the dead of night? For what have kingdoms been sold, great tracts of land ceded, and people been ground into serfdom till they rose and rioted against their oppressors? For what have princes and cardinals been created, emperors and kings destroyed, and the eternal peace of troubled souls promised? In a word, for what will man dare all things, sacrifice all things; for what will he toil during a lifetime; to what will he devote all his intellectual energies? This is surely the thing for the ready acquirement of which we may devote much time and thought, and this thing is *gold*. This is the key to the prodigious masses of alchemical literature, and to the mysteries and anomalies connected with men who often wasted their whole lives and all they possessed in the endeavour to change baser metals into gold.

If we consult alchemical MSS., no matter the date or author, or language, we find constant mention of Hermes Trismegistus, who was indeed considered, and sometimes designated, the *father of alchemy*. In a treatise attributed to Albertus Magnus we are told that the tomb of Hermes was discovered by Alexander the Great, in a cave near Hebron. In this was found a slab of emerald which had been taken from the hands of the dead Hermes by Sarah, the wife of Abraham, and which had inscribed upon it in Phœnician characters the precepts of the great master concerning the art of making gold. The inscription consisted of thirteen sentences, and is to be found in numerous alchemical works. It is for the most part quite unintelligible, and in style closely resembles the great mass of Middle Age alchemical literature.

The following is cited as the inscription of the "Smaragdine Table," and is to be found in very early MSS. in various languages:—

1. I speak not fictitious things, but that which is certain and most true.
2. What is below is like that which is above, and what is above is like that which is below, to accomplish the miracles of one thing.
3. And as all things were produced by the one word of one Being, so all things were produced from this one thing by adaptation.
4. Its father is the sun, its mother the moon; the wind carries it in its belly, its nurse is the earth.
5. It is the father of all perfection throughout the world.
6. The power is vigorous if it be changed into earth.
7. Separate the earth from the fire, the subtle from the gross, acting prudently and with judgment.
8. Ascend with the greatest sagacity from the earth to heaven, and then again descend to the earth, and unite together the powers of things superior and things inferior. Thus you will obtain the glory of the whole world, and obscurity will fly far away from you.
9. This has more fortitude than fortitude itself: because it conquers every subtle thing and can penetrate every solid.
10. Thus was the world formed.
11. Hence proceed wonders, which are here established.
12. Therefore I am called Hermes Trismegistus, having three parts of the philosophy of the whole world.
13. That which I had to say concerning the operation of the sun is completed.

The story and the inscription, together with all books attributed to Hermes, are no doubt the production of monks of the Middle Ages, albeit they are attributed to Hermes, who is asserted to have lived about 2000 B.C. In spite of the obvious worthlessness of the inscription of the emerald table, men have not been wanting who have laboured long and lovingly to prove its authenticity, to interpret it, and to show that it is in good sooth a marvellous revelation, full of sublime secrets of considerable import to mankind.

Hermes Trismegistus is generally asserted by the alchemists to have been a priest who lived a little after the time of Moses. According to Clemens Alexandrinus he was the author of fortytwo books containing all the learning of the Egyptians; others tell us that he was the author of several thousand volumes. Plato speaks of him in the "Phædrus" as the inventor of numbers and letters. He was in fact the Egyptian god of letters, and as such of course could be described as the author of multitudinous works. He was the deified intellect, and hence has often been confounded with Thoth, "the intellect." Sir Gardner Wilkinson speaks of Hermes as an emanation of Thoth, and as representing "the abstract quality of the understanding." The woodcut (Fig. 6) representing Hermes, is from a temple at Pselcis, which was erected by Erganum, a contemporary of Ptolemy Philadelphus. It may be well to note the extent of the symbolism associated with the sculpture; in one hand Hermes holds the *Crux ansata*, the symbol of life, in the other a staff, associated with which are a serpent, a scorpion, a hawk's head, and, above all, a circle surrounded by an asp, each with its special symbolical significance. On the Rosetta stone Hermes is called "the great and great," or twice great; he was called *Trismegistus*, or thrice great, according to the twelfth aphorism of the emerald table, because he possessed three parts of the wisdom of the whole world, which in his light of deified intellect he might well do.

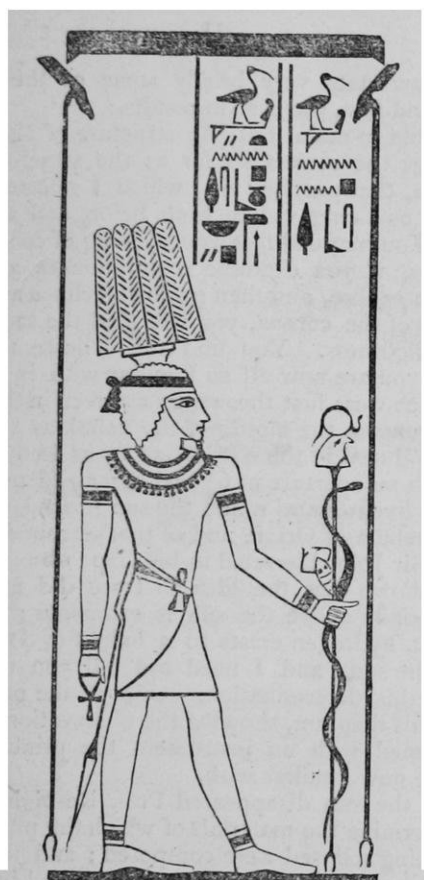


FIG 6.—Hermes Trismegistus; from the Temple at Pselcis.

Perhaps no author is more often quoted by the Alchemists than Hermes, the supposed father of their art. They called themselves *hermetic philosophers*. Alchemy is often called the *Hermetic Art*, or simply *hermetics*. To enclose a substance very securely, as by placing it in a glass tube and fusing, or sealing, the mouth of the tube, was called securing with "Hermes his seal," and the echo of the idea lives amongst us yet; for, in our most modern treatises, the expression "to seal hermetically" may be found.

