PROCEEDINGS

OF THE

LITERARY AND PHILOSOPHICAL SOCIETY

OF

MANCHESTER.

VOL. XIV.

SESSION 1874-75

MANCHESTER:

PRINTED BY THOS. SOWLER AND CO., RED LION STREET, ST. ANN'S SQUARE.

LONDON: H. BAILLIÈRE, 219, REGENT STREET.

1875.

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ERRATA.

Page 6, line 8, for "Odontogigram" read "Odontogram."

„ 6, „ 17, for "indentification" read "identification."

„ 131, „ 1, for "1874" read "1875."

PROCEEDINGS

OF

THE LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, October 6th, 1874.

Rev. WILLIAM GASKELL, M.A., Vice-President, in the Chair.

"On the Ossiferous Deposit at Windy Knoll, near Castleton," by ROOKE PENNINGTON, Esq., LL.B.

In October, 1870, I was in the Windy Knoll quarry, near Castleton, a place well known to geologists, when I observed a large bone, a tibia, sticking out of some debris overlying the rock. I took it and one or two smaller bones away with me and showed them to Mr. Boyd Dawkins, who named them, and after conversation with him, I decided to explore the place. This could not be done for a long time, as the floor of the quarry was covered with an increasing mass of broken stone for the repair of the turnpike, and the fissure near which the bone was found was so placed that in removing earth from it serious injury would arise to the road stone.

The place was, however, looked after, the permission of the proprietor for an investigation obtained, and from time to time some good specimens were obtained both of bison and reindeer bones. (Mr. Dawkins had made me certain of the nature of the bones.) The day before Good Friday the quarrymen had picked up a number of bones from a fall of earth which had occurred, and placed them in a basket. They forgot to bring them down to Castleton, and on Good Friday, some young men from Manchester carried them off. They repeated their visit once or twice, and did considerable damage by pulling away the soil, so that we had to set a man purposely to watch the place, and preserve it as far as possible from this miscellaneous intrusion. The specimens thus obtained were carried to Mr. James Plant, who, on the 28th April, 1874, read an account of them to the Manchester Geological Society. One statement which he made then, and which he subsequently repeated in his remarks on a paper read before that Society, by Mr. Aitken, I must very distinctly deny. No bones were ever carted away from the place to any bone-mill, nor we (as will have been seen) ignorant of their nature; the only foundation for the carting statement is the fact that a man, casually employed in the quarry, did take a basketful of bones to his house, but they were immediately recovered, and are now in my collection. I shall have occasion to refer again to Mr. Plant's observations.

The position of the quarry is somewhat remarkable. It is in a small mountain limestone hill, near the extreme north of that tract of limestone which lies between the two ranges of millstone grit and Yoredale hills running S.E. and S.W. from Kinder Scout. The fault separating the mountain limestone from the overlying Yoredale rocks of Mam Tor runs close to the quarry. The water on both sides of the hill runs eastward into the vale of Hope and so into the Derwent. To the west is a valley extending about two miles in length, whence there is no surface outlet, but all the streams disappear towards the south and then turn east, appearing again in the Speedwell mine and flowing out of the Peak Cavern. There is no drainage from this valley into the Mersey, as stated by Mr. Plant, but all the water flows ultimately into the Trent. So far also from there being no appearance in this locality of "swallow holes," as he says, there is an unusually large number in the valley, one in the quarry itself and another very important one close by to the east.

We commenced work at the end of April. The bones observed were in a fissure some little distance up the northern side of the quarry. We soon ascertained that this fissure was but an opening into a rock basin lying still further to the north. There was no appearance of a cave, and certainly none connected with the fissure has ever existed to the south, that is, where the rock has been quarried away. This basin and the fissure were filled with a reddish coloured loam, such as usually occurs in mountain limestone fissures. Capping this was a quantity of rubbish, derived from previous workings of the quarry. This loam has been described by Mr. Plant as "drifts originally derived from the washing and wearing of the shales and sandstones of the great escarpment of Mam Tor," and as "drifted loam." There is no appearance whatever of the characteristics of drift, or glacial action of any kind. All the fragments included in the loam are angular, unrolled, and of limestone. Not a trace of any foreign rock, even of Yoredale origin, was present.

After clearing out the fissure, we began, in May, a systematic exploration of the basin behind, blowing down the rock which formed its southern wall. We had four men at work for a fortnight, Mr. John Tym superintending. The rubbish at the top contained no pleistocene animals, and the loam in its upper portion afforded but few bones. But at about 4 feet below the surface where we first commenced was a truly wonderful agglomeration of mammalian relics. Bones and teeth of bisons, reindeer, bears, and wolves were turned out in the greatest abundance. Lying as they did in a thick, sticky loam, the work was necessarily slow, as great care had to be taken not to break the bones. The depth of the ossiferous portion of the basin averaged about 12 feet, and about 22 cubic feet were got out. Near the top the specimens were rotten and ill preserved, lower down they were much firmer and more perfect. At the bottom of the fissure and near the sides of the basin, they were welded into a mass with included limestone fragments by stalagmite such as the specimens on the table. This had evidently been derived from the dripping of water charged with carbonate of lime from the sides. The bones numbered in all many thousands, and of teeth more than 500 were obtained.

The accumulation of these bones must have been a work of time. It is clear that those encrusted with stalagmite must have lain exposed for some tolerably lengthy period. As to the loam itself, it bears all the characteristics of being formed from the sub-ærial disintegration of the rocks immediately around. Moreover, all the included rocks being angular and of limestone have evidently fallen in from those above. There is no reason to suppose that the washing and wearing of the sandstones and shales of Mam Tor have had anything to do with it; on the contrary, the deposit is just like those in fissures, which are not near the Yoredale rocks, and very unlike the debris from Mam Tor in the Castleton valley. In fact, there is a slope of the limestone towards the place, but certainly there is no trace of the rapid action of water or of any drifting.

I should be inclined to say that this was probably in Pleistocene times a swampy drinking place. It is on the direct tract from the fertile valley of the Derwent (near which I have found traces of these and other Pleistocene animals) to the Cheshire plains. Probably large herds of bisons and reindeer passed the spot, in drinking some would fall in, some would be bogged, others might die in the vicinity and be washed in during rainy weather. The bears and the wolves probably attended to eat up the sickly ones and stragglers, just as such creatures do now in Siberia. Some of the bones and antlers bear marks of gnawing, by what animal I do not offer any opinion, but they no doubt had lain on the surface of the ground when so gnawed.

I should like to call attention to the absence of the rhinoceros, hyæna, cave bear, and other animals at Windy Knoll, and also the diseased character of some of the bones. Also to the absence of the urus (*bos primigenius*). Mr.

BOYD DAWKINS at first thought we possessed bones of this animal, but on further comparison found them to belong to the bison, which is, of course, a totally distinct species.

In conclusion attention was drawn to the absence of signs of glacial action in the neighbourhood of Castleton, and to the fact that such signs were only found on the western slope of the western fork of the Pennine chain in Derbyshire, Cheshire, and Staffordshire.

"On some teeth from a fissure in Waterhouses Quarry, in Staffordshire."

Mr. PENNINGTON called attention to some teeth of a bison (*Bos priscus*) from a fissure in a quarry at Waterhouses. The animal had evidently fallen in whilst coming to drink at the river Hamps. It had been erroneously described as an Irish elk.

Mr. BOYD DAWKINS, F.R.S., said that the two most abundant animals in the Windy Knoll fissure were the Bison and the Reindeer. It is worthy of remark that the young of the former were out of all proportion to the adult, a fact which implies that the place was haunted by these animals in the summer and early autumn, the number of calves under five months being very considerable, and May being the calving time of the Bison. They were unaccompanied by any other herbivora, the small phalange which I had at first referred to the Roedeer, viewed in the light of the large series discovered by Mr. Pennington, belonging to the former animal.

There were also the remains of the hare, rabbit and water rat.

The other animals which have been discovered consist of the wolf and bear, and these remains are comparatively rare.

There is nothing of any importance to be remarked concerning the wolf, but the ursine remains are of peculiar interest as implying the existence of a new carnivore in

Derbyshire. The mean measurements of the teeth, (molar and canines,) in Mr. Pennington's collection coincide, I may say, almost to a hair's breadth, with the mean measurements of the fossil Grizzly Bear (*Ursus priscus*) which Professor Busk has defined so admirably in his recent memoir on the animals found in the Brixham cave, and leave no room to doubt that the Bear of Windy Knoll belongs to that species or variety. If the Odontogigram of the dentition be compared with that published in the Philosophical Transactions 1873, pl. 47, fig. 8, it will be seen that the agreement is exact.

The Cave-bear, or, *Ursus spelæus,* is also stated by Mr. Plant, (Manchester Geological Transactions, xiii, 130—156), to have been discovered in the Windy Knoll fissure, principally on the fancied resemblance which a sacrum of a young animal bore to a sacrum in the Peel Park Museum, said to belong to *Ursus spelæus,* partly also on the stumps of two teeth, worthless for purposes of specific indentification. I have carefully analysed this evidence, and on comparing the sacrum in question with that of the ox and bear, I believe that it belongs to a young bison, and not to any carnivora. And, further, even if it belong to a bear, there is no evidence as to the species, because the specific characters of that bone in the fossil bears have not yet been ascertained. The researches of Professor Busk, during a long series of years, and my examination of the most important collections of fossil bears in this country and in France, prove that the determination of the species is a point of extreme difficulty, and we are only able to detect characters of specific value in the heads and dentition. On this point I would refer to Professor Busk's memoir, and to the vast collection at Toulouse. The Cave-bear, therefore of Windy Knoll, must be given up, as being based on a faulty determination.

The net result of the examination of the whole group of remains is the conclusion that in the Pleistocene age great herds of bison and reindeer passed up from the valley of the Derwent into the plains of Cheshire, and that they were accompanied by grizzly bears, wolves, and a few foxes, which ate up the stragglers. The bison, in its migrations, still has the escort of grizzly bears and wolves in the region of the Rocky Mountains; and the reindeer is described, by Admiral Von Wrangel, as being followed by the same animals in Siberia, in its vernal and autumnal migrations.

"On the Extent and Action of The Heating Surface for Steam Boilers," by Professor OSBORNE REYNOLDS, M.A.

The rapidity with which heat will pass from one fluid to another through an intervening plate of metal is a matter of such practical importance that I need not apologise for introducing it here. Besides its practical value it also forms a subject of very great philosophical interest, being intimately connected with, if it does not form part of, molecular philosophy.

In addition to the great amount of empirical and practical knowledge which has been acquired from steam boilers, the transmission of heat has been made the subject of direct inquiry by Newton, Dulong and Petit, Péclet, Joule, and Rankine, and considerable efforts have been made to reduce it to a system. But as yet the advance in this direction has not been very great; and the discrepancy in the results of the various experiments is such that one cannot avoid the conclusion that the circumstances of the problem have not been all taken into account.

Newton appears to have assumed that the rate at which heat is transmitted from a surface to a gas and *vice versa* is *ceteris paribus* directly proportional to the difference in temperature between the surface and the gas, whereas Dulong and Petit, followed by Péclet, came to the conclusion from their experiments that it followed altogether a different law.*

These philosophers do not seem to have advanced any theoretical reasons for the law which they have taken, but have deduced it entirely from their experiments, "à chercher par tâtonnement la loi que suivent ces résultats.†"

* *Traite de la Chaleur,* Péclet, Vol. I., p. 365.

† *Ib.,* p. 363.

In reducing these results, however, so many things had to be taken into account and so many assumptions have been made that it can hardly be a matter of surprise if they have been misled. And there is one assumption which upon the face of it seems to be contrary to general experience, this is, that the quantity of heat imparted by a given extent of surface to the adjacent fluid is independent of the motion of that fluid or of the nature of the surface;* whereas the cooling effect of a wind compared with still air is so evident that it must cast doubt upon the truth of any hypothesis which does not take it into account.

In this paper I approach the problem in another manner from that in which it has been approached before. Starting with the laws recently discovered of the internal diffusion of fluids I have endeavoured to deduce from theoretical considerations the laws for the transmission of heat, and then verify these laws by experiment. In the latter respect I can only offer a few preliminary results; which, however, seem to agree so well with general experience, as to warrant a further investigation of the subject, to promote which is my object in bringing it forward in the present incomplete form.

The heat carried off by air or any fluid from a surface, apart from the effect of radiation, is proportional to the internal diffusion of the fluid at and near the surface, *i.e.*, is proportional to the rate at which particles or molecules pass backwards and forwards from the surface to any given depth within the fluid, thus, if AB be the surface and *ab* an ideal line in the fluid parallel to AB then the heat carried off from the surface in a given time will be proportional to the number of molecules which in that time pass from *ab* to AB—that is for a given difference of temperature between the fluid and the surface.

This assumption is fundamental to what I have to say, and is based on the molecular theory of fluids.

Now the rate of this diffusion has been shown from various considerations to depend on two things:—

1. The natural internal diffusion of the fluid when at rest.

* *Traite de la Chaleur,* Péclet, Vol. I., p. 383.

2. The eddies caused by visible motion which mixes the fluid up and continually brings fresh particles into contact with the surface.

The first of these causes is independent of the velocity of the fluid, if it be a gas is independent of its density, so that it may be said to depend only on the nature of the fluid.*

The second cause, the effect of eddies, arises entirely from the motion of the fluid, and is proportional both to the density of the fluid, if gas, and the velocity with which it flows past the surface.

The combined effect of these two causes may be expressed in a formula as follows:

$$H = At + B\rho vt, \qquad \text{(I)}$$

where t is the difference of temperature between the surface and the fluid, ρ is the density of the fluid, v its velocity, and A and B constants depending on the nature of the fluid H being the heat transmitted per unit of surface of the surface in a unit of time.

If therefore a fluid were forced along a fixed length of pipe which was maintained at a uniform temperature greater or less than the initial temperature of the gas, we should expect the following results.

1. Starting with a velocity zero, the gas would then acquire the same temperature as the tube. 2. As the velocity increased the temperature at which the gas would emerge would gradually diminish, rapidly at first, but in a decreasing ratio until it would become sensibly constant and independent of the velocity. The velocity after which the temperature of the emerging gas would be sensibly constant can only be found for each particular gas by experiment; but it would seem reasonable to suppose that it would be the same as that at which the resistance offered by friction to the motion of the fluid would be sensibly proportional to the square of the velocity. It having been found both theoretically and by experiment that this resistance is connected with the diffusion of the gas by a formula:

$$R = A^1 v + B^1 \rho v^2, \qquad \text{(II)}$$

* Maxwell's Theory of Heat, Chap. XIX.

And various considerations lead to the supposition that A and B in (I.) are proportional to A^1 and B^1 in (II.)

The value of v which this gives is very small, and hence it follows that for considerable velocities the gas should emerge from the tube at a nearly constant temperature whatever may be its velocity.

This, as I am about to point out, is in accordance with what has been observed in tubular boilers as well as in more definite experiments.

In the Locomotive the length of the boiler is limited by the length of tube necessary to cool the air from the fire down to a certain temperature say 500°. Now there does not seem to be any general rule in practice for determining this length, the length varying from 16ft. to as little as 6, but whatever the proportions may be each engine furnishes a means of comparing the efficiency of the tubes for high and low velocities of the air through them. It has been a matter of surprise how completely the steam-producing power of a boiler appears to rise with the strength of blast or the work required from it. And as the boilers are as economical when working with a high blast as with a low, the air going up the chimney cannot have a much higher temperature in the one case than in the other. That it should be somewhat higher is strictly in accordance with the theory as stated above.

It must, however, be noticed that the foregoing conclusion is based on the assumption that the surface of the tube is kept at the same constant temperature, a condition which it is easy to see can hardly be fulfilled in practice.

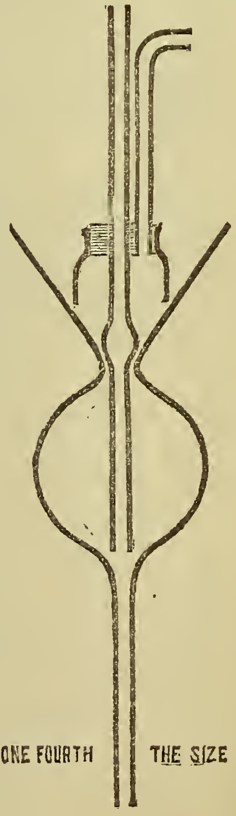
The method by which this is usually attempted is by surrounding the tube on the outside with some fluid the temperature of which is kept constant by some natural means, such as boiling or freezing, for instance the tube is surrounded with boiling water. Now although it may be possible to keep the water at a constant temperature it does not at all follow that the tube will be kept at the same temperature; but on the other hand, since heat has to pass from the water to the tube there must be a difference of temperature between them, and this difference will be proportional to the quantity of heat which has to pass. And again the heat will have to pass through the material of the tube, and the rate at which it will do this will depend on the difference of the temperature at its two surfaces. Hence if air be forced through a tube surrounded with boiling water, the temperature of the inner surface of the tube will not be constant but will diminish with the quantity of heat carried off by the air. It may be imagined that the difference will not be great: a variety of experiments lead me to suppose that it is much greater than is generally supposed. It is obvious that if the previous conclusions be correct this difference would be diminished by keeping the water in motion, and the more rapid the motion the less would be the difference. Taking these things into consideration the following experiments may, I think, be looked upon, if not as conclusive evidence of the truth of the above reasoning, yet as bearing directly upon it.

One end of a brass tube was connected with a reservoir of compressed air, the tube itself was immersed in boiling water, and the other end was connected with a small non-conducting chamber formed of concentric cylinders of paper with intervals between them in which was inserted the bulb of a thermometer. The air was then allowed to pass through the tube and paper chamber, the pressure in the reservoir being maintained by bellows and measured by a mercury gauge; the thermometer then indicated the temperature of the emerging air. One experiment gave the following results :—With the smallest possible pressure the thermometer rose to 96° F., and as the pressure increased fell until with $\frac{1}{10}$ inch it was 87°, with $\frac{1}{4}$ inch it was 70°, with 1 inch it was 64°, with 2 inches 60°, beyond this point the bellows would not raise the pressure.

It appears, therefore, (1) that the temperature of the air never rose to 212, the temperature of the tube, even when moving slowest; but the difference was clearly accounted for by the loss of heat in the chamber from radiation, the small quantity of air passing through it not being sufficient to maintain the full temperature, an effect which must obviously vanish as the velocity of the air increased; (2) as the velocity increased the temperature diminished, at first rapidly and then in a more steady manner. The first diminution might be expected from the fact that the velocity was not as yet equal to that at which the resistance of friction is sensibly equal to the square of the velocity as previously explained. The steady diminution which continued when the velocity was greater was due to the cooling of the tube. This was proved to be the case, for at any stage of the operation the temperature of the emerging air could be slightly raised by increasing the heat under the water so as to make it boil faster and produce greater agitation in the water surrounding the tube. This experiment was repeated with several tubes of different lengths and characters, some of copper and some of brass, with practically the same results. I have not however as yet been able to complete the investigation, and I hope to be able before long to bring forward another communication before the Society.