Petrus Hauboldus, of Copenhagen, was surely one of the most enterprising publishers of his day, for he had the temerity to publish a book entitled, *Hermetis Ægyptiorum et Chemicorum Sapientia*. A book square as to its dimensions, small as to its type, drier than dust as to its contents, of four hundred odd pages, of two centuries of age, writ in Latin, with a sprinkling of contracted Greek, and floridly dedicated to Jean Baptiste Colbert. A book wherein the author endeavours to prove that alchemy was known before the flood, that Hermes Trismegistus was a real personage, the inventor of all arts, the father of alchemy, and much else besides. We may well imagine that the author of such a treatise was no ordinary man, and our conjecture proves a tolerably correct one. Olaf Borch, whose Latinised name because the more resounding *Olaus Borrichius*, was apparently the great mainstay of the University of Copenhagen; at all events, he was simultaneously Professor of Philology, Poetry, Chemistry, and Botany, and we must either imagine that in 1660, professors were difficult to procure in the Kingdom of Denmark, or else that Olaus Borrichius was such an astounding genius that he could readily undertake the duties of four diverse professorships at the same time. We can scarcely imagine three greater antitheses than the philological faculty, the poetical faculty, and the chemical faculty; but here we find them united, or assumed to be united, in one man. Yet more, Borrichius was appointed Court Physician, and Assessor of the Supreme Court of Law. He was the very personification of all learning, if we may judge by the treatment he received from his countrymen. In addition to the work mentioned above, he wrote several on philology, on the quantity of syllables, on the Greek and Latin poets, on medicine, chemistry, and botany. It is strange that a man who, presumably in his capacity of judge, was in the habit of sifting evidence, and of avoiding hasty generalisation, should have endeavoured with much elaborate argument to prove that Hermes Trismegistus was a real personage; that his Smaragdine table was really found by the wife of Abraham, and that it contained matter of the highest import to mankind. We must imagine that in this matter Borrichius allowed the imaginative faculty due to his poetical temperament to exert an undue influence over his more sober judgment. He is equally at pains to assert the authenticity and antiquity of the various Greek MSS. on alchemy in the libraries of Europe. He specially mentions a MS. by Zozimus of Panapolis, on the art of making gold, in the King's Library in Paris; and Scaliger tells us that this same MS. was written in the fifth century. M. Ferdinand Hoefer is apparently penetrated by the Borrichian spirit of faith and imagination, and he unhesitatingly accepts the early date attributed to the Paris MS.

M. Hoefer traces the rise of Alchemy to the fourth century of our era; it was then known as the "sacred art" (*ars sacra*; τέχνη ἱέρα), and one of the chief writers on the subject was the said Zozimus of Panapolis. The principal Greek MSS. attributed to Zozimus, which exist in the Bibliothèque Nationale, have the following titles:—(α) On Furnaces and Chemical Instruments; (β) On the Virtue and Composition of Waters; (γ) On the Holy Water; (δ) On the Sacred Art of making Gold and Silver. In the latter, Zozimus mentions that if the "soul of copper," which remains above the water of mercury, be heated, it gives off an aëriform body (σῶμα πνευματίκον), and this (says M. Hoefer) was probably oxygen gas, while the soul of copper was oxide of mercury. A second author of early Greek MSS. was Pelagius, who alludes to two writers named Zozimus—one the "Ancient," the other the "Physician." A third author, Olympiodorus, who calls the "sacred art" chemistry (χημεία), quotes Hermes, Democritus, and Anaximander as alchemists.

Democritus (not to be confounded with the Greek philosopher of that name), in his "Physics and Mystics," informs us how he invoked the shade of his master, Ostane the Mede, and how the spirit appeared and accorded him mystical communings. Synesius, the commentator of Democritus, lived, according to M. Hoefer, about fifty years after Zozimus (say 450 A.D.); but a treatise on the Philosopher's Stone is in existence which claims Synesius as its author, which mentions Geber, who lived at least 400 years later. Mary the Jewess, who is often alluded to by later alchemists, was a contemporary of Democritus, and a writer on alchemy; she also invented various chemical vessels, among others a bath, to gently transmit heat by means of hot sand or cinders, which (according to M. Hoefer) is still called after her, a *Bain-Marie*.

We cannot assign to the Greek MSS. in the Bibliothèque Nationale the antiquity which M. Hoefer and others so readily accept; and we must still hold to our opinion that they and all other known Greek MSS. on alchemy are the production of later centuries, and are probably the work of Greek monks. In the first place, who was Zozimus? Was it Zozimus the Anti-pope, who succeeded Innocent I., or Zozimus the Sophist of Alexandria, or Zozimus the historian? No one can tell. It cannot be pretended that any of the Paris MSS. are in the actual writing of Zozimus. One of them is entitled "Zozimus the Panapolite, on the Chemical Art, to his Sister Theosebia;" but, according to the "Biographie Universelle," it was Zozimus of Alexandria who dedicated books to his sister Theosebia, and he lived in the third century B.C., while Zozimus of Panopolis lived in the fourth century A.D. Here, then, we have a discrepancy of 700 years, and a clear confounding of Zozimus of Alexandria with his namesake of Panapolis. Suidas attributes chemical works to the former, but we must remember that the word χημεία does not occur before the eleventh century, A.D. The director of the Bibliothèque Nationale,* in a recent letter for which we have to thank him, writes as follows:—"La Bibliothèque Nationale ne renferme aucun manuscrit grec de Zosime de Panapolis qui puisse attribué a une époque antérieure au XIII. Siécle. Le plus ancien de ceux qu'elle possède ne remonte pas plus loin que cette date." Everything tends to prove that the MSS. were not only written, but composed at a period posterior to the fifth century. The fanciful titles of some of them show us that their authors adopted any name they pleased; thus we have "the Epistle of Isis, queen of Egypt, and wife of Osiris on the sacred art, addressed to her son Horus," in which we find a solemn oath dictated to Isis by the angel Amnaël, who swears by Mercury and Anubis, by Tartarus, the Furies, and Cerberus, and by the dragon Kerkouroboros. The whole thing is plainly a blending of eastern and western thought; personages of Egyptian, Greek, and Roman mythology, with angels of the Talmud, and genii of Arabic lore. We are glad to find that M. Hoefer breaks freely away from the too confident Olaus Borrichius, as to the authenticity of Hermes Trismegistus. He admits that the books which bear his name are spurious, and concludes that their author, "vivait probablement à l'époque critique du Christianisme triomphant et du paganisme à l'agonie." But if we take this as the time of Constantine the Great, we must venture to attach a later date to these writings.