I may state that should these conclusions be established, and the constant B for different fluids be determined, we should then be able to determine, as regards length and extent, the best proportion for the tubes and flues of boilers.

Dr. JOULE made a further communication respecting his mercurial air pump described in the Proceedings for Dec. 24, 1872; and Feb. 4, Feb. 18, and Dec. 30, 1873. He had successfully made use of the glass plug proposed in the Proceedings for Feb. 4, 1873. This he constructs by blowing out the entrance tube and grinding the bulb thus formed into the neck of the thistle-shaped glass vessel. To collect the pumped gases he now employs an inverted glass vessel attached to the entrance tube and dipping into the mercury in the upper part of the thistle glass.



ONE FOURTH THE SIZE

Ordinary Meeting, October 20th, 1874.

EDWARD SCHUNCK, Ph.D., F.R.S., &c., President, in the Chair.

Mr. WILLIAM H. JOHNSON, B.Sc., showed two remarkable pieces of iron cinder from a furnace in which iron is re-heated. The samples showed on one side small dark prismatic crystals which appeared to have been formed in a cavity of the cinder as it cooled in the cinder bogie. The reverse side of one of them had formed the wall of a second cavity; its surface was however smooth, black, shining, and studded all over with the sides of oblong jet-black crystals unusually iridescent. He remarked that probably these crystals were Fayalite, an iron chrysolite, a mineral found in the Mourne mountains in Ireland, which is sometimes iridescent, and whose chemical composition is represented by the formula Fe_2SiO_4. They are the more worthy of notice from the rare occurrence of crystals in mill furnace cinder.

E. W. BINNEY, F.R.S., F.G.S., said that in Tome XXII., No. 9, of the Memoirs of the French Academy of Science, MM. B. Renault and Grand' Eury have published a most valuable memoir on the structure of *Sigillaria spinulosa*, and substantially confirmed M. Brongniart's views of the structure of *Sigillaria elegans* published in 1839. Unfortunately the medulla in both these species was destroyed, as is generally the case with specimens of *Sigillaria* as well as the root so long known as *Stigmaria ficoides*. Professor Geoppert and himself many years since described the only two specimens of this fossil which showed structure in the medulla, and both these specimens were looked upon as more than doubtful. Professor W. C. Williamson, F.R.S., in Part 11 of his Memoirs in the Phil. Transactions, p. 215, states: "I have elsewhere called attention to the way in

" which the rootlets of *Stigmaria* have penetrated every- " thing within their reach which was penetrable, and I have " no doubt that in both Professor Goeppert and Mr. Binney's " specimens these supposed medullary vessels were really " Stigmarian rootlets that had found their way into the " interior of the cavity left by the decay of the medulla and " been mistaken for a part of the plant into which they had " intruded themselves." Now in his (Mr. Binney's) Staffordshire specimen described in the *Quarterly Journal of the Geol. Society* for 1850, p. 77, mention is only made of the large vascular bundles found in the axis without calling them vascular or any other vessels. As figured in the plate and described in the letterpress no one could scarcely take them for the radicles of *Stigmaria.* The woody cylinder was one of those having the inner parts of their vascular circle close together and not open as in Professor Goeppert's specimen. It is certainly possible that the large tubes in his specimen may not be in their normal condition and may have been somewhat altered in the process of mineralization, but it is very improbable that they had ever been introduced into the axis after the pith had been removed.

The beautiful specimen figured and described by Goeppert more than thirty years since is very different from his (Mr. Binney's), being much more open in the spaces between the wedges of the woody cylinder, and its central part is enclosed in a *Stigmaria,* shewing the external characters in a most excellent state of preservation, and one of the best that has ever been found. However it might be urged that the vascular bundles in the medulla had been squeezed from their true position into the parts where they are now found, they are certainly not intruded rootlets, as any one who examines the learned author's plate can satisfy himself.

For many beautiful specimens of *Stigmaria,* shewing structure in most of their parts except the medulla from the trap ashes of Scotland, he was indebted to the kindness of Messrs. Wunsch, John Young, and Greive.

He had been so fortunate as to find a specimen of *Stigmaria,* which he now exhibited to the Society, from the

Bullion coal at Clough Head, near Burnley, having the medulla perfectly preserved. It is about two inches in diameter, and shews the inner bark composed of elongated utricles in radiating series and traversed by bell-shaped orifices, containing the bases of the rootlets, the zone of lax cellular tissue, and the woody cylinder of close wedges surrounding the central axis or medulla. Distinct evidence of both the large primary and the small secondary medullary rays is found in the tangential section of the woody cylinder exactly resembling those met with in the fossil plant described by him as *Sigillaria vascularis.* The sharp line of a dark colour separating the vascular cylinder from the central axis is the same in both plants, and the outer portion of the axis is formed of small vascular tubes of hexagonal and pentagonal forms, which gradually increase in size as they proceed inwards, and form something like a medullary sheath enclosing a medulla composed of very small and short barred tubes or utricles in which are mingled large vascular tubes or utricles, the latter being about 15 times the diameter of the former.

The size of these large vascular tubes or utricles in the medulla exceeding anything, so far as his knowledge extended, hitherto observed in fossil plants shews that it was easily decomposed, and thus accounts for the general absence of the medulla in *Sigillaria* and its roots. Every part of this specimen is identical in structure with the plant named by him *Sigillaria vascularis,* so if that is sufficient evidence of the connection of a stem with a root, it must be taken to be the root of that plant. One thing is certain that the large vascular tubes or utricles in the medulla existed in the living plant and are not the intruded rootlets of *Stigmaria.*

Mr. R. D. DARBISHIRE, F.G.S., exhibited and described the Palæolithic (French and English Drift) Implements collected for the Soirée at the Owens College.

Professor BOYD DAWKINS, F.R.S., brought before the notice of the Society the conditions under which the palæolithic implements are found in the river-strata and in the caves, in association with the extinct mammalia, such as the Mammoth and woolly Rhinoceros. Although the number of flint implements from the river-strata in various collections was very great, yet it is small when viewed in connection with the emormous quantity of gravel removed in their discovery. They are not evenly distributed, but cluster round certain spots. Their discovery in India along with the extinct mammalia proves that man was living, both in Europe and in southern Asia from the Ganges to Ceylon in the same rude uncivilised state, *at the same time* in the life-history of the earth. He also called attention to the art of the hunters of the reindeer and mammoth in the south of France, Belgium, and Switzerland, an art eminently realistic, and by no means despicable, and he inferred from their art and implements and the associated animals that they may be represented at the present day by the Eskimos.

"On a Colorimetric Method of Determining Iron in Waters," by Mr. THOMAS CARNELLEY, B.Sc. Communicated by Professor H. E. ROSCOE, F.R.S.

Of late years the analysis of water has become of such importance that any improvement in the methods employed in that analysis will, it is thought, be acceptable, however small such improvement may be; and it is with this consideration that the following paper is submitted to the Society.

In the determination of heavy metals in water, with the exception of lead, great inconvenience arises from the want of rapid and accurate methods of estimating very small quantities, and it is to remedy this inconvenience in the case of iron that the following method is proposed. Besides accuracy it fulfils both the other requisites, viz. rapidity and the power of determining exceedingly small quantities; for without any evaporation 1 part of iron in 13,000,000 parts of water can be detected and a determination made in less than fifteen minutes; the smallest amount of ammonia which can be detected by the well known Nessler test, without contraction, being only 1 part of ammonia in 20,000,000 parts of water; and moreover, as water will admit of evaporation without loss of any iron it may contain, the iron which can be estimated may be reduced to almost an infinitely small quantity.

The method consists in the comparison of the blue colours produced by adding to a solution of potassium ferrocyanide, first, a solution of iron of known strength, and secondly, the water in which the iron is to be determined.

The standard solutions and materials required are as follows:—

(1) *Standard Iron Solution.*—This is prepared by weighing out 0·7 grms. of ammonio-ferrous sulphate (= 0.1 grm. Fe), dissolving the water and adding 1cc. of the sulphuric acid; the iron is next oxidised by adding an exact sufficiency of the potassium permanganate solution from a burette and the whole diluted to 1 litre. Of this solution 1cc. =0·0001grm. Fe.

(2) *Solution of Potassium Permanganate.*—This must be moderately dilute, but it is not necessary that it should be of standard strength.

(3) *Standard Nitric Acid*—is prepared by diluting 50cc. of pure strong nitric acid to one litre.

(4) *Potassium Ferrocyanide Solution*—is obtained by dissolving 1 part of the salt in 25 parts of water.

(5) *Strong Sulphuric Acid* — diluted with an equal volume of water.

(6) *Two similar Glass Cylinders and a Glass Rod.*—The former should hold rather more than 200cc. each, the point equivalent to that measure being marked on the glass.

(7) *A Burette*—marked to $\frac{1}{10}$cc. for the iron solution and an ordinary burette for the permanganate.

(8) *Three one cubic centimetre pipettes*—for the ferrocyanide, nitric acid, and sulphuric acid respectively, the one for the last being marked also to deliver $\frac{1}{2}$cc.

The following is the method of analysis employed:—

A measured quantity of the water less than one litre in bulk is taken, the amount being regulated according to the quantity of iron contained in the water, which is judged by a previously made qualitative experiment of adding 1cc. of the ferrocyanide to a portion of the oxidised water. One cubic centimetre of the sulphuric acid is added and then the permanganate from a burette till a permanent faint pink colour is obtained; the whole is made up to one litre, when it forms what may be called the "water test solution." Into each of the cylinders 1cc. of the potassium ferrocyanide is added and then a measured quantity of the water test solution put into one of them (x), both are next filled with water up to the mark and 1cc. of the standard nitric acid added to each. After (x) has been well stirred the standard iron solution is gradully run into (y), the liquid being stirred after each addition, and the colours in the two cylinders compared by placing them side by side over a sheet of white paper in front of a window; this is repeated till the colours in each of the cylinders appear to be equal, which point completes the operation.

Every cubic centimetre of iron solution used corresponds to 0·1 mgrm. of iron, from which the amount of iron added to cylinder (y) can be calculated. Then assuming that equal shades of colour are, *ceteris paribus*, produced by equal weights of iron, the amount of the latter in cylinder (x) is equal to that added to (y), and since the volume of the original sample of water in the test solution is known, and also the volume of the latter put into (x), the amount of iron in a measured quantity of water can therefore be calculated. The volume of the test solution put into cylinder (x) should be such as not to require more than 5cc. of the iron solution to be added to (y) to produce an equal shade, for if more be added the colour obtained would be too dark to compare with ease and accuracy.

If the sample of water contains such a small amount of iron as, after oxidation, not to give a coloration directly with the ferrocyanide and nitric acid, a sufficient quantity of it must be evaporated with ½ a cubic centimetre of the sulphuric acid till it occupies from 100 to 200cc. The liquid is then poured into a flask, together with the rinsings, and oxidised with permanganate to a very slight excess, and then filtered so as to separate any precipitate, and also to destroy the excess of permanganate. The fluid thus obtained is next tested as before by adding the whole or a known part of it to one of the cylinders containing the ferrocyanide. When the water after being filtered has still a cloudy appearance, as is the case with sewage and polluted rivers, &c., a known quantity of the filtered water must be evaporated to dryness and ignited, the residue dissolved in a small quantity of hydrochloric acid and filtered, washed with water, and the free acid in the filtrate as nearly as possible neutralized with ammonia and then 1cc. of sulphuric acid, after which oxidised with permanganate, then filtered, if requisite, to destroy excess of permanganate, and the iron estimated as before. A green colour may be sometimes obtained instead of the pure blue; this is owing to a slight quantity of unreduced permanganate being present; this, however, is of no consequence, as with a little practice the green tint may be compared with the blue and correct results obtained; still the comparison may be rendered easier by adding 1 to 2 drops of permanganate to the cylinder to which the standard iron is run, and which by this means will also assume a green tint. Experiments were made with reference to this point and it was found that the presence of not more than a few drops of unreduced permanganate has little or no effect on the results obtained, the only consequence being the change of tint but not of depth of colour.

Potassium permanganate is employed as the oxidiser instead of the nitric acid, because (1) The oxidation is performed much quicker than it would be if nitric acid were used, and in the latter case the liquid would have to be heated. (2) It can be added to exactly the right point, which could not easily be done with nitric acid. (3) An excess of the latter is very detrimental to the accuracy of the method, for, from experiments made in relation to this point, it was found that when the amount of free acid present in 200cc. was more than 0·0025cc. of the strong acid, it renders the colour deeper than it otherwise would be.

One cubic centimetre of the standard nitric acid is added to each of the cylinders, because (1) It renders the reaction much more delicate. (2) Because the colours produced in the presence of this amount of free acid are almost always of the same tint, being of a pure blue, whilst when no free acid is present the colour varies, even when apparently of the same depth, from a blue to a bluish green, which renders them less easy to compare. (3) Because it destroys the effect which the presence of a small quantity of any free acid, previously existing in the liquid, might have in altering the shade of colour produced, for from a series of experiments made with reference to this point also, it was found that when the amount of free acid present, in addition to the 1cc. of standard nitric acid added is only small, *i.e* less than 0·05cc. of the strong acid in 200cc. of water, it has no effect on the depth of colour produced. When any free acid exists in the water to be examined it must, before being oxidised, be made as nearly neutral as possible with ammonia, and the iron then determined.

The following are some of the results obtained on detertermining the iron in solutions of known strength :—

Iron Found. Milligrams.		Iron Calculated. Milligrams.
17·99	....	19·48
4·20	....	4·14
1·80	....	1·86
·61	......with salts (C) present......	·57
·51	....	·52
·40	....	·41
·40	... with KNO_3 (D) present ...	·40
·33	....	·30
·28	....	·31
·23	......with salts (B) present......	·22
·20	....	·21
·14	....	·16
·12	....	·10
·070	....	·078
·025	....	·031

In order also to test the effect which the presence of different salts has on this method, four series of experiments were made by adding known weights of the following salts to 1 litre of the ammonio-ferrous sulphate solution :

(A) Calcium sulphate, magnesium sulphate, ammonium chloride, sodium chloride, and potassium carbonate, in all 1·6 grm.

(B) Ditto, in all 0·9 grm.

(C) Magnesium sulphate, ammonium chloride, potassium carbonate, sodium chloride, and calcium chloride, in all 0·8 grm.

(D) Potassium nitrate 0·4 grm.

The solutions thus obtained were oxidised with permanganate and sulphuric acid diluted to one litre, and the iron estimated as previously described. The results obtained are given below, the letters attached denoting to which of the preceding series they severally belong, and from them it will be seen that the presence of these salts has little or no effect.

It was also found that neutral organic matter is not detrimental to the method.

With reference to the delicacy of the method it was found as a mean of seven experiments that 0·0055 mgrms. of iron give a very distinct colour on the surface, and that 0·015 mgrms. give a blue colour on being stirred with 200cc. of water, and therefore that 1 part of iron produces a blue coloration in 13,000,000 parts of water containing ferrocyanide of potassium and nitric acid. According to Hartig,* however, 1 part of iron (in the form of sulphate) only produces a colour in 600,000 parts of water containing ferrocyanide. The difference of these results is due to the effect which the presence of the small quantity of free nitric acid, added in the new method, has in increasing the delicacy of the reaction.

As to the smallest differences of reading which can be detected, it was found that when any quantity of iron solution below 1cc. had been added, a difference of 0·05cc. can be discriminated; above 1 and below 2cc. a difference of 0·1cc.; above 2 and below 4cc. a difference of 0·2cc.; and above 4 and below 5cc. a difference of 0·3cc.

* Jour. Pr. Chem. 22. 51.

The following are a few samples of different waters in which the iron has been determined as described above:

PARTS PER 1,000,000.

Date, 1874.	Name of Water.	Amount used in Analysis	By new method	By $KMnO_4$	As found by other Observers.
Feb. 14	Manchest. Water Supply	5 litres	·21		·287, R. A. Smith, 1864.
Mar. 20	,, ,,	1 ,,	·18		
——	,, ,,	2 ,,	·175		
July 15	,, ,,	1 ,,	·10		
——	,, ,,	1 ,,	·11		
Aug. 31	,, ,,	1 ,,	·27		
Sept. 1	,, ,,	1 ,,	·18		
,, 2	,, ,,	1 ,,	·26		
——	,, ,,	1 ,,	·27		
Sept. 3	,, ,,	½ ,,	·30		
——	,, ,,	1 ,,	·32		
Sept. 4	,, ,,	½ ,,	·38		
——	,, ,,	1 ,,	·36		
Sept. 5	,, ,,	½ ,,	·42		
——	,, ,,	1 ,,	·41		
Feb. 19	Medicinal Spring Trefriew, North Wales	30. cc	1600·00	1575·50*	
Feb. —	Chloride of Iron Spa, Harrogate	50. cc	290·00	290·34	289·40 H. Davies, Feb., 1872.
Feb. 16	R. Irwell nr. Pomona Gardens	¾ litre	·86		
Feb. 18	R. Mersey, Northenden	1½ ,,	·48		
Feb. 23	R. Dane, above Cong'ton	1 ,,	·57		
——	,, below ,,	¾ ,,	·44		
——	Liverpl. Water Works, Compensa. Water, White Cop'ce Heapy	2 ,,	·42		
Jan. 3	Barnsley Water Supply	2½ ,,	·25		
Feb. —	R. Thames, Lon. Bridge	1 ,,	·19		
Jan. 3	Cockerhm Well, Barnsl'y	2 ,,	·075		
Feb. —	New River Company ..	1 ,,	·050		Trace } Graham, Miller and Hofmann.
——	Lambeth ,, ..	1 ,,	·044		12·1 (Al_2O_3 & Fe_2O_3)
——	East London ,, ..	1 ,,	·038		6·8 (,, ,,)
Jan. 3	Friars' Well, Barnsley..	1¾ ,,	·005		

* The author hopes shortly to bring an analysis of this water before the Society.

ERRATA.

In the last number of the Proceedings, page 6, line 8, for "Odontogigram" read Odontogram.

Line 17, for "indentification" read identification.

Ordinary Meeting, November 3rd, 1874.

Rev. WM. GASKELL, M.A., Vice-President, in the Chair.

Mr. William Carleton Williams, F.C.S.; Mr. Harry Grimshaw, F.C.S.; and Mr. William E. A. Axon, M.R.S.L., F.S.I., were elected Ordinary Members of the Society.

"On the Corrosion of Leaden Hot-water Cisterns," by Professor H. E. ROSCOE, F.R.S., &c.

As the question of the occurrence of lead in town's water has been brought forward in the daily papers, I think it right (whilst stating my experience of many years' duration to be that the Manchester Corporation water when cold does not take up lead from the pipes under ordinary circumstances) to guard persons from using for drinking purposes water drawn from hot-water cisterns made of lead.