We recently had an opportunity of examining the MS. in the Bibliothèque Nationale, attributed to Zozimus and to the fifth century; a MS. which, from its frequent mention in both ancient and modern works on the history of chemistry, possesses special interest. It is entitled "Zozimus on Chemical Instruments and furnaces, and on the Holy Water" (Ζωσίμου περὶ ὀργάνων καὶ καμίνων καὶ περὶ του θείου ὕδατος), and it is a well-preserved MS. of the thirteenth century, written on vellum. The few drawings which it contains are asserted to have been taken by the author

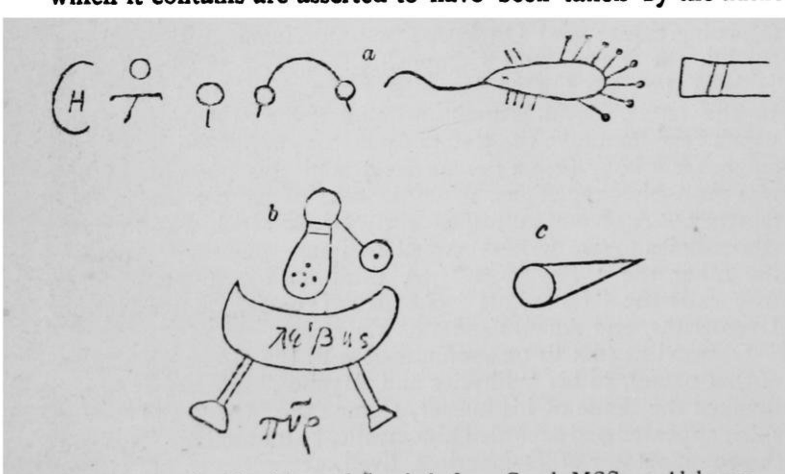


FIG. 7.—An Alembic, and Symbols from Greek MSS. on Alchemy.

from a temple at Memphis. The Alembic (*b* in the accompanying woodcut, Fig. 7) is copied from this MS., in which also the line of symbols (*a*) is found. These symbols occurred in almost every Greek MS. on alchemy which we examined, but we could find no clue to the curious porcupine-like animal. The symbol *c* is clearly of astronomical origin, and is not often met with in later works. The MSS. are for the most part devoid of figures, and not so full of symbols as later alchemical treatises

We have endeavoured to prove (α) that no reliable date can be assigned to existing Greek MSS on alchemy, and (β) that the accepted date is too early. Even if we could prove that a man named Zozimus, living in the fourth century, wrote treatises on alchemy, we could not use the existing MSS. for any exact purpose connected with the history of science with safety; for, since we have no such MS. earlier than the tenth or eleventh centuries, it would be quite impossible to determine whether additions had been made during transcription. The facts are simply these:—There exist in various parts of the world Greek MSS. on alchemy, none of which are older than the tenth century. Many of these bear the names of mythical personages of Egyptian mythology, some of ancient Greek philosophers, some of people who are supposed to have lived in the fourth or fifth century, A.D. When we remember that no ancient writer makes mention of alchemy or chemistry, that the word χημεία is first used in the eleventh century, and when we further bear in mind the condition of the intellectual world in the fourth and fifth centuries, we think we may well admit that further evidence is necessary before we can assert that alchemy arose in the fourth century. Indeed we are of opinion that, in spite of all that has been written on the subject, there is no good evidence to prove that alchemy and chemistry did not originate in Arabia not long prior to the eighth century, A.D.

G. F. RODWELL

* This library has so often changed its name of late, that we think it necessary to mention that we mean the library in the Rue Richelieu, which is called by old writers the *Bibliothèque du Roi* sometimes the *Bibliothèque Royale*, lately the *Bibliothèque Impériale*, still more lately the *Bibliothèque Communale*, now the *Bibliothèque Nationale*. Juncker in his *Conspectus Chemiæ*, in speaking of various writers on alchemy cites "Zozimus Panapolites celeberrimus et magni cognomen adeptus, cujus varia scripta exstant in Bibliotheca Regia Parisiensi."

ON THE ECLIPSE EXPEDITION, 1871*

II.

I MUST now state very briefly some of the results of our work; and first, the certain results.

We were able to make out the structure of the corona. We know all about the corona so far as the structure of its lower brighter strata, that portion, viz., which I referred to in my lecture last year as being visible both before and after totality, is concerned. You may define it as consisting of cool prominences; that is to say, if you examine a prominence any day without waiting for an eclipse, and then go to an eclipse and examine the lower portion of the corona, you will find the same phenomena, minus the brightness. You find the delicate thread-like filaments which you are now all so familiar with in prominences—filaments which were first thrown on a screen in this theatre; the cloudy light masses, the mottling, the nebulous structure, are all absolutely produced in the corona, as far as I could see it with a telescope with an aperture of $6\frac{1}{4}$ inches; and I may add that the portion some five minutes round the sun reminded me forcibly in parts of the nebula of Orion, and of that surrounding η Argus, as depicted by Sir John Herschel in his Cape observations.

We have shown that the idea that we did not get hydrogen above 10 seconds above the sun is erroneous; for we obtained evidence that hydrogen exists to a height of 8 or 10 minutes at least above the sun; and I need not tell you the extreme importance of this determination. One of the proofs we have of that lies in this diagram, showing the observations made by Prof. Respighi, armed with an instrument the principle of which I hope you are now familiar with.

Just after the sun disappeared Prof. Respighi employed this prism to determine the materials of which the prominences which were then being eclipsed were composed; and he got the prominences shaped out in red, yellow, in blue, and in violet light; a background of impure spectrum filling the field, and then as the moon swept over the prominences these images became invisible; he saw the impure spectrum and the yellow and violet rings gradually die out, and then three bright and broad *rings* painted in red, green, and blue, gradually form in the field of view of his instrument; and as long as the more brilliant prominences were invisible on both sides of the sun he saw these magnificent rings, which threw him in a state of ecstacy. And well they might.

These rings were formed by C and F, which shows us that hydrogen extends at least 7 minutes high, for *had we not been dealing with hydrogen we should have got a yellow ring as well*, because the substance which underlies the hydrogen is more brilliant than the hydrogen itself, and in addition to the red ring and the blue ring, which indicate the spectrum of hydrogen, he saw a bright green ring, much more brilliant than the others, built up by the unknown substance which gives us the Kirchhoff line, 1474.