My friend, Mr. Melland, Surgeon, of Rusholme, handed to me a white powder taken from the inside of the covering of his leaden hot-water cistern, which presented a honeycombed surface, and in many places stalactitic masses hung down which were from $\frac{1}{4}$ to $\frac{1}{3}$ of an inch in length.

This powder consisted of a hydrocarbonate of lead, giving the following results on analysis :

Lead Oxide (PbO)	85·67
Carbonic Acid (CO_2)	12·12
Water (H_2O)	2·21
	100·00

It was doubtless formed by the solvent action of the condensed water containing oxygen upon the metal and the subsequent formation of the insoluble hydrocarbonate, and there can be little doubt that water drawn from such a cistern would be contaminated with lead.

"On an Improvement of the Bunsen Burner for Spectrum Analysis," by Mr. F. Kingdon, Assistant in the Physical Laboratory, Owens College.

The students in the Physical Laboratory of Owens College having occasionally experienced some difficulty in obtaining the spectra of some salts with the ordinary bunsen, through apparently a deficiency of pressure in the gas, it occurred to me that the amount of light even at this deficient temperature might be increased by multiplying the number of luminous points. This is accomplished by broadening out the flame of the bunsen, that is, causing the gas to issue through a narrow slit instead of a round hole. We have, so far, only made a rough experiment, the slit being about $\frac{7}{8}$in. long and $\frac{1}{8}$in. wide. The result is, as expected, a more brilliant spectrum.

"Some Notes on Pasigraphy," by Henry H. Howorth, Esq., F.S.A.

Among the Utopian schemes which have interested others beside paradoxers and dreamers none has perhaps been more plausibly urged than the scheme of an universal language which should enable men to communicate with one another who are now inevitably sundered.

During the time of the Roman dominion it may have been hoped that Latin, which was its universal language, and in being so was also the language used by all those who in its point of view were not mere barbarians, would become in the future, as it was at the time, the universal language; be to the world what Hindustani is to the inhabitants of Northern India with their great variety of dialects, namely the common language of all. On the break up of the Roman Empire the Latin which was spoken so universally within its borders began to decay, and decayed differently in different localities, so that in a few centuries each fragment of the empire had developed a peculiar tongue of its own, to a large extent unintelligible to its neighbours. Latin had then ceased to exist except as a dead and artificial language. It was no longer *the* universal language. But it still remained the universal language of divinity, of philosophy, and in fact of the narrow arcana of the sciences studied during mediæval times; it remained the learned language in which cultured people could and did communicate. At the Reformation this began to alter; culture ceased to be the peculiar heritage of the Romance peoples, and the so-called barbarians beyond the Rhine began to elbow their way into the arena of science, literature, and art, and gradually to acquire a peculiar vantage in all three. These barbarians spoke a language whose pedigree was not rooted in Latin. Latin to them was a foreign tongue, not as it was to Frenchmen and Italians, their grandmother-language, if I may coin the phrase. For a while its difficulties were eagerly mastered by the most patient race of students that ever lived; and like the rest of Europe for a while the Germans used Latin in their various learned compositions; but it was gradually disused. More and more valuable matter was published in the vernacular, and this was imitated rapidly elsewhere, so that the Latin language ceased to be a practical means of communication, and the Babel of tongues replaced the one uniform medium of intercourse. There can be no doubt that this was a serious loss. There are some people who value the mere knowledge of a language for its own sake, and acquire with equal delight and ease two or three languages. To others the difficulty is as great as is the grievance, and among the latter class are numbered many who value a language not for itself, who look upon the knowledge of several languages as a mere feat of memory in which one knows several names for each idea instead of one, and only value the knowledge of a language in so far as it gives them a key to the knowledge which is buried under it. This class was no doubt aggrieved by having to learn French and German in order to be even with the latest discoveries. But to learn German and French was at least possible to a studious man. As time went on, however, other races besides the German and Romance speaking folk began to have a valuable literature. Russians, Bohemians, Hungarians, Scandinavians, *et id genus omne.* More lately still, a vast revival is on the point of breaking out again in the further east, and we may expect that Hindus and Chinese will be aspirants for at least a place in the great threshing mill where science and literature thresh their harvests. It is clearly appalling to give an outlook into the future and to contemplate the time when each man must be a Mezzofanti in order to prepare himself for literary or scientific work. Nor is this a mere chimæra. The Russians, who are very diligent students, are yearly giving up their old practice of composing in French and German, and will write only in their own difficult tongue; and perhaps I feel my toes especially pinched, inasmuch as they are working in mines where the ore I chiefly value is found, namely those relating to Eastern Ethnography. This frightful difficulty is naturally of interest to others besides dreamers, and it has often been suggested that all should agree once more to write in some language which, though artificial to most of its students, should yet enable all to communicate with one another.. But this seems at present hopeless. English, from its wide extension, from the enormous number of individuals in Europe, America, and Australia who speak it, and from the general familiarity of most students with it, might promise such an end, but the Russians point to their future no less proudly than we to our present, and the mutual jealousies of nations make it impossible that any living language should be thus used, while the dead languages, perfect as they are for polish and rhetorical excellencies, are deficient both in plasticity and vocabulary when it is attempted to employ them to meet the various requirements of our complicated scientific and other nomenclature.

Difference of language, although the greatest, is not the only bar to communication. Another lesser but still very appreciable difficulty is the variety of characters and alphabets in use in various parts of the world. Thus in Europe alone we have, beside the ordinary Italian characters, the German, Greek, and Cyrillic or Russian; and if we go further east, among those languages where the so-called tones prevail, or where gutturals of different kinds are in use, and where our limited alphabet becomes almost useless, we have a large number of peculiar alphabets, each one an irritating barrier to free intercourse with the language.

In the presence of these various difficulties it has been thought by some that a scheme might be devised by which communication might be carried on independently of language; that by a system of ideographs instead of words we might invent a conventional formulary, by means of which the common ideas of men might have a common representation; that we might do, in fact, what was done in the earliest period of writing, what the Chinese, the Mexicans, the Egyptians, and the Akkadians of Mesopotamia did, namely, use characters which should represent ideas and not words or sounds. It is well known that this is still the case in China; that many people can read Chinese books who know nothing or very little of the Chinese language. The Japanese, for instance, whose language is entirely different, are taught in their schools to read Chinese books without being taught the Chinese language. Such a system, if universally accepted, would be well described by the term pasigraphy. It is such a system which has been developed with great sacrifice and patience by a German savant called M. Bachmaier, and which I wish to bring before you to-night. Without expressing any opinion as to its utility, there can be no doubt as to its being quite practicable and easy to learn; and my friend Dr. Birch, of the British Museum, has told me that he has used it with ease in correspondence.

The systems of picture writing above-named are all more or less cumbrous and difficult of application, because they employ an immense number of signs. Even the Chinese, which is the most satisfactory of these systems, and has by an ingenious system of combination reduced its simple forms to about 300, is very cumbrous. The system which I now introduce to you is much simpler, in that there are only 10 simple signs, namely the 10 first numbers, from the combination of which any vocabulary of any length can be represented, while it is an easy matter by a few simple marks to represent grammatical forms, and thus enable us to put down actual phrases and sentences, and not merely so many crude and substantive ideas which it requires an effort of the mind to combine into either sentences or logical propositions.

The principle of the plan is this:—A dictionary is prepared of each language: this may be of any length. In the scheme of M. Bachmaier 4,334 words have been chosen, by means of which an interchange of ideas on nearly any subject can be carried on. The words in these dictionaries each have a number attached to them, beginning with 1 and ending with 4,334. These numbers correspond to exactly the same words in each language; thus, if heart have the number 26 attached to it in English, 26 will be attached to cœur in the French, and to herz in the German dictionary, etc. etc. Each number thus becomes, therefore, an ideograph, and represents one idea to those who speak a variety of languages. Instead of communicating by words, therefore, we here have a simple, easy, conventionalism, by which we communicate by signs; a code of signals, in fact, which mean the same thing to all those who can read them.

These dictionaries, again, are twofold; in the one part we can find the word we need and its corresponding number.

This is the part used by the writer or the person making the communication. In the other part the numbers are ranged in order with their meanings attached, so that if one gets a communication consisting of a series of ideographic numbers, one has only to turn to this part of the dictionary to find a key to each. In corresponding, therefore, with a China man, 2 dictionaries would be needed, one an English dictionary would enable the person in England to find the ideographs answering to the words or ideas he wishes to communicate; the other a Chinese dictionary, in which these same ideographs could be read off into Chinese by a China man. This without the labour of acquiring a knowledge of Chinese characters, etc. etc.

So far we have rivalled the more ancient systems of ideography in completeness and have much simplified them. It next becomes clear that we may by very slight marks about our figures qualify the ideas so as to convey what is otherwise conveyed by the grammatical structure of language, by inflection, etc.

Dr. Bachmaier has drawn up a list of such signs which may be easily applied, thus; masculine or feminine are denoted by a slight mark above or below the first digit of the figure, as—$\bar{1}26$ masculine, $\underline{1}26$ feminine; the plural is denoted by a mark extending entirely beneath the number, as—$\underline{126}$; a substantive is denoted by an accent, thus—$\acute{1}26$; an adjective by another kind of accent, thus—$\hat{1}26$; a verb by a wavy line, as—$\widetilde{126}$; the past tense by a line through the figures 126, and the future by one above them, as—$\overline{126}$; the comparative and superlative degrees by dots, as—$1\dot{2}6$ comparative, $1\overset{:}{2}6$ superlative. Cases, by adding the numbers representing the prepositions that qualify the particular case, and so on. One or two rules to govern the position of the verb and of the adjective in the sentence and all is learnt that is required to enable us to communicate. The rapidity with which it can be done is a matter of practice, and for purposes of correspondence, of telegraphy, and of short communications, it seems difficult to find an objection to its use. It has been tested, as I said, by Dr. Birch and others, and by them found to answer admirably, and if by its means the problem be eventually solved by which the vast gulf may be bridged which now separates those thinkers who do not know each other's language, a very great gain will have been secured. Its inventor, at least, is hopeful enough, and has, I believe, in preparation a series of dictionaries in several languages; of these I exhibit three which were distributed at the late Oriental Congress, viz., the English, French, and German ones.

"On the Existence of a Lunar Atmosphere," by DAVID WINSTANLEY, Esq.

The non-existence of a lunar atmosphere is spoken of by many astronomical writers as confidently as if it were a demonstrated fact. It is certain, however, that it is not a demonstrated fact, and it is certain also that if a fact at all it is undemonstrable.

The failure of any optical test, however delicate, to detect the existence of such an atmosphere still leaves another alternative open to us than the inference of atmospheric non-existence, namely, the existence of an atmosphere in quantity below the minimum discernible by the means employed.

The non-existence of an atmosphere about the moon comparable in density with that which surrounds the earth may indeed be regarded as an established fact; but the total non-existence of such an atmosphere is certainly an unwarranted conclusion.

I shall endeavour to show presently that the refraction of a ray of light is not the most delicate test which can be employed for the determination of the point in question. But even this test has yielded indications which astronomers of note have construed into evidence of a lunar atmosphere of considerable attenuation. Arago, for instance, has observed on more than one occasion the apparent adhesion of a star for three or four seconds to the dark limb of the moon after it had been perceived to be in contact with it, and he has also observed a very sensible diminution of brightness previous to immersion.

From the distortion of the visible segment of the solar disc observed by Euler during the eclipse of 1748, Du Sejour, after making corrections for the effects of irradiation, arrived at the conclusion that the moon possesses an atmosphere having a horizontal refraction of 1.5″, and which is therefore 1,400 times more rare than common atmospheric air upon the surface of the earth.

A phenomenon similar in kind to the twilight of the earth has been recognised by Shroeter, in the form of a faint crepuscular light extending from each of the lunar cusps along the circumference of the unenlightened portion of her disc, from which he has been enabled to deduce the existence of an atmospheric envelope about our satellite capable at an elevation of 5,000 feet above her surface of causing a sensible inflexion of the light proceeding from a celestial body. But as the moon would describe an arc representing this amount in less than two seconds of time, "the circumstance has been adduced as affording a sufficient explanation of the difficulty of detecting a lunar atmosphere in the phenomena of occultations."

Chromatic dispersion is the test which in certain circumstances at any rate seems to offer better opportunities for ascertaining positively the existence of a lunar atmosphere than the test of simple refraction. It would cause the colour of an occulted object to change, making it green, and finally blue at the instant of disappearance.

The direct telescopic observation, by which alone this appearance could be noticed, would, from the operation of circumstances upon which I need not dwell, probably lead only to results of uncertainty. At the same time it is but proper to remark that appearances have been observed at eclipses of the sun suggestive of this phenomenon, and which have been interpreted by Flamsteed as indicating the existence of a lunar atmosphere. The particular circumstances in which, as I take it, chromatic dispersion may afford weighty evidence of the existence of a lunar atmosphere occur when the body occulted by the moon is one of considerable angular magnitude and great intrinsic splendour. Then it is manifest that the chromatic dispersion effected by such an atmosphere would cause the projections of prismatic bands upon the earth, forming as it were an iris on the borders of the shadow, and bathing the landscape and the clouds in all the rainbow hues. These circumstances it will be seen exist during the totality of a solar eclipse, and the rainbow hues bathing alike the landscape and the sky, which I have indicated as the inevitable consequences of chromatic dispersion by a lunar atmosphere, would seem to be almost constant accompaniments of such eclipses. "As early as the year 840 it was remarked that during the total eclipse of the sun which happened in that year the colours of objects on the earth were changed." "Kepler mentions that during the eclipse which occurred in the Autumn of 1590 the reapers in Styria noticed that everything had a yellow tinge," whilst during that which took place in 1706 objects were observed to change their colour, now appearing of an orange yellow, and now of a reddish tinge.

The illustrious Edmund Halley remarked that the face and colour of the sky were changed during the eclipse observed by him in 1715. "The serene azure of the sky," he says, "turned to a more dusky livid colour, intermingled with a tinge of purple, and grew darker and darker until the total immersion of the sun." Sir John Clarke, in his account of the eclipse of 1737, states that "the ground was covered with a dark greenish colour," whilst in the eclipse of 1842 "it was *universally* remarked that the colours of terrestrial objects were changed." Mr. Hind says that after the totality had commenced "the southern heavens were of a uniform and purple grey." "In the zenith and north of it the heavens were of a purplish violet, while in the north-west and north-east broad bands of yellowish crimson light, intensely bright, produced an effect which no person who witnessed it can forget." "The crimson," he says, appeared to run over large portions of the sky, *irrespective of the clouds*," a circumstance certainly suggestive of a cause differing from that which gives rise to the hues of sunset." "All nature," continues Mr. Hind, "seemed to be overshadowed by an unnatural gloom; the distant hills were hardly visible; the sea turned lurid red, and persons standing near the observer had a pale and livid look." Not only did the colours "run over large portions of the sky, irrespective of the clouds," but they were visible at stations so remote from one another as to give additional assurance of an extra-terrestrial origin. The *distribution* of the colours observed by Mr. Hind at Rævelsberg is consistent with the theory of their production by the chromatic dispersion of a lunar atmosphere, whilst the *order of their succession*, as stated by Sig. Piola who observed in Italy, and the sudden *change* of colours noticed by Mr. Lowe, and which took place as the shadow swept along, afford confirmation of the theory.

It has been suggested by Mr. Lockyer that the colours projected upon the landscape during the continuance of a total solar eclipse may be those of various layers of the chromosphere alternately disclosed by that great screen the moon in its passage over the solar disc. Manifestly, however, the purity of some of the colours would be interfered with, assuming them to be produced in this manner, and the yellow which is so frequently seen would seem to be unaccounted for. It is not unlikely that further and special observations will be required to say of either of these theories that it may or may not be maintained.

In the meantime, considering that the non-existence of a lunar atmosphere is undemonstrated and undemonstrable, that it is in opposition to analogy, and that even simple refraction has given evidence of such an inconsiderable atmospheric envelope as we might at most expect a body of the moon's small mass to have, it certainly seems to me that the balance of probability lies in favour of the theory that the rainbow hues observed at total eclipses of the sun are really the results of chromatic dispersion effected by a lunar atmosphere.

Ordinary Meeting, November 17th, 1874.

EDWARD SCHUNCK, Ph.D., F.R.S., &c., President, in the Chair.

"Some Remarks on Dalton's First Table of Atomic Weights," by Professor HENRY E. ROSCOE, F.R.S.

As the Society is aware, the first table, containing the relative weights of the ultimate particles of gaseous and other bodies, was published as the 8th and last paragraph to a paper by Dalton, "On the Absorption of Gases by Water and other Liquids," read before this Society on October 21, 1803, but not printed until the year 1805. There appears reason to believe these numbers were obtained by Dalton after the date at which the paper was read, and that the paragraph in question was inserted at the time the paper was printed. The remarkable words with which he introduces this great principle give us but little clue to the methods which he employed for the determination of these first chemical constants, whilst in no subsequent publication, as in none of the papers which have come to light since his death, do we find any detailed explanation of how these actual numbers were arrived at. He says, * "I am nearly persuaded that the circumstance" (viz. that of the different solubilities of gases in water) "depends upon the weight and number of the ultimate particles of the several gases—those whose particles are lightest and single being less absorbable, and the others more, according as they increase in weight and complexity. An inquiry into the relative weights of the ultimate particles of bodies is a subject, so far as I know, entirely new. I have been lately prosecuting this enquiry with remarkable success. The principle cannot be entered upon in this paper; but I shall just subjoin the results, as far as they appear to be ascertained by my experiments."

* Manch. Mem., Vol. I., 2nd Series, p. 286.

Here follows the table of the relative weights of the atoms :—

TABLE

Of the relative weights of the ultimate particles of gaseous and other matters.

Hydrogen	1	Nitrous oxide	13·7
Azot	4·2	Sulphur	14·4
Carbone	4·3	Nitric acid	15·2
Ammonia	5·2	Sulphuretted hydrogen	15·4
Oxygen	5·5	Carbonic acid	15·3
Water	6·5	Alcohol	15·1
Phosphorus	7·2	Sulphureous acid	19·9
Phosphurretted hydrogen	8·2	Sulphuric acid	25·4
Nitrous gas	9·3	Carburetted hydrogen from stagnant water	6·3
Ether	9·6		
Gaseous oxide of carbone	9·8	Olefiant gas	5·3

In the 2nd part of his New System of Chemical Philosophy, published in 1810, Dalton points out under the description of each substance the experimental evidence upon which its composition is based, and explains, in some cases, how he arrived at the relative weights of the ultimate particles in question. Between the years 1805 and 1810, however, considerable changes had been made by Dalton in the numbers; the table found in the first part of the New System being not only much more extended, but in many cases the numbers differing altogether from those given in the first table published in 1805. It is therefore, unfortunately, to a considerable extent now a matter of conjecture how Dalton arrived at the first set of numbers. All we know is that it was mainly by the consideration of the composition of certain simple gaseous compounds of the elements that he arrived at his conclusions, and in order that we may form some idea of the data he employed we must make use of the knowledge which chemists at that time (1803–5) possessed concerning the composition of the more simple compound gases.

As I can find no record of any explanation of these early numbers I venture to bring the following attempt to trace their origin before the Society to whom we owe their first publication.

The first point to ascertain, if possible, is how Dalton arrived at the relation between the atomic weights of hydrogen and oxygen given in the table as 1 to 5·5 (but altered to 7 in 1808). The composition of water by weight had been ascertained by the experiments of Cavendish and Lavoisier to be represented by the numbers 15 of hydrogen to 85 of oxygen, and the result was generally accepted by chemists at the time, amongst others doubtless by Dalton. That in those early days Dalton had actually repeated or confirmed these experiments appears improbable. At any rate he formed the opinion that water was what he called a binary compound, *i.e.*, that it is made up of one atom of oxygen and one atom of hydrogen combined together. Hence if he took the numbers 85 to 15 as giving the composition of water, the relation of Hydrogen=1 to Oxygen would be as 1 to 5·6, or nearly that which he adopted. It does not appear possible to explain why Dalton adopted 5·5 instead of 5·6 for oxygen; it may perhaps have been a mistake or a misprint, as there are two evident mistakes in the table, viz., 13·7 for nitrous oxide instead of 13·9, and 9·3 for nitrous gas instead of 9·7.

Let us next endeavour to ascertain how he obtained the number 4·3 for carbon (altered to 5 in 1808 and 5·4 later on). Lavoisier, in the autumn of 1783, had ascertained the composition of carbonic acid gas by heating a given weight of carbon with oxide of lead, and he came to the conclusion that the gas contained 28 parts by weight of carbon to 72 parts by weight of oxygen. Now Dalton was not only acquainted with the properties and composition of carbonic acid, but he was aware that Cruikshank had shown in 1800 that the only other known compound of carbon and oxygen, carbonic oxide gas, yields its own bulk of carbonic acid when mixed with oxygen and burnt; and also that Desormes* analysed both these gases, finding carbonic oxide to contain 44 of carbon to 56 of oxygen, whilst carbonic

* Ann de Chimie, T. 39, p. 38.

acid contained to 44 of carbon 112 of oxygen, being just double of that in the carbonic oxide. Dalton adds, "this most striking circumstance seems to have wholly escaped their notice." Hence Dalton assumed that one atom of carbon is united in the case of carbonic oxide with one atom of oxygen, whilst carbonic acid possessed the more complicated composition and contains two atoms of oxygen to one of carbon. Now if carbonic acid contains carbon and oxygen in the proportion of 28 to 72, carbonic oxide must contain half as much oxygen, viz., 28 of carbon to 36 of oxygen, and assuming that the atomic weight of oxygen is 5·5 that of carbon must be $\frac{28 \times 5 \cdot 5}{36} = 4 \cdot 3$. Having thus arrived at the number 4·3 as the first atomic weight of carbon, it is easy to see why Dalton gave 6·3 as the atomic weight of carburetted hydrogen from stagnant water, and 5·3 as that of olefiant gas. The one represents 1 atom of carbon to 2 of hydrogen, the other 1 of carbon to 1 of hydrogen, or olefiant gas contains two equal quantities of carbon, only half as much hydrogen as marsh gas. This conclusion doubtless expressed the results of Dalton's own experiments upon these two gases which were made, as we know from himself, in the year 1804. He proved that neither of these gases contains anything besides carbon and hydrogen, and ascertained—by exploding with oxygen in a Volta's Eudiometer—that if we reckon the carbon in each the same, then carburetted hydrogen contains exactly twice as much hydrogen as olefiant gas does, and that "just half of the oxygen expended on its combustion was applied to the hydrogen and the other half to the charcoal. This leading fact afforded a clue to its constitution." Whereas, in the case of olefiant gas, two parts of oxygen are spent upon the charcoal and one part upon the hydrogen.

The atomic weight of nitrogen (azote = 4·2) was doubtless obtained from the consideration of the composition of ammonia, whose atomic weight is given in the table at 5·2.

Ammonia was discovered in 1774 by Priestley, but the composition was ascertained by Berthollet in 1775, by splitting it into its constituent elements by means of electricity, when he came to the conclusion that it contained 0·193 parts by weight of hydrogen to 0·807 parts by weight of nitrogen. Dalton assumed that this substance is a compound of one atom of hydrogen with one of nitrogen, and hence he obtained for the atomic weight of azote $\frac{807 \times 1}{193} = 4{\cdot}2$; and $4{\cdot}2 + 1 = 5{\cdot}2$ as the atomic weight of ammonia. It is also probable that Dalton made use of the composition of the oxides of nitrogen for the purpose of obtaining the atomic weight of nitrogen. If we take the numbers obtained partly by Davy and partly by himself, as given on page 318 of the New System, as representing the composition of the three lowest oxides, it appears that the mean value for nitrogen is 4·3 when oxygen is taken as 5·5. In all probability the number in this table (4·2) was obtained from an experiment of Dalton's made at an earlier date.

It is not possible to ascertain the exact grounds upon which Dalton gave the number 7·2 for phosphorus; its juxtaposition, however, in the table to phosphuretted hydrogen shows that it was probably an analysis or a density determination of this gas which led him to the atomic weight 7·2, under the supposition that this gas (like ammonia) consisted of one atom of each of its components. In the second table, published in 1808, Dalton gives the number 9 as that of the relative weight of the phosphorus atom, and we are able to trace the origin of this latter number, although that of 7·2 is lost to us. On p. 460, Part II. of his New System, Dalton states that he found 100 cubic inches of phosphuretted hydrogen to weigh 26 grains, the same bulk of hydrogen weighing 2·5 grains; hence, assuming that equal volumes contain an equal number of atoms, we have: $\frac{26 - 2{\cdot}5}{2{\cdot}5} = 9{\cdot}4$ gives the atomic weight of phosphorus nearly. It was probably by similar reasoning from a still more inaccurate experiment than this one that he obtained the number 7·2.

Sulphur, which stands in the first table of 1803 at 14·4, was altered in the list published in the New System to 13. These numbers were derived from a consideration (1) of the composition of sulphuretted hydrogen, which he regarded as a compound of one atom of sulphur with one of hydrogen, and (2) of that of sulphurous acid, which he supposed to contain one atom of sulphur to two of oxygen. Dalton knew that the first of these compounds contained its own volume of hydrogen, and he determined its specific gravity, so that by deducting from the weight of one volume of the gas that of one volume of hydrogen he would obtain the weight of the atom of sulphur compared to hydrogen as the unit. The specific gravity he obtained was about 1·23 (corresponding nearly he says—p. 451—to Thenard's number 1·23); hence (as he believed air to be 12 times as heavy as hydrogen) he would obtain the atomic weight of sulphur as $(12 \times 1{\cdot}23) - 1 = 13{\cdot}76$, which number, standing half way between 14·4 as given in the first table and 13 as given in the second, points out the origin of the first relative weight of the ultimate particle of sulphur. So from sulphurous acid he would obtain a similar number, taking the specific gravity as obtained by him (Part II. 389) to be 2·3, and remembering that this gas contains its own bulk of oxygen (p. 391), he obtained $(2{\cdot}3 - 1{\cdot}12) \times 12 = 14{\cdot}16$ for the atomic weight of sulphur. As however we do not possess the exact numbers of his specific gravity determinations, and as we do not exactly know what number he took at the time as representing the relations between the densities of air and hydrogen (in 1803 he says that the relation of $1 : 0{\cdot}077$ is not correct, and that $\frac{1}{20}$ is nearer the truth), it is impossible to obtain the exact numbers for sulphur as given in the first table.

In reviewing the experimental basis upon which Dalton founded his conclusions, we cannot but be struck with the clearness of perception of truth which enabled him to argue correctly from inexact experiments. In the notable case, indeed, in which Dalton announces the first instance of combination in multiple proportion (Manch. Mem., vol. 1, series 2, page 250) the whole conclusion is based upon an erroneous experimental basis. If we repeat the experiment as described by Dalton we do not obtain the results he arrived at. Oxygen cannot as a fact be made to combine with nitric oxide in the proportions of one to two by merely varying the shape of the containing vessel, although by other means we can now effect these two acts of combination. We see, therefore, that Dalton's conclusions were correct, although in this case it appears to have been a mere chance that his experimental results rendered such a conclusion possible.

"Action of Light on certain Vanadium Compounds," by Mr. James Gibbons. Communicated by Professor H. E. Roscoe, F.R.S.

Potassium divanadate, in combination with organic matter, is first rendered green, and ultimately blue, by exposure to light, being reduced probably to the state of vanadium tetroxide. The salt is not sensitive to light in the absence of organic matter.

Gelatine, mixed with potassium divanadate, becomes slightly less soluble in warm water after being exposed to light; this is apparent by the unexposed portions of the film swelling and dissolving more quickly when treated with water than the exposed parts.

If a colourless film of dry sodium orthovanadate (Na_3VO_4), free from organic matter, be exposed on glass to the sun for several hours, it only acquires a faint brown tint. The film kept in the dark, with access of air for some hours, regains its normal colourless condition. The salt does not undergo any change when exposed to diffused daylight.

Paper, which does not contain any size of an animal origin, when coated with a solution of sodium orthovanadate, is darkened on exposure to light, the depth of tint depending on the length of exposure and on the strength of the solution used. The tint, however, never becomes darker than a slate colour.

If the paper thus prepared be immersed, after exposure to light, in a solution of silver nitrate, the colour in the exposed part instantly changes to a deep brown or to a black colour, varying according to the amount of exposure. A tint of the decomposed vanadate, which is of so slight an amount as to be with difficulty distinguished from the whiteness of the paper, will, by immersion in the silver nitrate, be toned so as to exhibit a very perceptible tint.

It is evident that paper prepared in this way might be employed for the purposes of photographic printing.

The unexposed parts are converted, by treatment in the silver bath, into yellow silver vanadate. This substance may be dissolved out either by ammonia or by sodium hyposulphite. This act of fixing converts the dark brown or black part into those of a red colour. This may be prevented to some extent by using a bath of ammonio-silver nitrate, with an excess of ammonia, instead of the simple silver nitrate bath. The developed print can afterwards be toned with gold chloride.

The length of exposure required to produce a deep black is about one hour to a strong sun light. This by using a solution of the sodium orthovanadate containing about 11 per cent of the salt.

Some ligneous substance only must be present with the sodium orthovanadate for the production of the above-mentioned slaty tint; for if an albuminous body be present, a faint brown tint is produced after exposure to light, and the silver nitrate is not afterwards reduced to any very great extent. The slate colour of the reduced salt appears to be due to the formation of vanadium trioxide. If the exposed paper be kept for some weeks its colour changes to that of a yellowish brown, free vanadic acid appearing to be produced.

Gelatine impregnated with sodium orthovanadate exposed to light, and afterwards dipped into a solution of silver nitrate, becomes insoluble in hot water.

Silver orthovanadate is capable of forming a photographic image, which is nearly latent, and which may be developed by the ordinary ferrous developer used in photography.

To produce this image two or three minutes' exposure to sunlight is required. To develope it, it is essential that little or no silver nitrate be present; otherwise, the exposed and unexposed parts are reduced indiscriminately. The washed silver vanadate can be mixed with a solution of gelatine containing a little albumen, spread upon paper, and allowed to dry; it can then be exposed to light, and afterwards developed.

"On Basic Calcium Chloride," by HARRY GRIMSHAW, F.C.S.

When a strong solution of calcium chloride is boiled with calcium hydrate, the solution filtered, and allowed to cool, a salt separates out in long, slender, needle-shaped crystals. This salt is called in Gmelin's Handbook, hydrated chloride of calcium and lime, or hydrated tetra-hydrochlorate of lime, and, according to him, has been noticed by Bucholtz and Trommsdorf and by Berthollet, and analysed by H. Rose, who found the formula $3CaO, CaCl+16Aq$, or in present notation $3CaO, CaCl_2+16H_2O$. This is not a very simple or intelligible formula, and moreover the percentage of water found, which was 49·084, is considerably lower than that required by the formula, namely, 50·793. The salt was therefore prepared and analysed as follows.

The solution of calcium chloride was prepared by dissolving, by heat, pure white marble in moderately concentrated hydrochloric acid until saturated. This was boiled with an excess of milk of lime for about an hour, filtered whilst hot and allowed to cool. The salt separated out, on standing, in slender, white, needle-shaped crystals, generally from one half to an inch in length. They were sometimes obtained of not more than a quarter of an inch in length, and almost transparent, the separation not taking place until the solution was agitated. The composition of the crystals was in all cases the same, and was not affected by the length of time they were allowed to remain in contact with the liquid. The crystals, dried as quickly as possible between blotting paper, on analysis gave the following results:—

(*a*) 0·677 grm. gave 0·273 grm. CaO.
0·442 „ „ 0·228 „ AgCl and 0·0012 Ag.
0·307 grm. lost on heating 0·152 grm.

(*b*) 0·359 grm. gave 0·144 grm. CaO.
0·794 „ „ 0·2045 „ AgCl and 0·0245 Ag.
1·052 lost on heating 0·52 grm.

	Calculated for $CaO, CaOHCl + 7H_2O$.	Found (*a*)	Found (*b*)	Calculated for $3CaO, CaCl_2 + 16H_2O$.
Ca	29·144	28·80	28·77	28·22
Cl	12·932	12·86	12·794	12·522
O	5·829	—	—	8·465
OH	6·193	—	—	—
H_2O	45·901	—	—	—
Loss on heating	49·179	49·40	49·47	(H_2O) 50·793
	100·000			100·000

The constitution of the salt is therefore expressed by the formula $O\left\{\begin{matrix}CaOH\\CaCl\end{matrix}\right. + 7H_2O$. On heating, two molecules of the salt decompose, forming $3CaO + CaCl_2 + 15H_2O$. The difference of the proportion of the constituents according to the above formula, and according to that assigned by Rose, is therefore that corresponding to one atom of water more or less. As the amount of water is nearly 50 per cent of the whole, this constituent will exhibit the greatest difference, namely 1·514. Accordingly, the numbers above will be found to agree with the formula $O\begin{cases}CaOH\\CaCl\end{cases}+7H_2O$, which loses on heating 49·179 per cent. The number found by Rose (49·084) agrees very nearly.

The salt is perfectly stable for any length of time if kept out of contact with the air. It may be also kept unaltered in the mother liquor for some time. In the air it decomposes, absorbing carbonic acid and water. Over sulphuric acid in vacuo or in air, or over quicklime, it parts with a portion of its water of crystallization. Both these circumstances interfere with the exact drying of the salt.

With water, it decomposes into calcium hydrate and calcium chloride—

$$2\left[O\begin{cases}CaOH\\CaCl\end{cases}\right]+2H_2O=3Ca(OH)_2+CaCl_2.$$

By the substitution of hydrobromic for the hydrochloric acid in the preparation of the salt, I expect to obtain a corresponding bromine compound.

"On the Structure of Stigmaria," by Professor W. C. Williamson, F.R.S.

At the meeting of the Manchester Literary and Philosophical Society, held on October 20th, Mr. Binney called in question some conclusions at which I had arrived, and had published in Part II. of my Memoirs on the Structure of the Coal Plants, respecting the organisation of Stigmaria. Mr. Binney further published an abstract of his remarks in Part II. of Vol. 14 of the Society's Proceedings. Believing that Mr. Binney's observations, if allowed to pass unnoticed, may mislead some Palæontologists unacquainted with Stigmaria, I feel called upon to reply to them through the same channel as that which he has employed for their promulgation. The general features of the plant, known for half a century as Stigmaria ficoides, have been so well described by Lindley and Hutton, Dr. Hooker, Mr. Binney, and Brongniart, that no one familiar with those descriptions can fail to recognise it without difficulty. That plant consisted of a central medulla, surrounded by a cylinder of scalariform vessels arranged in radiating wedges, very distinctly separated by two kinds of medullary rays (primary and secondary), the whole being enclosed in a thick bark from the surface of which spring numerous large cylindrical rootlets. The vascular cylinder gives off numerous large vascular bundles of scalariform vessels, which proceed outwards, through the conspicuous primary medullary rays, to reach the rootlets.

The dispute between Mr. Binney and myself resolves itself chiefly into three points. 1st.—The structure of the medulla of Stigmaria. 2nd.—The source whence the vascular bundles supplying the rootlets are derived. And 3rd.—The nature of some vascular bundles which both Mr. Binney and M. Goeppert have figured as existing within the medulla, and one of which is prolonged radially in M. Goeppert's example through a medullary ray. Mr. Binney and M. Goeppert believe that the cellular medulla of Stigmaria contained bundles of very large scalariform vessels, and that those bundles proceeded outwards to supply the rootlets. On the other hand, in my 2nd Memoir, referred to by Mr. Binney, I not only expressed my conviction, but demonstrated the absolute certainty that such was not their origin. I adhere to the same opinion as I previously expressed, and have the specimens on the table which prove its correctness. The fact that these bundles were derived, not from the medulla, but from the vascular wedges of the woody cylinder, was illustrated by the figures 43, 44, and 47 of the Memoir referred to, figures which accurately represent, not conditions occasionally met with, but, those which characterise every specimen of the true Stigmaria ficoides. In the Memoir I further affirm that immediately within the woody cylinder there exists a delicate cellular tissue, and state that one of my specimens makes it perfectly clear that the entire medulla consisted of similar cells, unmixed with any vascular bundles whatever such as were represented in M. Goeppert's and Mr. Binney's figures, and the accuracy of which was, and it appears still is, endorsed by Mr. Binney. After thus endorsing what I believe to be a grave mistake, Mr. Binney proceeds to justify his doing so by appealing to a specimen which I have not seen, but which Mr. Binney's own description convinces me is a plant altogether different, alike from THE Stigmaria of authors, and from M. Goeppert's and Mr. Binney's own figures. Mr. Binney describes his new specimen as having a radiating woody cylinder, immediately within which is a second series of large vessels not arranged in radiating wedges, and which Mr. Binney says is "something like a medullary sheath, enclosing a medulla composed of very small and short barred tubes or utricles, in which are mingled large vascular tubes or utricles." Though this use of vague terms renders the sense obscure, I presume that Mr. Binney simply means that in the medulla of his plant a *vascular* cylinder encloses a *cellular* medulla, or, in other words, that his specimen has a Diploxyloid axis. That Mr. Binney possesses a specimen having the above structure, and giving off rootlets from its periphery, I have no reason for doubting, since in the Memoirs already quoted I have described a similar structure under the name of Diploxylon Stigmarioideum, and respecting which I make the following observations:—"It is possible that the plant may, like Stigmaria, prove to be the uppermost part of a root of some of the other forms" (*i.e.* of Lepidodendroid stems), "though I have never yet found it associated with any rootlets, and it may be a fragment from the base where stem and roots united."—(loc. cit. p. 239.) I arrived at the above conclusions because I found in the specimen described evidence that large rootlet bundles were given off from the woody zone as in the true Stigmaria. But I affirm that out of hundreds of Stigmarian fragments that I have examined, I have only found two possessing this structure; and I unhesitatingly express my conviction that Mr. Binney's specimen is another example of an equally rare type, both being entirely distinct from Stigmaria ficoides, to which latter plant alone is referable Mr. Binney's previously published figures, M. Goeppert's description and figures of which Mr. Binney approves, and mine which he rejects.