Now at the time that Prof. Respighi was observing these beautiful rings by means of a single prism and a telescope of some four inches aperture, some 300 miles away from him—he was at Poodocottah and I was at Bekul—I had arranged the train of prisms which you see here so that the light of the sun should enter the first prism, and after leaving the last one should

* A Lecture delivered at the Royal Institution of Great Britain, Monday, March 22, 1872, by J. Norman Lockyer, F.R.S. (concluded from p. 58).

enter my eye. And what I saw is shown, side by side with Respighi's observations, in this diagram, in which I have separated the rings somewhat, so that there should be less confusion that in the actual observation. Here is Prof. Respighi's first observation. He gets indications of C, D^3, F, and the hydrogen line near G. He was observing the very lowest, brightest region of all, and therefore 1474 was obliterated by the brightness of the continuous spectrum; but as the eclipse went on D^3 was entirely obliterated, and afterwards he got C and F building up rings together with 1474, which was not represented in the lower regions of the prominence—not because it was not there, but because, as I have already insisted, of the extreme brilliancy of the background. Now my observation was made intermediately as it were between the two observations of Prof. Respighi's. Let me show the observations together.

Respighi ...	C D^3	F G	Prominences at beginning of eclipse.
Lockyer ...	C	1474 F G	Corona at 80 seconds from commencement.
Respighi ...	C	1474 F	Corona at mid eclipse.

Note that I had no object-glass to collect light, but that I had more prisms to disperse it; so that with me the rings were not so high as those observed by Respighi, because I had not so much light to work with: but such as they were I saw them better because the continuous spectrum was more dispersed, and because, with my dispersion, the rings—the images of the corona—therefore did not so much overlap. Hence doubtless Respighi missed the violet ring which I saw, so faint, however, that both that and 1474 were almost invisible, while C shot out with marvellous brilliancy, and D^3 was absent.

These observations thus tend to show, therefore, that instead of the element—the line of which corresponds with 1474—existing alone just above the prominences, the hydrogen accompanies it to what may be termed a great height above the more intensely heated lower levels of the chromosphere, including the prominences in which the lower vapours are thrown a greater height. With a spectroscope of small dispersion attached to the largest mirror of smallest focus which I could obtain in England, the gaseous nature of the spectrum, as indicated by its *structure*, that is, bands of light and darker intervals as distinguished from a continuous spectrum properly so called, was also rendered evident.

These are results of the highest importance, which alone are worth all the anxiety and labour connected with the expedition.

But there is more behind.

The photographic operations (part of the expense of which was borne by Lord Lindsay) were most satisfactory, and the solar corona was photographed to a greater height than it was observed by the spectroscope, and with details which were not observed in the spectroscope.

Mr. Davis was fortunate enough to take an admirable series of five photographs at Bekul, and Captain Hogg also obtained some at Jaffna; but I am sorry to say the latter lack somewhat in detail.

I have prepared two lamps, because I am anxious to exhibit the photographs two at a time, that you may compare one with the other. [This was done.] You see that so far as the camera goes—and mark this well—the corona was almost changeless during the whole period of totality; this is true, not only for one place, but for all the places at which it was photographed.

I now exhibit two other photographs—one taken at Jaffna and the other at Ootacamund. Actinically the corona was the same and practically changeless at all the stations. You see that, though not so obvious as in the other case, there is the same similarity.

Before I leave the actinic corona, I am anxious to show you an image of it, taken during the American eclipse of 1869 in a camera exposed to the sun during the whole of the totality; to a certain extent in our recent photographs we have reproduced what was photographed in 1869.

The solar nature of most, if not all, of the corona recorded on the plates is established by the fact that the plates, taken in different places, and both at the beginning and end of totality, closely resemble each other, and much of the exterior detailed structure is a continuation of that observed in the inner portion independently determined by the spectroscope to belong to the sun.

While both in the prism and the $6\frac{1}{4}$ inch equatorial the corona seemed to form pretty regular rings round the dark moon, of different heights, according to the amount of light utilised by the instrument, on the photographic plates, the corona, which, as I have before stated, exceeds the limits actually seen in the instrument I have named, has a very irregular, somewhat stellate outline, most marked breaks or rifts (*ignored by the spectroscope*), occurring near the sun's poles, a fact perhaps connected with the other fact that the most active and most brilliant prominences rarely occur there.

From the photographs in which the corona is depicted actinically we pass to the drawings in which it is depicted visually. I would first call attention to two drawings made by Mr. Holiday, who formed part of the expedition, and in whose eye every one who knows him will have every confidence.

First there is a drawing made at the commencement of the totality, and then a drawing made at the end. There is a wonderful difference between the drawings; the corona is in them very much more extensive than is represented actinically on our plates.

Here is another drawing, made by Capt. Tupman, in which again we have something absolutely different from the photographs and from Mr. Holiday's sketches, inasmuch as we get an infinite number of dark lines extending down to the moon, and a greater extension than in the photographs, though in radial places the shape of the actinic corona and some of its details are shown.

Now the corona, as it appeared to me with the naked eye, was nothing but an assemblage of bright and dark lines, it lacked all the structure of the photographs, and apppeared larger; and I have asked myself whether these lines do not in some way depend on the size of the telescope, or the absence of a telescope. It seems as if observations of the corona with the naked eye, or with a telescope of small power, may give us such lines; but that when we use a telescope of large power, it will give, close to the moon, the structure to which I have referred, and abolish the exterior structure altogether, leaving a ring round the dark body of the moon such as Prof. Respighi and myself saw in our prisms, and in the 6-inch telescope, in which the light was reduced by high magnification so as to bring the corona to a definite ring some five minutes high, while Prof. Respighi, using a 4-inch telescope and less magnifying power, brought the corona down to a ring something like 7 minutes high.

And here we have an important connection between spectroscopic and telescopic work. If we employ a telescope in which the light is small or is reduced by high magnification, we bring the corona to a definite ring, and perhaps here we have the origin of the "ring-formed" coronas.

Many instances of changing rays, like those seen by Plantamour in 1860, were recorded by observers in whom I have every confidence. One observer noted that the rays revolved and disappeared over the rifts.