Mr. Binney proceeds to say, "The size of these large vascular tubes or utricles in the medulla, exceeding anything, so far as his knowledge extended, hitherto observed in fossil plants, shows that it was easily decomposed, and thus accounts for the general absence of the medulla in Sigillaria and its roots." At this reasoning I must altogether demur. Size has nothing whatever to do with the preservation of the tissues in fossil plants. Vascular structures strengthened by transverse bars of lignine are equally well preserved whether they are large or small. The medulla of Stigmaria disappeared or became much disorganised because it consisted of an unusually delicate cellular tissue with extremely thin walls. This tendency to decay was more manifest towards the centre of the medulla than at its circumference. Specimens on the table exhibit this peripheral part of the cellular medulla in exquisite perfection, giving off its characteristic cellular prolongations constituting the medullary rays, as described in my memoir. And yet this beautiful cellular tissue occupies the position which Mr. Binney says was occupied by "large vascular tubes or utricles." The specimens referred to showing these conditions constitute unanswerable facts.

Mr. Binney correctly notes the resemblance of the inner vascular cylinder in his specimen to a "medullary sheath." I have already said the same thing in several of my memoirs, and M. Brongniart said it before either of us. But this very homology, if correct, indicates the probability of Mr. Binney's specimen being a fragment derived from the junction of stem and root rather than a true root, since in living plants possessing a medullary sheath, that sheath, as every botanist knows, is never prolonged into the true roots, for the simple physiological reason that its origin is directly connected with that of the leaf formations of the ascending axis.

As I have already observed, M. Goeppert's and Mr. Binney's previous figures represent a structure altogether different from that now described by Mr. Binney. Instead of the continuous inner vascular cylinder of the latter M. Goeppert's figure displays two detached, unsymmetrically arranged, vascular bundles in the interior of the medullary cavity. I have already affirmed my conviction that these belong to intruded rootlets of a Stigmaria, and are in no respects part of the true medullary axis. On the other hand Mr. Binney says that "they are certainly not intruded rootlets, as anyone who examines the learned author's plates can satisfy himself." On this point Mr. Carruthers writes to me on November 2nd, "No one who is accustomed to sections of Stigmaria can fail to see that Goeppert has mistaken the accidental rootlets of Stigmaria penetrating the decayed axis for an organic part of that axis." I may allow this opinion of an experienced botanist, with which I wholly concur, to neutralise that of Mr. Binney, who further says, "It is very improbable that they" (*i.e.* Goeppert's vascular rootlets) "had ever been introduced into the axis after the pith had been removed." To this I reply that it is an extremely rare thing to find any such axis which does not contain more or less of these rootlets. My cabinet is full of such examples, and in two specimens on the table, one of which has been lent me by Captain J. Aitken of Bacup, similar rootlets not only exist in the central axis but have penetrated the medullary rays as in M. Goeppert's specimen.

Mr. Binney, referring to my comments upon his previous memoir, says that "in that memoir mention is only made of the large vascular bundles found in the axis, without calling them vascular or any other vessels." I do not very clearly understand what this sentence means, but I presume it is intended to imply that Mr. Binney never affirmed that the pith of Stigmaria contained VASCULAR tissues, and that I have misrepresented him in stating that he had done so. I can only answer this by giving Mr. Binney's words. "The most important circumstance thus developed is the existence of a double system of vessels in Stigmaria, first shown by Goeppert, and the consequent approach in this respect to Diploxylon, Corda. In Diploxylon, however, the inner system forms a continuous cylinder, concentric with and in juxtaposition to the wedges of wood forming the outer; while in Stigmaria the same inner system is broken up into scattered bundles, apparently unsymmetrically arranged in the medullary axis or pith of the plant"—*Quarterly Journal of the Geological Society,* vol. 15, p. 17—and on p. 78 of the same memoir, describing the specimen represented by fig. 2, he says, "The axis is filled with eleven or twelve large vessels of circular or oval form," and the same structures are again spoken of as "vessels" no less than six times in the next seventeen lines, with the further remark that "altogether these angular vessels remind me somewhat of the vascular tissue in the middle of Anabathra"—(loc. cit. p. 78). It is true that in two places Mr. Binney applies to these structures the term "utricles," by which, I presume, he means cells, but such a term, applied to such tissues, is equally applicable to all known fibro-vascular structures, and is simply equivalent to saying that scalariform vessels have no existence.

I have entered into these details because by promulgating vague and groundless doubts respecting work already carefully done, Mr. Binney's communication tends to reintroduce confusion into questions that have been virtually settled. It does this through failing to discriminate between things that differ. His introductory remarks refer to the common Stigmaria ficoides, whilst his justification of those remarks rests upon a plant of a very different character, and which I am absolutely certain is not the common form of Stigmaria.

Ordinary Meeting, December 1st, 1874.

Rev. Wm. Gaskell, M.A., Vice-President, in the Chair.

"Some Doubts in regard to the Law of the Diffusion of Gases," by Henry H. Howorth, Esq.

The Author said that he had a difficulty in reconciling the conclusions drawn by Dalton, Berthollet, and Graham respecting the diffusion of gases with the actual facts of nature, and it seemed to him that the only way in which the inferences drawn from experiments in the laboratory and what was going on in nature on a large scale could be reconciled was in the belief that either diffusion was extremely slow in some cases or that it was sometimes prevented.

He argued that the continuity of condition between gases and liquids which had lately been so admirably illustrated made it, *a priori*, probable that similar laws prevailed in both classes of matter in respect to their laws of diffusion, &c., and that, as in the case of liquids, the law of diffusion was not a universal one, but had at least apparent exceptions, so also among gases there might occasionally be conditions which resisted or very greatly impeded the operation of the law. He granted at once that the gases that form air, and many others, bear uniform testimony to the correctness of the generalisation ; but in the case of carbonic acid, watery vapour, and hydrogen, there seemed to be some room for doubt. The fact that in all abandoned wells, tunnels, and mines, where atmospheric currents do not play, and where there is no absorbing vegetation, there is an accumulation of carbonic acid gas, although these hollows have ample access to the air, goes to show that the rate of diffusion must be exceedingly slow in these cases, if in fact diffusion be not actually suspended. The mephitic vapours in low valleys in volcanic districts, and the gases that generate malaria in many low-lying marshy districts—such as the Maremma in Italy, the neighbourhood of Montpelier in France, &c.—seem to point in the same direction. The very diverse condition in regard to the amount of watery vapour contained in contiguous areas of the atmosphere, whether we examine it in different neighbouring localities or in the superimposed strata of air in any particular locality, show that the working of the law of diffusion is here greatly impeded. In regard to hydrogen the evidence is somewhat different. It is clear that if under certain conditions hydrogen be an exception to the general law of the diffusion of gases, and follows rather the more general law of gravitation, that it will exist in a stratum above the atmosphere and beyond the reach of direct observation. In his experiment upon the occlusion of gases, Mr. Graham examined several aerolites, and found that under the air pump they parted with a very large quantity of occluded hydrogen. If, as is probable, the gas was occluded by the aerolites when at a red heat, and this red heat was coincident with their passage through that layer of the upper atmosphere in which the phenomena of shooting stars and of the aurora occur, it seems more than probable that this stratum is a layer of hydrogen. This is confirmed by what we know of the spectrum of certain auroras, which resembles those of the zodiacal light and the solar corona. The spectrum of the corona has been the most attentively studied, and Jansen, perhaps the greatest authority on it, speaks most confidently about its distinguishing feature being the hydrogen lines, while a special line which characterises both its spectrum and that of the aurora, and which is different to that of any terrestrial substance, is considered by Father Secchi to be an abnormal hydrogen line. Dr. Dalton long ago argued, as Mr. Baxendell has reminded Mr. Howorth, that the peculiar features of the aurora could best be explained by the hypothecation of a stratum of some peculiar gas above the atmosphere. A gas of a "ferruginous nature" is the expression of Dr. Dalton. Now hydrogen in the higher chemistry is not only classed among the metals, but Faraday and others have shown that in its relation to magnetism it is nearly allied to iron, so that a stratum of hydrogen above the air would seem to exactly answer Dr. Dalton's postulate. If it should exist, the earth would resemble the sun in one remarkable feature, for we now know that the sun is girdled with an immense layer of hydrogen. Lastly, he would add that the heterogeneous texture of the gaseous nebula, like the great nebula in Orion, seems to argue that the law of the equal diffusion of gases does not prevail there.

Mr. Howorth presented these facts with considerable hesitation, his excuse for doing so being his view that all physical laws are tentative only; that is, they are good as long as they explain all the facts, and no longer, and that it sometimes becomes a duty to present apparently aberrant and abnormal facts to an audience so well qualified to criticise them as the Manchester Literary and Philosophical Society, in order that they may either be brought within the law or that the law may be revised.

Ordinary Meeting, December 15th, 1874.

Edward Schunck, Ph.D., F.R.S., &c., President, in the Chair.

Mr. Joseph Carrick and Professor Morrison Watson, M.D., were elected ordinary members of the Society.

Rev. Wm. Gaskell, M.A., read an interesting account of Horrocks' and Crabtree's Observations of the Transit of Venus in 1639, published in the Annual Register for 1769.

"Some Particulars respecting the Negro of the Neighbourhood of the Congo, West Africa," by WATSON SMITH, F.C.S.

These particulars were furnished by Mr. Richard C. Phillips in two letters dated respectively July 17th, 1873, and July 17, 1874. The parts of the coast are those situated between the towns Chillunga, Landana, Cabenda, Ambrizette, Kinsembo, and Ambriz.

With respect to the Coast trading, which chiefly consists of a system of barter, the following information is given. The articles of barter are chiefly rum, beads, cloth, knives, rings, hatchets, and miscellaneous articles of the kind. On certain parts of the coast some articles will pass as currency to the exclusion of others; thus beads are essential in Ambrizette and Kinsembo, being the true money of the country, and in consequence comparatively little spirits are used in those places, while at Loango rum plays a most prominent part. The produce of the country exchanged by the Negroes for the above mentioned articles is as follows: Palm nuts, ivory, coffee. No doubt numerous other articles are bartered, but those named are principal.

The African uses most of his rum as money. Suppose a Negro trader receives half a gallon; he will divide this into many portions—drinking some, giving some to his wives (perhaps ten), spending some in palm nuts, casada, corn, firewood, &c. The rum is preferred, partly on account of its being readily divided without suffering loss of value. The same applies to beads, which are preferred in some localities. The drinking of spirits is thus very much limited by its scarcity, and by its use as currency; yet occasionally drunkenness breaks out and a "big dance" is held. One thing is evident, viz., that a settled and confirmed taste for spirits is being formed amongst these coast natives. Also, that this being a tropical country, this fact points to a great peril in store for the future of the native people; and not a very vivid imagination might picture the effect probably following the introduction in larger quantity of such a beverage, or say the method of manufacturing the article for themselves.

The character of the Negro is thus described by Mr. Phillips: "He is very averse to work, and takes little thought for the future, has little love or hate, is not revengeful, as that would entail trouble or expense, lives unto himself alone. Crafty, cunning, a born swindler, often a confessed rogue, avaricious yet lazy, he generally attaches himself to some one of importance and does his bidding like a stray cur who follows you home, and of which you take charge. This is not the individual, but the national character." In the early part of this year, 1874, the small-pox broke out violently on the Coast. Mr. Phillips at once set to work to grapple with the evil in a manner which is beyond praise. Having procured a quantity of vaccine lymph, he vaccinated some hundreds of the Negroes. The result exceeded his expectations, for not one died who had been vaccinated, though numbers fell around them. Later on, Mr. Phillips writes, "I am entirely out of lymph, and, in connection with this, I'll tell you something. When I had finished the 'batch' of which I have spoken I told several to come at the time of ripening, so that I could transfer the matter for the use of others; but not one had the generosity to remember his neighbours, and not one came." Mr. Phillips further writes: "I believe if the vaccine lymph be fresh, be it syphilitic, cancerous, scrofulous, what not, it acts in precisely the same manner."

The social customs are of a very peculiar nature, and certain of them furnish, as I have recently found, an interesting contribution to the elucidation of a question connected with ancient Greek History. Mr. Phillips writes: "The women are the slaves of their husbands or the mother's eldest brother. This may seem a strange arrangement. It is after this principle—If I die leaving children they may not be mine really, but another man's; but my eldest sister is certainly of my blood, having been born of the same mother, then her eldest son is certainly of her, consequently of my blood. My property would then go to her children, not my wife's and (presumed) mine. In like manner I should have the control of my sister's children during my life. My sister's husband cannot take the charge of his children because they cannot be proved to be his; but on my side there can be no mistake, they are of my blood. This arrangement is necessary on account of concubinage, which is every woman's portion until she is married, and illegitimacy is a term of which they have no idea. One and all children are alike, the mother's eldest brother having charge of the whole. They seem to get on very well without the domestic strife which one would expect; the wives seem contented and happy. In fact, before the manner in which the domestic machinery works can be appreciated, an examination of it is necessary. Now in Dr. Ernst Curtius' History of Greece, translated by Prof. Ward, of the Owens College, the following paragraph occurs (p. 83) concerning the Lycians, a people of Greek descent, who lived in Lycia, a country of Asia Minor. Quoting the opinions of that day, Dr. Curtius writes: "Their patriotism they proved in heroic struggles, and in the quiet of home developed a greater refinement of manners, to which the special honour in which they held the female sex bears marked testimony." "This is one of the blessings of the religion of Apollo," &c., &c. "*And in the families of the citizens the matrons were honoured by the sons designating their descent by the names of their mothers.*"

In a foot-note Dr. Curtius explains as follows: "It is true that the usage of the Lycians to designate descent by the mother was interpreted even in ancient times as a proof that in their social life they conceded a peculiar influence to women. They are called women's servants by Heraclides Ponticus. However, it would be an error to understand the usage in question as a homage offered to the female sex. It is rather rooted in primitive conditions of society, in which monogamy was not yet established with sufficient certainty to enable descent on the father's side to be affirmed with assurance. Accordingly this usage extends far beyond the territory commanded by the Lycian nationality. It occurs even to this day in India. It may be demonstrated to have existed amongst the ancient Egyptians. It is mentioned by Sanchuniathon, where the reason for its existence is stated with great freedom. Hence we must regard the employment of the maternal name for the designation of descent as the remains of an imperfect condition of social life and family law, which as life became more regulated was relinquished in favour of the usage, afterwards universal in Greece, of naming children after the father. This diversity of usage, which is of extreme importance for the history of ancient civilisation, has been recently discussed by Bachofen."

With respect to the language, Mr. Phillips furnishes me with the following interesting particulars:—"The native tongue is very peculiar, but very musical. I fancy it would sound well sung. The sound of one word often determines that of several others in a sentence, as lĭ-īlu-lĕ ămi, chinkutu-chi-ami, malo-mami, where the alliteration is plainly perceived. Ami means 'my.'" In another letter is the following: "The language is a study of great interest, being one of the Bantu or alliterative languages, the peculiarity of which consists of euphonious changes of consonants for the sake of the alliteration. Thus one sound will often predominate through a sentence governed by some principal word. It may be considered in the following light: Suppose it to contain several nouns—five or six—and each gender to depend on the sound of the first syllable, then let the pronouns, adjectives, verbs, all be declined, with the same corresponding generic sounds; thus we get an alliteration, the subject governing all until the object is reached. The inflexions are of the first, not the last syllable. The following are a few specimens of singular and plural with personal pronouns attached, illustrating the theory, which however is not invariably carried out:—

Chinkūtū chiāmi / *shirt my* } my shirt.	Lūngŏ chiami / *ring my* } my ring. (*No alliteration*)
Binkutu biami / *shirts my* } my shirts.	Lungö biamī / *rings my* } my rings. (*No alliteration*)
Li-īlu leami / *nose my* } my nose.	Mwŏnŏ ami / *child my* } my child.
Mātū māmi / *eyes my* } my eyes.	Bānŏ bami / *children my* } my children.

There are some very interesting forms of verbs, adverbs of negation, &c., phrases, for example—toto twāmĭ / *sleep my* } I am asleep, or was asleep at the time spoken of. They say in answer to the question, "Have you eaten?" "No." In answer to "Have you anything to eat?" they do not say "No," but "Nothing." The phrase "I have not eaten" involves again a different negative. Many phrases are of a double nature, like the French negative in "je *ne* sais *pas*." Altogether it is a highly elaborate tongue, with whose beauties few are acquainted. If rapidly spoken a sentence seems but one long word, so easily do the syllables flow together. The words themselves seem intricate changes on simple syllables; few double consonants unless at the beginning of a word, then generally of the extraordinary forms in "Mpembo," "Njeiö," "Msītū," "Nkōmbō," and as the preceding word ends in a vowel these readily combine. I do not think a dozen words in the language end in a consonant. The word for a cat is a suggestive one, "wai-ö," pronounced "why-ö."

"Analysis of one of the Trefriw Mineral Waters," by Thomas Carnelley, B.Sc. Communicated by Professor H. E. Roscoe, F.R.S., &c.

An analysis of this strongly ferruginous mineral water has not, so far as the author has been able to learn, been published before any scientific society; and though two general analyses of it have previously been made, the first by D. Waldie, Esq., in 1844, and the second by Dr. Hassall in 1871, and published in the form of pamphlets for public reading by Dr. Roberts and Dr. Hayward respectively, yet as it is peculiar for the extremely large quantity of iron and alumina that it contains, and as its composition has varied considerably since it was analysed by the last named chemist (whose results also varied from those of the first), it is thought that another and more complete analysis will not be out of place.

The village of Trefriw is situated on the left bank of the Conway about 2½ miles from Llanrwst and between the latter place and Conway. The springs, which now belong to a company and are often visited by invalids as they are said to be good for the cure of diseases of the digestive organs and of the skin, are close to the high road which runs between Conway and Llanrwst, and are rather over a mile from the village. The entrance to them is a short way up the side of the mountain called the Alt cae Coch, and consists of an underground passage cut in the rock. There are at present two springs (formerly there were three), one opposite and close to the entrance, the other at the end of a gallery 10 or 12 yards long to the right. The former water is used to supply the baths, and the latter exclusively for drinking; they differ considerably in the relative proportions of their mineral constituents, but it is only the last named which is the subject of this paper.