We have next to deal with the polariscopic observations.

Mr. Lewis, in sweeping round the corona at a distance of 6′ or 7′ from the sun's limb, using a pair of compensating quartz wedges as an analyser, which remained parallel to itself while the telescope swept round, observed the bands gradually change in intensity, then disappear, bands of a complementary character afterwards appearing, thereby indicating radial polarisation.

Dr. Thomson at Bekul saw strong traces of atmospheric, but none of radial polarisation, with a Savart. With the same class of instrument the result obtained by myself was precisely similar; while on turning in the Biquartz, at the top and bottom of the image of the corona, *i.e.*, near the sun's equator, faint traces of radial polarisation were perceptible for a short distance from the moon's limb. Captain Tupman, who observed with the polariscope after totality, announces strong radial polarisation extending to a very considerable distance from the dark moon.

Leaving the extreme outside of the corona as a question to be determined at some future time—and it can well wait—let us come to the base of the corona, and deal with the region to which I have already referred, close to the sun.

What was the general conclusion at which we arrived on this important point? Before I state it, let me tell you the instrumental conditions of the inquiry. We can use such a spectroscope as the one with which you are all familiar, and so arrange matters that the slit shall be carried by a clock, so that it may follow accurately the edge of the moon; but if the least variation in the rate of motion takes place, the observation is rendered almost valueless. But if we employ a spectroscope, in which we sum up the light—do not localise the light, but throw it together—it does not matter whether your clock goes well or not, you are certain to have a result worthy of credit. But if you employ such an instrument as Prof. Respighi employed, and abolish the slit altogether, the weight of any observations made with such conditions is very great.

Captain Maclear, who was observing with me at Bekul, has undoubtedly shown that when the light of our atmosphere is cut off by the interposition of the dark moon, we see very many more bright lines than we do when this is not the case, the lines being of unequal height.

Mr. Pringle, also at Bekul, showed that, at the end of totality, many lines flashed into one of these instruments, carried under these difficult conditions.

Captain Fyers, the Surveyor-General of Ceylon, observing with a spectroscope of the second kind, saw something like a reversal of all the lines at the beginning, but nothing of the kind at the end.

Mr. Fergusson, observing with a similar instrument, saw reversal neither at the beginning nor the end.

Mr. Moseley, whose observations are of great weight, says that at the beginning of the eclipse he did not see this reversal of lines. Whether it was visible at the end he could not tell, because at the close the slit had travelled off the edge of the moon.

Prof. Respighi, using no slit whatever, and being under the best conditions for seeing the reversal of the lines, certainly did not see it at the beginning, but he considers he saw it at the end, though about this he is doubtful.

From the foregoing general statement of the observations made on the eclipse of last year, it will be seen that knowledge has been very greatly advanced, and that most important data have been obtained to aid in the discussion of former observations. Further, many of the questions raised by the recent observations make it imperatively necessary that future eclipses should be carefully observed, as periodic changes in the corona may then possibly be found to occur. In these observations the instruments above described should be considered normal, and they should be added to as much as possible.

I had intended, if time had permitted me, to point out how much better we are prepared for the observation of an eclipse now than we were when we went to India, and how a system of photograph record should be introduced into the spectroscopic and polariscopic work; but time will not allow me to do more than suggest this interesting topic. I am anxious, however, that you should allow me one minute more to say how very grateful we feel for the assistance rendered by all we met, to which assistance so much of our success must be ascribed. I wish thus publicly to express the extreme gratitude of every one of our Expedition to the authorities in India and in Ceylon for the assistance we received from them, and our sorrow that Admiral Cockburn, a warm and well-known friend to Science, who placed his flagship at the disposal of the expedition, and the Viceroy, whose influence in our favour was felt in every region of India whither our parties went, and to whom we gave up our ship, are now, alas! beyond the expression of our thanks. We are also anxious to express our obligations to the directors and officers of the Peninsular and Oriental Company for the magnificent way in which they aided us. If they had not assisted us as they did, Science would have gained very much less than she has done from the observations of the last eclipse.

SCIENTIFIC SERIALS

THE *Journal of the Quekett Microscopical Club* for October 1872, contains but three papers, of which the first is a short one by Dr Guy, F.R.S., on the "Hand Illuminator Microscope," which is followed by a more elaborate communication of considerable length, by Mr. M. C. Cooke, on "Old Nettle Stems and their Micro-fungi," in which twenty-seven species of fungi are enumerated and described which develop themselves on the old stems of the common nettle.—C. H. Peck, of Albany, U.S., communicates an article on the disease of plum and cherry trees in the United States known as "black knot," and his observations on the structure and growth of the *Sphæria morbosa* (Schweinitz) which accompanies, or causes, these gouty excrescences. The record of the proceedings of the club completes the contents of the present number.

Bulletin de l'Académie Royale de Belgique, No. 7. This number contains a paper, by M. P. J. Van Beneden, on the fossil whales of Antwerp, in which he describes several new types, among others, one (named Cetotherium) characterised chiefly by the articular condyle on the inferior maxillary, and forming a transition-type between the Balænoptera and the Cetodonts. Four species of Cetotherium are described. G. Dewalque gives a description, with plate, of a new fossil sponge, met with in the Eifel system; a species of the Astræospongium of Roemer, so named from the six-rayed star forms composing it. A new mode of estimating the advantage of binocular vision over monocular, as regards the brightness or clearness of objects, is proposed by H. Valerius. He employs Foucault's photometer, which consists of a long box, having a glass disc fixed in one end of it, and a pasteboard diaphragm in the direction of the axis of the box, moveable to or from the disc with screws. Lights are placed on either side of the diaphragm, which thus forms shadows on the disc, and the diaphragm is so adjusted that the shadow from each light occupies half of the disc. The lights having been so adjusted that the disc seems uniformly lighted, their relative intensities are as the squares of the distances separating them from the disc. M. Valerius uses, for his purpose, a prismatic tube, through which he observes the disc of the photometer. It contains a vertical screen which conceals one-half of the disc from one of the eyes. Suppose the disc to be receiving equal quantities of light from the two sources, the observer, on looking through the tube, finds that the half-disc seen with only one eye, appears less illuminated than the other. The equality is restored by moving one of the lights, and the distance of the motion is measured.—This paper is followed by one on formulæ in Ballistics, by J. M. De Tilly.—In the literature department, Baron Kervyn de Lettenhove gives an interesting account of certain documents which he examined at Hatfield House, bearing on the later history of Mary Queen of Scots. He discusses the celebrated casket letters, two of which are preserved at Hatfield, and are considered by him to be translations from the Scotch text. The letters are given in lithograph.—E. Varenbergh communicates an account of a journey made by three Flemish gentlemen to Nuremberg in the thirteenth century; an exact statement being made of the expenses incurred in travelling. One or two minor articles complete the number.

Poggendorff's Annalen der Physik und Chemie.—No. 7 (1872) commences with a paper of careful research, by H. Knoblauch, on the passage of heat-rays through inclined diathermanous plates. The rays, polarised by a Nicol's prism, were caused to pass horizontally to the plate, which was moveable about a vertical axis, and, passing through it, affected a thermopile. Two things determine the passage of radiant heat through inclined plates—the nature of the ray's polarisation, and the absorptivity of the substance composing the plate. These two influences are fully investigated and their effects described.—A continued account, by Hagenbach, of researches on Fluorescence is followed by a somewhat mathematical paper by Ketteler (also a continuation), on the influence of astronomical motion on optical phenomena. Dr. Stoletow discusses at some length the "Function of Magnetisation" of soft iron, and a description is given by G. Vom Rath, of the meteoric stones which fell at Ibbenbühren in 1870. W. Beetz, in a short note, contests the assertion of Zöllner, that an electric current is generated in the flowing of water, pointing out that, in the experiments made, the electric phenomena probably arose from the actual formation of a voltaic element consisting of two different metals (of tap and pipe), and the water, so that the same thing might be observed though the water was at rest. Zöllner's theory of terrestrial magnetism connects itself with the observation in question, as he supposes the flowing liquid masses in the earth's interior generate electric currents by their motion. This number contains, in addition, two contributions on the structure of hailstones, and one or two other short notes.

No. 8 contains the concluding part of Herr Hagenbach's researches on Fluorescence. His experiments, made with a great variety of substances, confirm Stokes's laws. He considers that all the rays are capable of exciting fluorescence. The maxima of the fluorescence varied from 7 (in chlorophyll) downwards. The spectrum of the fluorescent light varied also for different substances, but no necessary connection was apparent between the "intermittence" in the fluorescence of the ordinary spectrum, and that in the fluorescence spectrum. Change of solvent often displaced the maxima. He points out the similarity between phosphorescence and fluorescence, and thinks these are phenomena differing not in kind, but only in degree.—In the next paper

A. Helland adduces a large amount of evidence to show that the fjords in Norway have been formed by glacial action.—H. C. Vogel describes some careful experiments on the spectrum of aurora, which he compared with the spectra of various gases in Geissler tubes. He regards it as a modification of the air spectrum; one line of the former, at least, corresponding with the maximum brightness of the latter, while the remaining lines probably appear in the spectra of atmospheric gases under certain conditions of temperature and pressure.—A new mode of measuring rate of rotation is proposed by A. Schuller. The principle is briefly this: A disc divided into three sectors (black, red, and green), rotates on a horizontal axis; a seconds pendulum fitted with a screen, in which is a vertical slit, oscillates at the back of it, and a ray of light passes through the slit and disc to a telescope through which the observer looks. The recurrence of particular colours observed gives a means of estimating the speed of rotation.—Among the remaining papers are one on a block of lava from the recent eruption of Vesuvius, one on compounds of thallium, and one on a new form of the Noë thermopile.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, Nov. 14.—Mr. W. Spottiswoode, F.R.S., President, in the chair.—The following gentlemen were elected as officers and members of council for the ensuing session:—President, Dr. Hirst, F.R.S.; Vice-Presidents, Prof. Crofton, Mr. S. Roberts, and Mr. Spottiswoode; Treasurer, Mr. S. Roberts; Secretaries, Mr. M. Jenkins, Mr. R. Tucker; other members, Prof Cayley, Prof. W. K. Clifford, Mr. T. Cotterill, Mr. J. W. L. Glaisher, Rev R. Harley, Prof. Henrici, Mr. C. W. Merrifield, Prof. H. J. S. Smith, Mr. J. Stirling, and Mr. J. J. Walker. Messrs. Glaisher and Harley were elected in the room of Dr. Sylvester and the Hon. J. W. Strutt. The new president having taken the chair, alluded in feeling terms to the loss the mathematical world and the Society had just experienced by the death of Dr. Clebsch, of Göttingen, who had been elected a foreign member in December last. Mr. Spottiswoode then read his paper, "Remarks on some recent Generalisations of Algebra." It gave an analysis of methods used by Prof. Peirce, of Harvard, in his "Linear Associative Algebra," and by Dr. Hermann Hankel in his "Vorlesungen über die complexen Zahlen und ihre functionen," Part i. Prof. Henrici exhibited a series of models of cubic surfaces, and pointed out the several singularities, and explained how the models were constructed. Prof. Clifford next read a paper "On a theorem relating to polyhedra analogous to Mr. Cotterill's theorem on plane polygons," and exhibited several illustrative models. The plane theorem is "for every plane polygon of n vertices there is a curve of class $n-3$ touching all the diagonals; the number of diagonals is such as to exactly determine this curve and no more; and when the curve touches the line at infinity the area of the polygon is zero." The analogous theorem in space should therefore apply in the first instance to those solids whose volume can be expressed as the sum of tetrahedra, having one vertex at an arbitrary point of space, and the other three at three vertices of the figure; that is to say, it should apply to solids having triangular faces. For such solids the author finds that the analogy is very complete and exact. Defining the plane which contains three vertices and which is not a face, as a diagonal plane and a line joining two vertices, but not being an edge as a diagonal line, he proves the following theorems:—"For every polyhedron of n summits having only triangular faces ($\triangle$ faced n-acron, Cayley) there is a surface of class $n-4$, touching all the diagonal planes. This surface contains all the diagonal lines. The diagonal planes and lines are so situated, however, that the conditions of touching the planes and containing the lines are precisely sufficient to determine a surface of class $n-4$. When this surface touches the plane at infinity, the volume of the solid is zero." Prof. Clifford then proceeded to apply these propositions to polyhedra having other than triangular faces.—A paper by the Hon. J. W. Strutt was, in his absence, taken as read. Its title was "Investigation of the disturbance produced by a spherical obstacle on the waves of sound." The problem to which chief attention is given in the paper is that of a rigid pherical obstacle, which is either fixed, or (more generally) so supported that, when disturbed from the position of equilibrium, it is urged back by a force proportional to the displacement. The mathematical solution is worked out without any limitation as to the size of the sphere; but in drawing conclusions from it, attention is confined for the most part to the case when the diameter of the sphere is small compared to the length of the sound waves. Mr. Strutt then considers the problem of a fluid spherical obstacle, working it out in full for a very small sphere; and afterwards he investigates anew the same problem by a very different analysis, not restricted to the case of a sphere or an abrupt variation of mechanical properties on the one hand, but on the other less general in requiring the variation and the region over which it occurs to be small. In conclusion he indicates the solution of the problem when the source of sound is at a finite distance from the obstacle, the primary waves being accordingly spherical instead of plane.—The following abstract of M. Hermite's paper "sur l'intégration des fonctions circulaires," was furnished by Prof. Cayley. M. Hermite's paper relates to the integral