The water, which flows into a basin cut in the rock, is said to be uniform in quantity and issues at the rate of about 40 gallons per hour; its temperature varies only within very narrow limits and is quite cold. As it occurs in the spring it is perfectly clear, bright, and colourless; but after a short exposure to the air it turns yellow and deposits flakes of ferric oxide; it has no smell, but possesses a strong and very disagreeable inky taste. On being shaken up in a closed bottle no disengagement of gas takes place; it has a strongly acid reaction, and contains neither free carbonic acid, carbonates, nor sulphides; and when first taken from the spring is perfectly free from ferric salts.

The following (I) is the analysis made of the water collected by the author on September 8th, 1874, together with that (II) made by Dr. Hassall in the early part of September, 1871,* or just three years previously.

Temperature of the External Air.........	15·5° C.
" " Air at the Spring....	12·5° C.
" " Water	11·0° C.

	I.	II.
Specific Gravity at 17° C..........................	1·00716	1·00570
	Parts per 1,000,000.	
Loss on ignition..	7217·5	——
Precipitate formed on boiling 1 hour............	32·8	——
Iron..	1507·0	2009·4
Aluminium..	233·3	112·4
Calcium...	271·3	116·5
Magnesium...	134·1	45·4
Potassium	31·5	——
Sodium	25·1	15·3
Manganese	trace	trace
Lead	0·86	——
Ammonium (NH_4)	1·63	——
Albumenoid Ammonia	0·34	——
Silica (SiO_2)	157·0	149·0
Sulphuric Acid (SO_4)	4985·3	4512·0
Chlorine	11·8	10·9
Nitric Acid (NO_3)..	9·1	——
Phosphoric Acid (PO_4)	2·45	——
Total Solid Contents	7370·78	6970·9
The Residue dried at 310° C.	7370·00	——

* See "Guide to Trefriw and Vale of Conway Spa," by Dr. J. W. Hayward, M.D., M.R.C.S. Second edition.

The following table represents the above in combination:

	I.	II.
Ferrous Sulphate	4090·4	5454·3
Aluminium Sulphate	1358·9	700·7
Calcium Sulphate	922·3	376·0
Magnesium Sulphate	670·3	225·7
Potassium Sulphate	70·3	——
Sodium Sulphate	49·9	47·0
Lead Sulphate	1·25	——
Calcium Chloride	——	16·8
Sodium Chloride	19·4	——
Sodium Nitrate	4·8	——
Ammonium Nitrate	7·2	——
Aluminium Phosphate	3·2	——
Manganese	trace	trace
Silica	157·0	149·0
Albumenoid Ammonia	0·34	——
Bases for which there is not sufficient Acid	15·5	1·4 Loss
	7370·79	6970·9

With reference to this analysis the following observations are to be made:—

(1.) The determination of the total residue was first made at 180°C., as recommended by Fresenius,* and the result obtained corresponded to 8,100 parts per 1,000,000; it was found however that this was much too high, the reason being that ferrous sulphate, though it looses six molecules of water at 114°C., yet retains the seventh even at 280†. In order to drive off this remaining molecule, the residue from 100cc of water was heated in an air bath to 300°—310° and weighed; after repeated heating two successive weighings did not differ by more than a milligramme. In heating to so high a temperature, however, there is a danger of a little sulphuric acid volatilising by decomposition of the sulphate of iron, but by careful heating this may be avoided; a loss of ammonia will, nevertheless, have been incurred, but as this, together with the trace of organic matter, did not amount to more than 8 to 10 parts per 1,000,000, it was not of very much consequence.

* Fresenius. Quantitative Analysis. 4th Edition, p. 560.

† Watts. Dictionary of Chemistry. Vol. 5, p. 597.

(2.) It will be seen from the table showing the supposed combination of the salts, that the total bases formed were rather more than sufficient to combine with the acids, and the base which is given above as uncombined is alumina, as it is thought that the quantity of this body obtained was rather too high, for, in addition to the total bases being too large for the total acids, the sum of the oxides ($Fe_2O_3+Al_2O_3+P_2O_5$) calculated from the Fe, Al, and P_2O_5, each estimated directly, is rather greater than the result obtained by weighing the three oxides together, the numbers being 2,592 and 2,570 respectively—difference 22.

(3.) In the determination of the alumina it was separated from the iron by means of tartaric acid and sulphide of ammonium, and weighed as $Al_2O_3+P_2O_5$; the difference between this and the determined amount of P_2O_5 gave the quantity of alumina.

(4.) The phosphoric acid was estimated by precipitating with ammonium molybdate, and as the amount was only small, by weighing the precipitate obtained on a constant filter, the calculation was then made from the composition of the precipitate, which contains, according to various authorities, 3·142 per cent P_2O_5.

(5.) The iron was determined directly at the spring with potassium permanganate, and afterwards gravimetrically in the laboratory. The results obtained agreed very nearly.

(6.) Several determinations were made of the alkalies, but rather varying results, comparatively, could only be obtained for the sodium. The above is the mean of four, of which the highest was 32 and the lowest 22 parts per 1,000,000, the reason being that the quantity of sodium present was only very small, so that the traces of it also contained in the reagents had an appreciable effect, though they were as pure as could be obtained. The results got for the potassium, however, agreed very nearly.

(7.) The lead was determined by the method given in

Wanklyn & Chapman's Water Analysis, as were also the ammonium, albumenoid ammonia, and nitric acid.

By a comparison of the above two analyses it is evident that between September, 1871, and September, 1874, the composition of the water has varied considerably, and though the author has not had an opportunity of seeing the analysis made in 1844 by Waldie, yet from Dr. Hassall's report, given in the above-mentioned pamphlet, it would seem that the results there given also vary much from those obtained by Waldie. The quantity of iron appears to have greatly diminished, while, with the exception of SiO_2 and chlorine, that of the other constituents occuring in larger quantities has considerably increased. A determination of the iron made last February gave 1575·4 parts per 1,000,000, though in this case the determination was not made till after the water had been collected some days. From this it would seem that the iron is gradually diminishing in quantity. The result, however, obtained by Waldie is very nearly the same as that got by Hassall.

From the analysis it will be seen that the Trefriw water is peculiar, as already mentioned, on account of the large quantity of sulphate of iron which it holds in solution; there being, so far as the author has been able to learn, no spring in the United Kingdom, and perhaps not even on the Continent, which contains it in anything approaching to the same amount, while there are only a few springs known which contain it even in a notable quantity, the analyses of which have been described. The water is also remarkable for the large quantity of sulphate of alumina and silicic acid which are dissolved in it, while the phosphoric and nitric acids, though existing only in small amounts, are rather large compared with what is found in most other mineral waters; on the other hand the proportion of chlorine is only small.

The other Trefriw mineral spring was not analysed, but from Dr. Hassall's analysis of the two waters, it appears to contain less iron and alumina, but a larger quantity of alkalies and alkaline earths than the one which is the subject of this memoir.

With regard to the geological position of Trefriw, and the source of the mineral impregnation of the springs, it may be observed that the mountains at the base of which the wells are situated consist chiefly of beds of limestone, ironstone, alum slate, and iron pyrites, together with varying proportions of silicates, very much fractured and dislocated, forming the northern extremity of the Bala or Caradoc beds. Up in the mountains and on these beds lie some small lakes from which the springs are supposed to derive their principal supply of water, which, after percolating through the above beds and dissolving large quantities of their constituents, finds its exit near the base of the mountain Alt cae Coch, where it issues from the slate bed (Black Band), and between it and the ironstone. From the above data the composition of the water is easily accounted for. There are several pyrites mines in the vicinity, one of which is situated just over the springs, but much further up the mountain side.

The author has been indebted for Dr. Hassall's analysis and some of his remarks relative to the geological position of the springs to the pamphlet of Dr. Hayward previously mentioned.

Ordinary Meeting, December 29th, 1874.

E. W. Binney, F.R.S., F.G.S., Vice-President, in the Chair.

"On a case of Reversed Chemical Action," by James Bottomley, B.Sc.

Having observed the solubility of iodine in a solution of borax, an experiment was made to see what the result of this solution would be, expecting to obtain a combination of soda with excess of acid. 27·8475 grms. of borax were dissolved in about 250 grms. of water. As it was difficult to anticipate what the action of the iodine might be, this element was added at hazard, the quantity used being nearly seven grms. When assisted by heat almost the whole of this quantity dissolved in the solution, only a small quantity evaporating along with the aqueous vapour. The solution, which amounted to about 200 cc., had only a faint yellowish tint. Being set aside for some days, it deposited crystals which proved to be ordinary borax, for 0·5932 grms. of the crystals lost by heating 0·2773 grms. of water of crystallisation corresponding to 46·75 per cent, the theoretical quantity being 47·13. After removing the crystals the solution was still further evaporated in a retort. As the evaporation proceeded, instead of the faint yellow tinge disappearing as was anticipated, the colour of the solution began to darken, finally becoming opaque owing to the quantity of free iodine in solution; vapours of iodine were also given off along with the steam. Thus the iodine which had previously dissolved and chemically united with the soda when the solution was dilute, was displaced and eliminated in the free condition when the mixture was past a certain degree of dilution. The explanation of this reversal of chemical action is as follows. When sodic borate is diluted with water its constituents are so far dissociated that the iodine acts towards the soda in the same way as it would towards caustic soda, sodium iodide and sodium iodate being the result. When however the solution is concentrated the boracic acid, notwithstanding its feebly acid power, is able to displace continuously and simultaneously small quantities of iodic and hydroiodic acid from combination with sodium, but these two acids cannot coexist in the free state; by mutual reaction they give iodine and water. To test the correctness of this explanation the following experiment was made. Boracic acid was added to a solution of sodium iodide; even after boiling some time the solution only acquired a feeble yellow tint, and no iodine vapours were given off; but on the addition of sodium iodate the solution soon became dull brown owing to the presence of free iodine, which also was given off along with the steam. This behaviour of iodine with sodic borate favours the view of the decomposition of the salt by dilution; it also shows the varying character of chemical affinity under different circumstances of temperature and dilution.

Ordinary Meeting, January 12th, 1875.

R. Angus Smith, Ph.D., F.R.S., Vice-President, in the Chair.

E. W. Binney, F.R.S., V.P., said that at the present time great attention was being paid to the sewerage of towns. Our Corporation had brought before the public a plan for dealing with the flood waters of the Medlock, and it is generally understood that Parliament will attempt to do something to prevent the further fouling of streams. Both Parliament and Corporate bodies have been long in moving in this matter, and the doing of that which should have been done 30 years ago will now be a matter of the greatest difficulty. In 1840 the Irwell approached Salford in so pure a state that numerous fish were seen in its waters near the present Peel Park, but after Manchester and Salford sewers had entered it none were to be met with in it at Cornbrook. Fish were also at that time in the Medlock above Pin Mill Bridge.

In order to show how long a time authorities take to consider before they trouble themselves with action he brought a Report on the Streams of Manchester, published by Dr. Lyon Playfair in the Health of Towns Commission in 1844. After describing the geology, watersheddings, and streams of the district, the report proceeds as follows:—"When the boroughs of Manchester and Salford were not so thickly populated as at present and the surface of the soil was in its primeval condition, without any irregularities arising from artificial excavations, since caused by the making of bricks and for other economical purposes, the sites of the towns, from their undulating surfaces alone, would possess good top drainage into the streams and rivulets before mentioned. Some little obstruction to the drainage might arise from the rows of cottages which are generally built nearly at right angles to the inclinations of the surface of the land; still the irregularities produced by the hand of man have doubtless been in part rectified by public sewering into the watercourses above alluded to, and had such watercourses been allowed to pass unimpeded through the towns, although they might have caused some nuisances, still they would not be in anything like the filthy condition which they are now, owing to the weirs and dams marked X in map appended to this report that stop their courses and form so many cesspools, allowing some of the top waters certainly to flow along but collecting all the heavier particles, and thus continually generating the most offensive effluvia.

"The River Irwell, after having by its tributaries afforded drainage and sewerage to the towns of Bolton, Heywood, Bury, Rochdale, Radcliffe, and numerous other places, and having been pent up in countless reservoirs and dams for manufacturing purposes, approaches Salford by the Adelphi in a pretty tolerable condition as to purity, inasmuch as small fish live in its waters—a very rare circumstance in any other of the streams hereinafter mentioned. At the Adelphi is a high weir built quite across the river. After passing this impediment the stream is polluted by numerous works upon its banks and the contents of the sewers of the eastern and south-eastern parts of Salford, until it receives the waters of the Irk at Hunt's Bank in a much worse condition than its own—in fact, as filthy as water can well be; thence the river flows sluggishly along the western part of Manchester to Hulme, where it receives a portion of the waters of the Medlock and Shooter's Brook (a part of this being kept in the Bridgewater Canal) charged with the contents of the sewers of the eastern and southern parts of Manchester; it is then stopped at Throstle Nest by a dam across its stream. For many miles in its course towards Runcorn it emits offensive smells, and bubbles of light carburretted hydrogen gas rise to its surface.

"The Irk approaches Manchester from Blackley. It, like the Irwell, is anything but a pure stream to begin with. After being dammed up at Messrs. Appleton's paper mills, Mr. Hartley's dyeworks, Mrs. Crompton's paper mill, and Messrs. Appleton's upper logwood mills, it joins the Moston Brook at Collyhurst. This last-named brook is impeded in its course within a quarter of a mile of its junction by three weirs, namely, at Messrs. Appleton's St. George's logwood mills, Messrs. Dentith & Co.'s chemical works, and a weir not far from the old Rochdale Road at Collyhurst. Proceeding with the Irk:—This river after its junction with the Moston Brook is dammed up at Messrs. Appleton's lower logwood mills and near the Bull's Head Inn in Newtown; and after receiving the refuse from the numerous dyeworks, size manufactories, chemical works, tanneries, skinyards, gasworks, sewers, &c., it is stopped at Messrs. Caistor and Thompson's corn mill at Scotland Bridge and the School Mills in Long Millgate before it reaches the Irwell at Hunt's Bank.

"The Medlock enters the borough at Beswick charged with the refuse of numerous works, and is dammed up by weirs across its course at Messrs. Guest's weir at Beswick, Neck Break weir, the Island Mill weir (a little below which near Fairfield Street it receives some fetid water from a small dam at Cruickshank's Mill), Messrs. Hoyle's weirs in Ardwick, and the weir near Messrs. Wood and Westhead's Mill in Garratt. At this place it receives the water of Shooter's Brook, a filthy little stream as black as ink, which enters Bradford from Newton, and after flowing under Butler Street to New Islington exposed is covered in till it reaches the Medlock at Garratt. This last named stream, after its junction with Shooter's Brook, passes under Oxford Road along Little Ireland, and is dammed up near Messrs. Birley's Mill in Kenyon Street. It then receives many sewers from the surrounding district and the river Tib in Gaythorn, which runs under the centre of Manchester but is entirely built over, and reaches the Duke of Bridgewater's Canal in as polluted a state as possible, thence some of its water after being employed as a power of winding goods escapes into its old course, which joins the Irwell near Hulme Hall. The waters of the Duke of Bridgewater's Canal are chiefly derived from the Medlock after it has received the contents of the Manchester sewers, and thus are in as bad a condition as the streams before described.

"Cornbrook enters Ardwick from Gorton, and partly open and partly built over traverses Ardwick, Chorlton-upon-Medlock, Greenheys, Hulme, and Cornbrook, at which last mentioned place it reaches the Irwell in as polluted a state as any of the other streams.

"Besides the streams before described I may mention a little rivulet near Stock Street in Cheetham, which crosses York Street, and after forming several stagnant ponds enters the reservoir in Strangeways Park. There is also another rivulet, which crosses the New Bury Road at Stocks, and flows down to the pool near Strangeways Hall. A third goes from Cheetwood by the end of Broughton Lane; and a fourth by Broughton Grove. All these run into the Irwell. There is also a filthy and stagnant pool of water in front of the houses at Stony Knolls, which excites very little attention among the inhabitants. In Pendleton there is a small stream which, though it has often been presented at the court leets as a nuisance, and is correctly designated "The Black Ditch," remains in just as bad a condition as it ever did. In all the streams above described a number of dead dogs and cats are to be seen in the various states of decomposition, bubbles of gas, light carburetted hydrogen, rise up to the surface, and, although offensive smells are met with at all times, they are by far the most annoying when the barometer has experienced a sudden depression after having been high for a considerable time previously. Sulphurretted hydrogen is the gas which chiefly causes the odour, though doubtless phosphuretted hydrogen assists in some measure."

Such was the condition of the Manchester streams prior to 1844. Immediately after the publication of the Health of Towns Commissioners' Report the sewerage of towns and villages was increased to a great extent, and in nearly all cases the refuse matter was conveyed into the neighbouring streams instead of being utilised in manuring the land as it had been previously employed. No doubt sanitary engineers have been the chief offenders in polluting our waters during the last 30 years, but manufacturers have also done their share by disposing of their refuse matter into the streams. The consequence is that not only are the waters more polluted, but their beds are being continually raised. Single towns on the banks of streams have little power to alter matters, there are so many vested interests to be dealt with. Numerous owners of property have by law what is called a right to foul waters by long user, and it will require strong parliamentary powers to effect any good. The owners of the numerous weirs will have to be compensated prior to such obstructions being removed and allowing the waters of the streams to flow and cut their courses as they once did. Before any great engineering works in the making of tunnels are attempted it is only reasonable that the streams should have a fair chance to cleanse themselves by their own natural flow of water. Manchester and Salford could try what the removal of the weirs at Douglas Mill, the Adelphi, and Throstle Nest would do. Surely such a simple experiment is worth trying before hundreds of thousands of pounds are spent in forming tunnels.

However, let Manchester and Salford spend what money they may, little good will be done unless the pollution of the waters above from their sources downwards to those towns is stopped. No doubt those towns set a bad example in the beginning, but as all the places on the streams are more or less guilty, they ought all to make a fair start together in the race of amending their evil ways of fouling streams and wasting manure.

If once the fœcal matter of a large town is diluted with water it is very costly to get it back again either by evaporation or sewage farming. Rival patentees advertise and recommend their respective plans as most efficacious, but at the present time he was not aware of the whole of the sewage waters of any large town in England having been profitably applied for farming purposes.