$$\int f(\sin x, \cos x)\, dx$$

where f is any rational function of $\sin x$, $\cos x$. The substitution of $e^{xc}=z$, where $c=\sqrt{-1}$, converts this into an integral of the form $\int \frac{F_1(z)}{F(z)} dz$, where $\frac{F_1 z}{F z}$ is a rational function of z, viz. $F_1 z$ and Fz are each of them a rational and integral function of z. The last mentioned integral is treated by the ordinary method of the decomposition of rational fractions; and the gist of the paper is in the transformation of the resulting expressions back from the new variable z to the original variable x, so as to obtain the required integral $\int f(\sin x, \cos x)\, dx$, in terms of the circular functions of x. It is shown that the process leads to an equation of the form $\int (\sin x, \cos x) = \Pi x + \Phi x$, where Πx is a rational and integral function of z, $\sin x$, $\cos x$: and Φx is of the form

$$\begin{aligned}\phi x = C + \alpha \cot \frac{x-\alpha}{2} + a_1 \frac{d}{dx} \cot \frac{x-\alpha}{2} +, \&c. \\ + b \cot \frac{x-\beta}{2} + b_1 \frac{d}{dx} \cot \frac{x-\beta}{2} +, \&c. \\ + \&c.\end{aligned}$$

each series, and also the number of the different series, being finite: so that the integration is made to depend upon the integrals

$$\int \Pi\, x dx \text{ and } \int \cot \frac{x-a}{2} dx = 2 \log \sin \frac{x-a}{2}$$

The paper contains processes for the complete determination of the coefficients, C, a, a_1, &c. and other interesting matter.

Meteorological Society, Nov. 20.—Dr. Tripe, president, in the chair.—On the storms experienced by the Submarine Cable Expedition in the Persian Gulf on November 1 and 2, 1869, by Mr. Latimer Clark. The first storm occurred at 9 o'clock at night, when the vessels of the expedition were about 130 miles from Bushire, and burst upon them without any preliminary warning, lowering the temperature by nearly 30° in a few minutes. It was accompanied by heavy rain and much lightning and thunder, and progressed from N.W. to S.E. After the tempest had lasted for two hours the wind changed to a gale from S.E., and subsequently fell calm as before The next day the cable was spliced up, and paying out had scarcely re-commenced, with a strong south-east wind, when notice was received that another violent storm from the north-west had passed Bushire, and was on its way down the Gulf. At 3 o'clock black clouds were seen rising, and at 3.52 the storm burst forth with the same suddenness and fury that characterised the previous one. Being daylight many phenomena were observed which were missed the night before. As the clouds approached they gathered into a peculiar form, resembling the cap of a large mushroom, extending across the heavens from one horizon to the other. The lower edge had a rounded and wrinkled margin, but was very sharply defined; the surface was composed of innumerable similar strata, as if melted pitch had been poured out and allowed to solidify in numerous cakes, each rather smaller than the one below.* Suddenly there came a profound calm,

* This is the form of cloud mentioned by M. Poey in NATURE, Vol. iv. No. 103.

and a few hundred yards ahead the squall was seen approaching. The sea was elsewhere covered with full-sized waves, but under the influence of the hurricane it became one dead-level of creamy foam, the top of every wave being swept off into spray as soon as it arose. When the squall struck the vessels the thermometer fell at once from 81° to 53°; torrents of rain swept the decks, accompanied with continuous thunder and lightning. After two hours the wind changed into a gale from the south-east, followed by a calm. It was noticed that the barometer was unaffected till the last moment, but as soon as the storm arrived it rose two-tenths of an inch, and fell again as it passed over. The electrical instruments, although of the most sensitive character, were not at all affected during the storm. The other papers read were "On the Meteorology of Southland, New Zealand, in 1871," by Mr. C. R. Martin, and "On a Self-registering Tide-gauge and Electrical Barograph," by Mr. H. C. Russell, B.A., Government Astronomer, Sydney.

PARIS

Academy of Sciences, Nov. 18.—M. Faye, president, in the chair.—The meeting commenced with another instalment of the ferment controversy, M. Pasteur rising and objecting to M. Fremy's remarks as reported in the *Comptes Rendus* of the last meeting. M. Bouillaud followed, expressing his regrets that M. Pasteur's proposition with regard to the experiments had not been acceded to. M. A. Trécul then rose, and regretted that certain words which had appeared in the same number had not been uttered at the meeting. He then read a note criticising M. Pasteur's remarks at that meeting. The discussion then dropped, and M. Tresca read a note on the best form for the international standard meters. He proposes a section like the letters H or X.—M. Bouillaud then read a paper on the theory of the production of animal heat.—M. F. Perrier read a paper on the prolongation of the French meridian into the Sahara by means of the trigonometrical junction of Algiers with Spain.—The next paper was by M. Jeannel on the natural production of nitrates and nitrites. Among other conclusions the author arrives at this, that "calcareous humus" in drying determines the combination of the elements of the air.—M. Max Marie presented the concluding paper of his series on the elementary theory of integrals of any order and their periods, after which followed a paper on a new method of analysis founded on the use of imaginary co-ordinates, by M. F. Lucas.—M. C. Dareste presented his fifth paper on the osteological types of osseous fishes.—"Studies on the ventilation of transports" was a paper by. M. E. Bertin, giving the results of some experiments on ventilation made on board the *Calvados* and *Garonne*, transports. The apparatus used, worked by the waste heat of the furnaces, evacuated 35,000 cubic metres of air per hour from the lower decks.—Notes on the *Phylloxera* were received from M. Saint-Pierre and M. Loarer. The former has found the insects on the wild vines of Vaucluse known as *lambrusques*, and hence considers that the general opinion that this disease is the result of cultivation is erroneous. Both letters were sent to the *Phylloxera* Commission, and notes from M. F. Barilla on a remedy for cholera, and M. G. Fabretti on the transmission of infectious miasmata were sent to that appointed to administer the Bréant legacy.—A note from M. Curral on the realisation of perpetual motion in the planetary system was submitted to the examination of M. Phillips, while a note from M. Andru on the quadrature of the circle was, in accordance with a very old rule of the Academy, considered as not received.—M. Serret then presented a note on the planetoid 116 Sirona, by M. F. Tisserand.—M. J. Bourget's Memoir on the Mathematical Theory of Kundt's acoustic experiments followed, after which came a note on "Magnetic Energy" by M. A. Cazin.—M. E. Becquerel next presented a note on the multiplicity of images, and the theory of accommodation, a paper on optical physiology, by M. F. P. Le Roux.—M. Sainte-Claire Deville then communicated an account of M. Cailletet's researches on liquid carbonic anhydride and M. F. Pisani's description and analyses of a new silver amalgam from Konsberg in Norway.—M. Becquerel presented M. Aug Guerout's researches on the action of sulphurous anhydride on recently precipitated insoluble sulphides. The author finds that a hyposulphite is the result of the reaction which takes place in three successive stages, these are the formation of a sulphite and hydrosulphuric acid, the decomposition of the latter, and of the sulphurous anhydride into sulphur and water, and the combination of this sulphur, whilst in the nascent state, with the sulphite formed at first.—A note on the geographical distribution of the *Percina* by M. Léon Vaillant came next; and then M. A. Gaudry's note on a tooth of *Elephas primigenius* from Alaska. The tooth contained as much as 23·97 per cent. of organic matter.—Next came M. A. Laboulbène's paper on the elevation of central temperature in cases of acute pleurisy, on the abstraction of the liquid from the pleura, the temperature rose from 0°·2 to 0°·3 C. after the operation.—M. Béchamp followed with observations on M. Pasteur's paper, in which he stated that the wine ferment came from the grape skin.

BOOKS RECEIVED

ENGLISH.—How I found Livingstone in Central Africa: H. M. Stanley (Sampson Low and Co.).—A Report on the Expedition to Western Yunan, *viâ* Bhamô: Dr. Anderson, Calcutta.—Mineral Phosphates and Pure Fertilisers: C. Morfit (Trübner).—The Physiology of Man; Nervous System: A. Flint (Appleton and Co).—Elements of Zoology: Andrew Wilson (A. and C. Black).—Small Pox and Vaccination: Dr. C. Both (Trübner).

FOREIGN.—Beiträge zur Biologie der Pflanzen: Dr. F. Cohn, Heft II.

DIARY

THURSDAY, DECEMBER 5.

ROYAL SOCIETY, at 8.30.—On the Colouring Matters derived from Aromatic Azodiamines. 2. Safranine: Dr. Hofmann, F.R.S., and Dr. Geyger.—Synthesis of Aromatic Monamines, by intra-molecular atomic interchange: Dr. Hofmann, F.R.S.—Investigation of the Attraction of a Galvanic Coil on a small Magnetic Mass: J. Stuart.

SOCIETY OF ANTIQUARIES, at 8.30—On Certain Prevailing Errors respecting French Chambered Barrows: Rev. W. C. Lukis, M.A.

LINNEAN SOCIETY, at 8.—On the Skeleton of the *Apteryx*: Thomas Allis.—On New and Rare British Spiders: Rev. O. P. Cambridge, M.A.

CHEMICAL SOCIETY, at 8.—On the Reducing Power of Phosphorous and Hypophosphorous Acids and their Salts: Prof. C. Rammelsberg.—On Hypophosphites: Prof. C. Rammelsberg.—On New Analyses of some Mineral Arseniates and Phosphates: Prof. A. H. Church.

FRIDAY, DECEMBER 6.

GEOLOGISTS' ASSOCIATION, at 8.—On Coal Seams in the Permian at Ifton, Shropshire, with Remarks on the Supposed Glacial Climate of the Permian Period: D. C. Davies.—Note on a Well Section at Finchley: Caleb Evans.

SUNDAY, DECEMBER 8.

SUNDAY LECTURE SOCIETY, at 4.—On Arctic Experience; with a description of the Esquimaux; John Rae, M.D.

MONDAY, DECEMBER 9.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.

TUESDAY, DECEMBER 10.

LONDON INSTITUTION, at 4.—On Elementary Physiology: Prof. Rutherford.

PHOTOGRAPHIC SOCIETY OF LONDON, at 8.—Landscape Photography: F. C. Earl.—A New Actinometer: J. R. Johnson.

WEDNESDAY, DECEMBER 11.

SOCIETY OF ARTS, at 8.—On Galvanic Batteries: Rev. H. Highton.

THURSDAY, DECEMBER 12.

ROYAL SOCIETY, at 8.30.

SOCIETY OF ANTIQUARIES, at 8.30.

LONDON MATHEMATICAL SOCIETY, at 8.—On Geodesic Lines, especially those of a Quadric Surface; and on the Mechanical Description of certain Quartic Curves by a modified Oval Chuck: Prof. Cayley.—Note on the breaking up of the Inharmonic-ratio Sextic: J. J. Walker.

CONTENTS

ERRATA.—No. 157, p. 540, 2nd col. l. 15: For "2328·3 = 2,250,821,000," read "2328·3 × 2,250,821,000;" p. 541, 1st col., l. 14 from bottom: for "absolute certainty" read "supposed absolute certainty." No. 160, p. 47, 1st col., l. 14: for "water-fall" read "water falling."