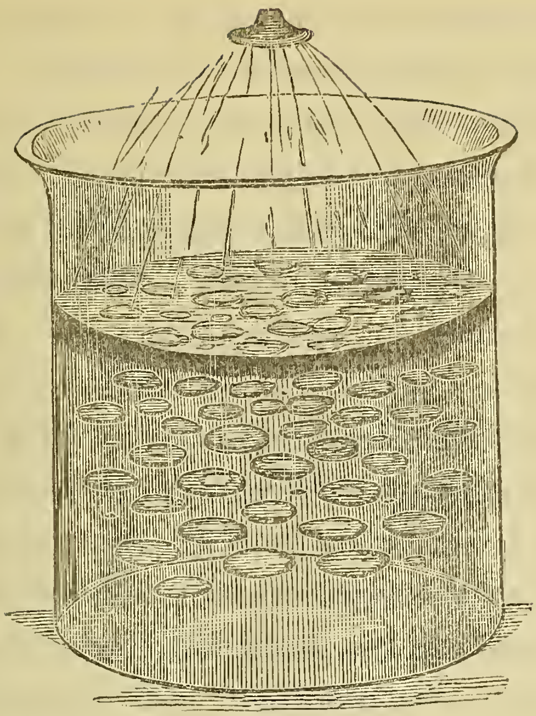
"On the Action of Rain to calm the Sea," by Professor Osborne Reynolds, M.A.

There appears to be a very general belief amongst sailors that rain tends to calm the sea, or as I have often heard it expressed, that rain soon knocks down the sea.

Without attaching very much weight to this general impression, my object in this paper is to point out an effect of rain on falling into water which I believe has not been hitherto noticed, and which would certainly tend to destroy any wave motion there might be in the water.

When a drop of rain falls on to water the splash or rebound is visible enough, as are also the waves which diverge from the point of contact; but the effect caused by the drop under the surface is not apparent, because the water being all of the same colour there is nothing to show the interchange of place which may be going on. There is however a very considerable effect produced. If instead of a drop of rain we let fall a drop of coloured water, or better still if we colour the topmost layer of the water, this effect becomes apparent. We then see that each drop sends down one or more masses of coloured water in the form of vortex rings. These rings descend with a gradually diminishing velocity and with increasing size to a distance of several inches, generally as much as 18, below the surface.

Each drop sends in general more than one ring, but the first ring is much more definite and descends much quicker than those which follow it. If the surface of the water be not coloured this first ring is hardly apparent, for it appears to contain very little of the water of the drop which causes it. The actual size of these rings depends on the size and speed of the drops. They steadily increase as they descend, and before they stop they have generally attained a diameter of from 1 to 2 inches, or even more. The annexed cut shows the effect which may be produced in a glass vessel.



It is not that the drop merely forces itself down under the surface, but in descending carries down with it a mass of water which when the ring is 1 inch in diameter would be an oblate spheroid having a larger axis of 2 inches and a lesser of about $1\frac{1}{2}$ inches. For it is well known that the vortex ring is merely the core of the mass of fluid which accompanies it, the shape of which is much the same as that which would be formed by winding string through and through a curtain ring until it was full.

It is probable that the momentum of these rings corresponds very nearly with that of the drops before impact, so that when rain is falling on to water there is as much motion immediately beneath the surface as above it, only the drops, so to speak, are much larger and their motion is slower.

Besides the splash, therefore, and surface effect which the drops produce they cause the water at the surface rapidly to change places with that at some distance below.

Such a transposition of water from one place to another must tend to destroy wave motion. This may be seen as follows. Imagine a layer of water adjacent to the surface and a few inches thick to be flowing in any direction over the lower water, which is to be supposed at rest. The effect of a drop would be to knock some of the moving water into that which is at rest, and a corresponding quantity of water would have to rise up into the moving layer, so that the upper layer would lose its motion by communicating it to the water below. Now when the surface of water is disturbed by waves, besides the vertical motion the particles move backwards and forwards in a horizontal direction, and this motion diminishes as we proceed downwards from the surface. Therefore in this case the effect of rain drops will be the same as in the case considered above, namely to convey the motion which belongs to the water at the surface down into the lower water where it has no effect so far as the waves are concerned, and hence the rain would diminish the motion at the surface, which is essential to the continuance of the waves, and thus destroy the waves.

"On the Stone Mining Tools from Alderley Edge," by Professor W. Boyd Dawkins, F.R.S.

Discovery.

In May, 1874, Mr. H. Wilde and myself happened to take a walk to the new excavations which were in progress at the copper mines at Alderley Edge, which penetrate the rock on the east side of "the Street Road," leading to Alderley. The Lower Keuper sandstone in that place is impregnated with carbonate of copper, in search of which tunnels had been driven into the base of the hill in the main parallel to the strata, having there a depth to the west of about 29°. In following the ore from the deep upwards the miners had worked their way to the surface, on the hillside immediately above the heaps of refuse near the reducing tanks, and laid bare a considerable portion of the rock. While walking over this surface, which was fantastically hollowed, a worked stone happened to catch my eye; and when we examined the stones lying about in the hollows we saw at once that a large number had been used in mining operations; and of these, owing to the kindness of the manager and the captain of the mine, we were able to secure thirty-five, which are now lodged in the Museum at the Owens College.

Description of Tools.

These mining tools are divisible into three classes: 1, the hammers with a simple groove round the middle for the retention of the withy which formed the handle; 2, the hammers which besides this groove have one of their ends also grooved for the reception of another withy, and thus were prevented from slipping when a blow was struck; and lastly, there were two implements which probably had been used as wedges, being possessed of an edge blunted by wear, and exhibiting marks of having been struck on the other. One of these has a surface which looks as if it had been glaciated, and the second, in shape very much like a celt, is remarkable for the clear evidence which its surface offers, that the groove around it for the reception of the withy was cut *after* the stone had been ground to its present shape, and probably long after, in consequence of the decomposition of the surface of grinding as compared with that of the groove.

All these implements were derived from the ice-borne stones of the boulder clay, of which they were merely picked specimens which happened to be useful for the special purpose of mining.

Tools found in old Surface Workings.

Subsequently, in the autumn of 1874, many more specimens were obtained by Col. Lane Fox and myself through the kindness of Lord Stanley of Alderley and the manager of the mine, and we were able to make a careful examination of the conditions under which they were found. To pass over those which have been buried, the number which I have examined is considerably over one hundred, belonging to the three types mentioned above.

The rock where the tools were met with was hollowed out irregularly and evidently artificially, and to a depth in some cases of from 8 to 11 feet from the surface. And from an examination of the ground it was perfectly obvious that the ancient users of these tools had worked the metalliferous portions from above, without attempting to make galleries. The tools lay buried in the *debris* which had been thrown into the old surface workings after they had been discontinued, and which presented all the characters of "a wheelbarrow formation," and were found in the greatest abundance near the bottom.

Comparison of Stone Hammers with those of other Districts.

Stone hammers of the kind mentioned above, and especially of the simple grooved class, are very widely distributed. They have been found equally in the ancient copper mines of Anglesea, of Spain and Portugal, and of Lake Superior. With these also the Egyptians worked the turquoise mines of Wady Magarah, in the Sinaitic peninsula. They undoubtedly represent one of the ruder and probably earlier stages in the art of mining. With the solitary exception offered by the turquoise mines at Magarah, they have only been discovered in old copper workings, and they may therefore be inferred to have been used in ancient times mainly for the extraction of that metal.

No Direct Evidence as to Date.

I will not venture to attempt to assign a date to the mining operations carried on at Alderley, when these implements were in use. In all the ancient mines, worked by the Romans, so far as I know, iron tools have alone been met with. Nor am I aware of any mines, of post-Roman date in Europe, which have been carried on with tools composed of any other material. It would, therefore, seem probable that they are of pre-Roman age, and that they are of the class termed pre-historic by the archæologists.

What Ores were sought in the Surface Workings.

Nor is it absolutely certain what metal was sought in these surface workings, because ores of copper, cobalt, lead, iron, and manganese are associated together in that spot. If they were in search of copper, the ore must either then have been richer than that which they left behind, or they must have been acquainted with some mode of reducing the small per centage of copper (which averages considerably less than 5 per cent) from the matrix, of which we are ignorant. This is at present effected by a bath of hydrochloric acid. Possibly, like some of the joint-stock companies of the present day, they may have been seeking for copper without success; but in that case the large number of stone hammers is not explained. Had tools such as these been used for the extraction either of lead or of iron they would most probably have been discovered in the workings which have been carried on throughout Great Britain, certainly since the Roman occupation to the present day. And it is hard to believe that the miners of Alderley worked these metals in a ruder fashion than any others in this country, so far as the present evidence stands. Nor is it at all likely that the insignificant and obscure ores of lead and iron at Alderley would attract the notice of miners in ancient times, when both were obvious, and very rich in the adjacent districts of Lancashire and Derbyshire.

The only conclusion which I will venture to draw, is that these implements imply a ruder phase of the art of mining than has hitherto been known in the neighbourhood of Manchester—a phase which may point back to the bronze age, when the necessary copper was eagerly sought throughout the whole of Europe.

"Archaic Iron Mining Tools from Lead Mines near Castleton," by Rooke Pennington, LL.B.

The iron and wooden mining tools now submitted for the Society's inspection are from the Mock mine, a lead mine in the High Rake, a vein of ore in the Tideslow liberty, about four miles to the south of Castleton. They were found in old workings at between 80 and 90 yards below the surface. According to the information I have been able to collect in the neighbourhood, this mine has not been worked for more than 200 years, but I cannot say that this is entirely to be relied upon. Probably however a minimum of 200 years may be taken as the age of the tools, independently of such evidence, for the following reasons. In the first place, a similar collection of tools from another part of the same "rake" is very well described by Mr. Benjamin Bagshawe at p. 43, No. 13, vol. 3, of the "Reliquary." These tools were found associated with silver coins of the time of Charles I, and two tradesmen's tokens dated 1667.

Again, the tools I am describing were accompanied by a particular form of small tobacco pipe, which according to Mr. Llewellynn Jewitt, F.S.A. (Reliquary, October, 1862, p. 75), is probably Elizabethan, and certainly not later than Charles I. These pipes are usually known in Derbyshire as "fairy pipes," or sometimes (with great correctness) as "old man's pipes," the "old man" being the term used to describe the miners of past ages and by transposition applied to the mines themselves, so that old workings are usually called the "Old Man."

An amusing mistake once arose from this confusion of terms. A miner from the Peak giving evidence in London on a mining case, continually referred to the "Old Man," until the opposing counsel objected that this second-hand evidence ought not to be admitted, but that the individual referred to should himself be called as a witness. It is also an illustration of the untrustworthy character of popular names that these pipes are also known as "carl's pipes," just as a prehistoric hill fort near Hathersage is called the "Carl's Wark."

It will be observed that one of the tools has been a wooden spade, tipped with iron. This serves to show the value iron possessed, or rather its comparative scarcity. All the other tools are altogether of iron, except the handles, but I do not on this account regard the spade as of earlier date, inasmuch as nothing but metal would serve the purpose in the other tools, whilst a mere shovel might do very well although made of wood.

All the tools are of archaic type, though some are recognised by old miners as similar to those in use in their youth.

MICROSCOPICAL AND NATURAL HISTORY SECTION.

December 7th, 1874.

Professor W. Boyd Dawkins, F.R.S., in the Chair.

Mr. James Cosmo Melville, M.A., F.L.S., was elected Secretary of the Section, in place of Mr. Sidebotham, resigned.

Joseph Sidebotham, F.R.A.S., read a paper on *Œcophara Woodiella* (Curtis). This moth was discovered on Kersall Moor in the year 1829, and figured and named by Curtis in 1830, since which time it has not been again met with, either in this country or abroad. The only specimens known to exist are the one from which the original drawing was made, and a pair in the museum of Owens College. The author exhibited the last-mentioned specimens, also drawings from the various published figures of the species, as well as photographs of the natural size from the pair belonging to the College.

Ordinary Meeting, January 26th, 1875.

EDWARD SCHUNCK, Ph.D., F.R.S., &c., President, in the Chair.

John Dixon Mann, M.D., M.R.C.S., was elected an Ordinary Member of the Society.

"A Descent into Elden Hole, Derbyshire," by ROOKE PENNINGTON, LL.B.

Near the road from Buxton to Castleton, and about four miles from the latter place, stands Elden Hill. It is a bleak, bare, mountain, one of the highest of the grassy eminences of the Derbyshire limestone district, and, though uninviting itself, commanding a most extensive and fine view. Its summit was long ago in the prehistoric past chosen as a resting place for the bones of some savage chief, and in its side is Elden Hole.

Elden Hole is a perpendicular chasm in the rock, and like many such apertures is reputed to be bottomless; and indeed the sound of a stone falling into the gulf is almost enough to justify the reputation, for, bounding from side to side and smashing as it bounds, the noise of each leap gradually diminishes, but the stone is never heard to stop. Though still famous, it is not so famous as it once was. It was once reckoned one of the seven wonders of the Peak. In the time of Queen Elizabeth the Earl of Leicester is said to have let a man down into it who was drawn out speechless and who shortly afterwards died. A cat subsequently lowered a considerable distance was also brought out dead. A hundred years later, Cotton, the poet of the Peak, tried unsuccessfully to fathom it; he has recorded his experiment in verse. At length, just a hundred years ago, Mr. Lloyd, F.R.S., went to the bottom himself and returned safely. His account of what he saw is printed in the Philosophical Transactions. But Mr. Lloyd was a man before his time, and the country-side still went on believing in Leicester's speechless man and dead cat rather than in the scientific explorer, and Elden Hole remains an unfathomable abyss to this day in the belief of the peasant and the tourist, and its glory has departed not through diminished depth, but because it is near no railway and even adjoins no carriage road, and the nineteenth century traveller rarely visits beauties or wonders the way to which can only be travelled on foot.

On the 11th of September, 1873, we explored the chasm for ourselves.

A number of stout beams and planks had been brought up the day before, and of these a rude platform was constructed. We found it was impossible to make this platform and place our windlass so as to obtain a descent plumb to the bottom, or rather to the first landing place in the chasm, inasmuch as the northern end is the only part where such a drop can be obtained, and there the gulph was much too wide to be bridged over. Having made all our arrangements, we commenced our descent. My friend Mr. J. Tym of Castleton was the first to go down. He was let down for about 15 or 20 yards before coming in contact with the projecting side of the gulf. For about another 10 or 12 yards he slipped over the rock, which was however perfectly smooth, so that there was no risk of cutting the rope. He sustained no further injury than that which befell those of us who followed him, viz., a complete rolling in mud derived from the damp and slippery rocks. As the pioneer, however, he ran considerable danger from stones which had lodged on ledges of rock and which there was risk of disturbing. When a little more than half way down he came clear of the rock again, and there was a sheer descent to the bottom, the rope continuing to run over the smooth projecting side. Three of us followed him, one at a time, each of us being tied to the rope so as to have the hands free to guide the body.

The effect of being lowered into the dark abyss, with the blue sky above and the green ferns and creepers around, was very fine, but the knocking one got against the rock a few yards down soon distracted the attention from scenic effect. At a distance of 180 feet from the top a landing place was reached, although not a very secure one, as it was inclined at an angle of about 45 degrees. Thence a cavern ran downwards towards the south or south-east; the floor was entirely covered with loose fragments of limestone, probably extending to a considerable thickness.

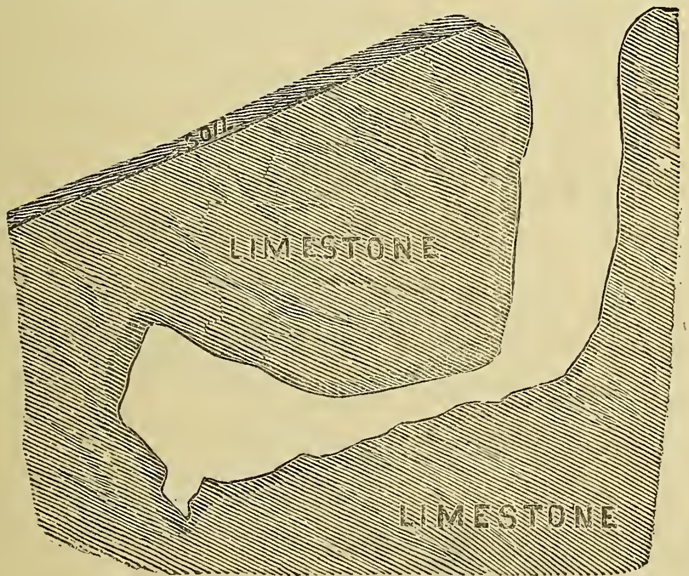
This is no doubt to some extent natural, but principally artificial, being the result of the favourite amusement of visitors, the throwing down of loose stones from the projecting wall which surrounds the top. The farmer told me that during his time two or three walls had disappeared and been replaced. No doubt it had been the same in time of his predecessors. There was quite sufficient light at this point to enable one to sketch or read. Having refreshed ourselves we left daylight behind, and scrambled, or rather slipped, into the cavern for some few yards, during which we descended a considerable distance; it was of a tunnel-like shape; then it suddenly expanded into a magnificent hall about 100 feet across and about 70 feet high. The floor of this hall sloped like the tunnel, and like it was covered with *debris.* At the lower side we were about 60 feet below our landing place, and therefore about 240 feet beneath the surface. The entire roof and walls of this cavern were covered with splendid stalagmitic deposits. From the roof were hung fine stalactites, whilst the sides were covered with almost every conceivable form of deposited carbonate of lime. In some places it was smooth and white as marble, in other places like frosted silver, whilst the rougher portions of the rock were clothed with all sorts of fantastic shapes glistening with moisture. When we had lighted some Bengal fire, I need hardly say the effect was exquisite. From this cavern we could find no opening of any length or depth save the one by which we had entered it, although we very carefully explored it. There is an absurd local tradition of an old woman's goose which flew down, and was given up as lost, but which subsequently re-appeared at the mouth of the Peak Cavern, at Castleton. The sagacious and enterprising bird must have been much cleverer than we were.

There can be no doubt that this chasm has been formed by the chemical action of carbonic acid in water, and that it has attacked this particular spot either from the unusual softness of therock originally situated here, or because there was here a joint or shrinkage in the strata. There is nothing, however, in the position of Elden Hole to lead one to suppose that any stream has ever flowed through it; no signs of such a state of things appear anywhere around.

In this it differs from the numerous water swallows of the neighbourhood, and from the pot-holes of North-West Yorkshire. It is not related to any valley or ravine, or to any running water, and there is, as observed, an absence of any well defined exit for water at the bottom. No mechanical action of a flowing stream can therefore have assisted the process of enlargement.

That so deep a chasm should be entirely isolated is certainly remarkable, because it cannot be said to represent a "weak point towards which the rainfall has converged." It must, therefore, be due to the gradual silent solvent properties of rain-water falling on the surface, and escaping through jointings and insignificant channels in the hard rocks below. Whether the excavation took place from above or below is uncertain. Applying the rule "a ravine is a cavern open to the sky," such an abyss is simply a perpendicular cave whose roof has at length fallen in. But there are many shallow funnel-shaped depressions in the limestone to which this rule will not apply, and which have been begun from the top, and there are also holes of very irregular shape, apparently of downward origin. So far as the perpendicular shaft of Elden Hole is concerned, it is not at all unlikely that the excavation descended from the surface; on the other hand, there are many underground chasms which have probably been excavated upwards, and which when uncovered will present very much the appearance of Elden Hole. For example, the upper part of the great chasm in the Speedwell Mine bears a strong resemblance to it, though the process is not there yet complete, and could sections of the district south of Castleton be made, these hollow mountains would probably reveal many such a cavity.

Section of Elden Hole, Derbyshire, September, 1873.



Scale 100 Feet in an Inch.

"Certain Lines observed in Snow Crystals," by Arthur W. Waters, F.G.S.

The crystalline form of water belongs to the hexagonal system, and the best condition, but not the only one, for observing this is as snow crystals, or perhaps more correctly as ice crystals, for with a very low temperature there are frequently beautiful ice crystals floating in the air when there is no snow-fall.

Of such some snow is formed but not all. Dr. Nettis, of Middleburg, published some drawings in 1740. Scoresby*

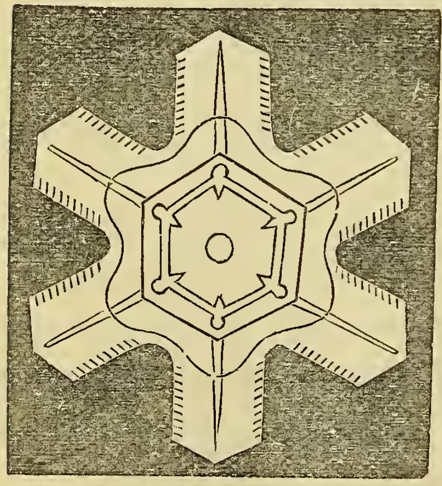
* Scoresby. Account of the Arctic Regions.

in 1822 figured about one hundred forms from the Arctic Regions, and Glaisher in 1844 gave some very elaborate drawings in the Journal of the Microscopical Society. The figures from both these two last sources have been very largely copied for various text books and scientific works, and are probably familiar to most present.

These figures are made up of angular lines, which seems quite natural for crystalline forms. Some such ice crystals* which I observed and figured from Davos in Switzerland, show a variety of curved lines, the cause of which I found for some time enigmatical, but the explanation is so extremely simple that I feel surprise that it did not at once present itself to me, and the explanation I believe shows that such observations may have a scientific utility.

It is not often in England that there are favourable opportunities for observation, as the temperature seldom is much below freezing. Frequently in the Swiss mountainous districts when a very low temperature obtains there are a great number of the ice crystals just mentioned floating in the air. These are usually the most beautiful and regular, and are the most readily examined. The illumination I used was Wenham's Parabolic Reflector.

FIG. G.



The lines which I wish to bring before your notice are the curved internal ones, especially such as the meander line in fig. G. This crystal I carefully watched during the process of melting. First the external arms melted down as far as this meander line; next the crystal melted down to the straight sided hexagon; this then melted further, leaving a crystal with the shape of the next interior lines. When we see it taken to pieces we may judge that it was built up in somewhat

* Klimatologische Notizen ü. d. Winter im Hochgebirge von Arthur Wm. Waters, Basel, 1871.

the same manner, that is to say by a growth from one form to another, so that on the simple tabular hexagon, growth takes place along the six sides, or from the corners arms may be thrown out, and such changes may, as my figures show, be repeated several times. But to explain the curved line found in the interior we must examine a little further. When a crystal begins to melt it loses the angular corners and gradually melts down, so that we can suppose a crystal, G, thawing down to take the shape of the meander line. This brings us to the explanation of these curved lines, which indicate in the first place a thawing, but as the arms extend beyond these lines it is clear that after this partial thawing freezing has begun again.

The production of these lines thus shows that the crystals, after having been formed in a cold atmosphere, have passed into a warmer one, where part of the crystal has been removed by thawing; after this it has again passed into colder air, and has formed anew upon the partially melted crystal.

It seems to me that these crystals bring down with them registers of the comparative temperature of regions inaccessible to the meteorologist, and that a systematic examination in favourable localities would add much to the knowledge of this science, as we may thus learn where counter currents exist. To take the crystal G, which fell on the 22nd of December, 1870, the meteorological observations for Switzerland show that the prevailing wind east of Davos was north or north-east, with thermometer falling, while to the west the wind was south and west. The conclusion which I have arrived at from the lines under consideration is that above Davos a layer of this southerly wind intrudes into the colder northerly winds, and the observations of other days do not militate against this theory; but, as I have been able to compare but few days, I should be glad to see a series of observations undertaken to obtain further information.

In Switzerland, the wind observations are taken by the anemometer placed near the meteorological station. Now many of these are in the valleys, and as the valley winds are so frequently merely local, these observations have little value for our purpose, and the same may be said for general meteorological purposes. On January 9th, when some of the crystals were observed, the wind registered in the valley at the meteorological station was north, while the clouds, which I always noticed for my observations, showed that a south wind was blowing above.

I have called attention to the fact that I did not find the classification of Scoresby* always corresponded with what I observed; finding sometimes low temperature forms on the coldest days. This may probably be explained by the fact that in the arctic regions there are fewer counter currents, and so the crystals were formed under more uniform circumstances; yet at the same time the only explanation of the variety exhibited in each crystal must arise from growth taking place under slightly altered circumstances, or else why should it suddenly change from one type to another?

The amount of wind seems to exert quite as much influence upon the form of the crystal as does the temperature. When there is little motion of the air the crystal can go on building itself up regularly in all six directions; but with a considerable amount of wind the conditions for this building up are more favourable on one side than another, so that we may get showers of acicular snow when a strong wind prevails. On the same principle the one side of a rope may be covered with hoar frost turning in the direction of the wind, but the same thing can sometimes be still better seen on a fir, all the leaves of which are covered with acicular hoar frost; these needles in the same way all having a direction against the wind.

The temperature when the crystal figured fell was between $-10{\cdot}5$ C. and $-11{\cdot}4$ C.

* Voyage to Greenland, 1823.

Ordinary Meeting, February 9th, 1875.

EDWARD SCHUNCK, Ph.D., F.R.S., &c., President, in the Chair.

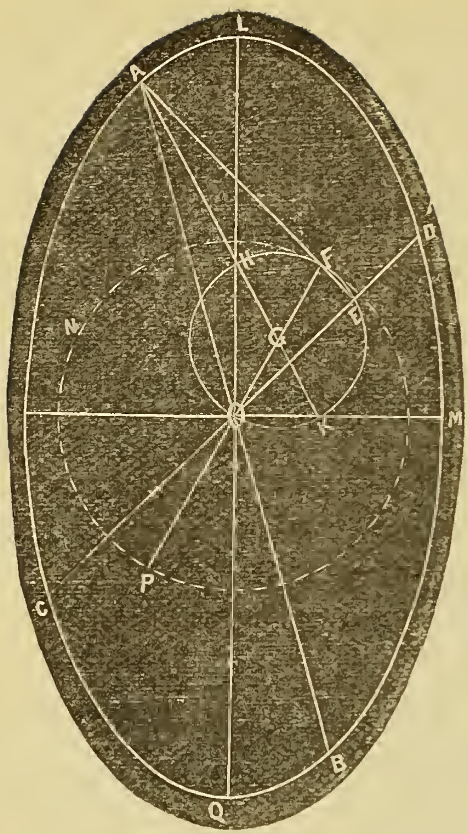
Mr. R. F. Gwyther, B.A., Lecturer on Mathematics at the Owens College, and Mr. M. M. Pattison Muir, Demonstrator in the Chemical Laboratory of the Owens College, were elected Ordinary Members of the Society.

"A Method of finding the Axes of an Ellipse when two conjugate diameters are given," by J. B. MILLAR, B.E. Communicated by Professor O. REYNOLDS.

In Mechanical Drawing it is frequently required to draw an ellipse of which two conjugate diameters are given, or; what comes to the same thing, to inscribe an ellipse in a given parallelogram.

The following, which so far as I know is new, is a simple method of solving this problem by obtaining the axes of the ellipse, from which it may be described by means of a trammel or any other of the well known methods.

Let AB and CD be two conjugate diameters of an ellipse; it is required to determine its axes.



Construction. — From A, the extremity of the longer diameter (or from the extremity of either if they be equal), draw AE at right angles to OD and make AF equal to OD: on the line OF as diameter describe a circle; join A with the centre G and produce AG to meet the circumference in K. OH and OK will be the directions of the major and minor axes respectively, and

OL=AK=semi-major axis.

OM=AH=semi-minor axis.

Proof.—The ellipse of which OL and OM are the semi-axes will evidently be traced by the point A if the line AK be made to move so that H and K move along the axes. It only remains therefore to show that this ellipse will pass through the point D and have AB and CD for conjugate diameters.

It is well known that when a circle rolls inside another of twice its diameter, every point on the circumference of the rolling circle moves along a diameter of the other. If then the circle OKH be rolled inside the circle FNP the points H and K would move along OH and OK so that the point of which A is the initial position, moving with the circle, would describe the ellipse of which OL and OM are the semi-axes. Now as the circle OHK rolls inside FNP the points E and F move along the diameters EC and FP;

so that when F has moved to O, FA will coincide with OD and the point A with D, since AF is equal to OD.

Therefore the ellipse will pass through D.

Again, as the circle OHK begins to roll from its present position F will be the instantaneous centre, and therefore the tangent to the curve at the point A will be perpendicular to AF, that is parallel to OD, since AE is perpendicular to OD.

Therefore OA, OD are conjugate diameters of the ellipse of which OL and OM are the semi-axes.

The PRESIDENT called attention to a paper in Poggendorff's Annalen for July, 1872, by H. Abich, on a fall of hail of a remarkable character which took place near Tiflis on the 9th of June, 1869.

E. W. BINNEY, F.R.S., V.P., presented to the Society a bust of the late James Wolfenden, of Hollinwood, one of most noted Mathematicians of the Lancashire school, who was born on the 22nd June, 1754, and died on the 29th March, 1841. In vol. 50, p. 387, of the *Mechanics' Magazine*, 1849, is a memoir of the deceased, written by the late Mr. T. T. Wilkinson, F.R.A.S., a corresponding member of the Society, who states that Mr. Wolfenden was sent to a day school at the age of six years, but the bobbin wheel and loom being considered much more profitable employment than learning to read, he was taken away after one week's attendance, and the sum of three halfpence defrayed the expenses of his scholastic education. Those deficiencies were in some degree supplied by the assiduity of his grandfather, who took advantage of the intervals of leisure, after the day's weaving, to instruct him in reading, writing, and arithmetic. From this stage Mr. Wolfenden may be said to have been self taught, if we except some occasional assistance he received from Mr. Jeremiah Ainsworth, a well-known mathematician, then resident near Hollinwood. Though his days were occupied at the loom, he spent most of his leisure hours in reading all the works on science he could procure in that then thinly populated neighbourhood, so that at the time he arrived at manhood he was well acquainted with most of the writers on physical and mathematical subjects, and had made the works of Euclid, Newton, Simpson, and Emmerson, his particular study. In 1807 Mr. Wolfenden calculated the first Tide Table for the port of Liverpool, which was published by Mr. Lang in the "Original Liverpool Almanack." In this work he proposed and solved the following problem :—" Suppose the sun and moon in the equinoctial, and the ratio of their forces to raise the tides to be given, it is required to find, *geometrically*, their elongation when the interval or intercepted arc between the place of high water and the moon is the greatest possible."

The solution is founded on the lemma to proposition 58, " Simpson's Select Exercises," and shows how much can be effected by geometry, when applied by a skilful hand. In a foot-note he informs his readers that Bernouilli and other writers on the theory of tides, make use of the fluxions in the investigation of this problem.

The bust was given to Mr. Binney by Mr. Wm. Hadfield Bowers, of West Gorton, who received it from his father-in-law, Mr. Whitaker, an old friend of Mr. Wolfenden.

On the motion of Mr. Bailey, seconded by Professor Reynolds, the thanks of the Society were voted to Mr. Binney for his donation of a bust of the late Mr. James Wolfenden.

PHYSICAL AND MATHEMATICAL SECTION.

February 2nd, 1875.

Alfred Brothers, F.R.A.S., President of the Section, in the Chair.

"Results of Meteorological Observations taken at Langdale, Dimbula, Ceylon, in the year 1873," by Edward Heelis, Esq. Communicated by Joseph Baxendell, F.R.A.S.

TEMPERATURE.

	Mean Temp. of the Month.	Mean Daily Range.	10.30 a.m.			6 p.m.		
			Air.	Evap.	Diff.	Air.	Evap.	Diff.
January	64·35	18·1	67·6	55·9	11·7	66·5	57·3	9·2
February	65·90	18·8	70·2	59·1	11·1	66·5	59·8	6·7
March	67·60	23·0	74·5	60·6	13·9	66·2	59·6	6·6
April	68·40	20·0	74·4	65·1	9·3	66·6	63·8	2·8
May	67·65	17·5	73·3	66·4	6·9	66·2	64·4	1·8
June	64·70	6·6	65·3	63·9	1·4	63·2	62·1	1·1
July	63·90	8·0	64·9	62·6	2·3	62·7	61·4	1·3
August	66·05	11·1	67·5	64·1	3·4	65·9	64·3	1·6
September	65·85	14·3	67·2	62·3	4·9	64·1	61·6	2·5
October	65·00	11·0	65·9	64·4	1·5	63·3	61·8	1·5
November	66·90	15·2	70·4	63·6	6·8	64·8	62·5	2·3
December	66·50	15·2	70·1	61·9	8·2	65·0	62·5	2·5
Means	66·06	14·9	69·3	62·5	6·8	65·1	61·8	3·3

RADIATION.

	Mean Max. in Sun.	Max. in Sun less Max. in Shade.	Max. in Sun Ther. in vacuo.	Min. on Grass.
January	99·5	26·1	129·4	44·1
February.........	106·7	31·4	137·1	50·2
March	118·8	39·7	146·8	49·5
April	116·3	37·9	151·0	52·3
May	117·9	41·5	143·7	54·3
June	93·1	25·1	116·6	59·6
July	98·4	30·5	126·1	57·4
August	109·6	38·0	134·2	58·2
September.......	113·7	40·7	140·1	54·7
October...........	106·0	35·5		56·5
November	115·5	41·0		53·9
December........	116·2	42·1		52·4

RAIN, CLOUDS, AND OZONE.

	RAIN.			CLOUDS.		OZONE.		
	Amount	No. of Days.	Greatest Fall in 24 hours.	10·30 a.m.	6-0 p.m.	Mean	Least Daily Amount	Greatest Daily Amount
January	0·40	3	0·17	3·4	4·1	7·1	3	9
February	5·60	10	1·47	4·7	6·3	7·4	5	9
March	3·47	8	1·17	1·9	4·6	6·6	3	9
April	8·61	13	1·55	3·7	6·7	6·2	5	9
May	11·89	22	2·45	4·0	8·4	6·4	4	9
June	26·98	30	2·65	9·0	9·9	6·5	5	8
July	19·59	26	2·55	8·7	8·8	5·8	3	9
August	12·89	26	1·31	5·5	8·6	5·3	3	9
September	11·40	15	3·13	5·1	7·7	4·9	2	8
October..................	10·24	25	1·26	7·9	8·9	5·6	3	9
November	5·90	16	1·62	6·2	7·2	5·6	3	9
December...............	6·43	16	2·75	5·3	7·1	5·7	4	8
	123·40	210		5·4	7·4	6·2		

The warmest month was April, and the coldest July, but the difference of mean temperature was only 4·5 degrees. The greatest mean daily range was 23·0 degrees in March, and the least 6·6 degrees in June. The mean humidity of the air, at 10.30 a.m., was greatest in June, and least in March; at 6 p.m. it was also greatest in June, but least in

January. In October, however, it was nearly as great as in June, both at 10.30 a.m. and 6 p.m.

The difference between the mean maximum temperature in the sun and the mean maximum in the shade was greatest in December, and least in June. The values for May, November, and September differed, however, but little from that in December, while the value for January was only one degree above that for June. The low value for January is remarkable as the dryness of the air was above the average, the rainfall at a minimum, and the mean amount of clouds much below the average.

The mean minimum temperature on the grass was lowest in January, the month of least amount of cloud at 6 p.m., and highest in June, the month of the greatest amount of cloud at the same hour. The lowest minimum on the grass was 33·0 degrees in January, and the highest 57·0 degrees in June.

The greatest monthly rainfall was 26·98 inches in June, and the least 0·40 inches in January. The six consecutive months of greatest fall were May to October, when the total amount was more than three times that of the remaining six months.

The greatest mean amount of ozone was 7·4 in February, and the least 4·9 in September, the difference being thus only 2·5. Ozone was present on every day of observation, and the lowest daily amount recorded was 2·0 in the month of September. In February, April, and June the daily amount never fell below 5·0. On the other hand the daily amount never exceeded 9·0 in any month.

In every month the mean amount of cloud at 10.30 a.m.

was less than at 6 p.m., which is contrary to what usually happens at most places in England.

On the 9th of December at 3 p.m. a miniature cyclone occurred on a portion of the estate at Langdale. Its diameter was about 200 yards; rate of progression say 4 miles per hour; and the velocity of the wind say 70 miles per hour. Bare branches 2 inches thick at butt and 6 feet long were carried some 50 feet high to a distance of at least 300 yards.

Ordinary Meeting, February 23rd, 1875.

R. Angus Smith, Ph.D., F.R.S., Vice-President, in the Chair.

Mr. Joseph Sidebotham, F.R.A.S., sent for exhibition a specimen of the Colorado Potatoe Beetle (*Doryphora decom-lineata*), which had appeared in great numbers in Canada last year, and had caused great destruction in the potatoe crops.

E. W. Binney, F.R.S., V.P., exhibited to the society specimens of a strong arenaceous shale, approaching to a flagstone, containing numbers of macrospores of *Lepidodendron*. Several times previously he had brought before the Society similar specimens in coals, and showed that they formed a considerable portion of the Fifeshire splint, but he had never previously found them in arenaceous shale or sandstone, although he had often looked for them. Many years since Professor John Morris, F.G.S., in Vol. V., part 3 (1840), of the Transactions of the Geological Society of London, in a catalogue of the fossils mentioned in Professor Prestwich's Memoir of the Coalbrookedale Coal Field states that "capsules neither bitumenized nor mineralized, but in a state of brown vegetable matter, are very abundant in some of the coarser sandstones of the coal measures." He collected the specimens from a new pit at Woodbank, near Methel Hill, Fifeshire, where a winning was being made down to the Cameron Bridge Coal, and his attention was first directed to them by his friend Mr. J. W. Kirkby, of the Pirnie Colliery. Their great abundance in seams of coal was considered very remarkable, but when they are also found largely in arenaceous shales and sandstones associated with such coals it clearly shews that the plant of which they are the organs of reproduction must have contributed very largely to the production of such beds of coal. They doubtless were floated in water with other vegetable remains to the places where they are now found, and owing to their coriaceous covering have been preserved whilst their accompanying plants have only left traces of their remains in the black charcoal dispersed throughout the shale. The macrospores are compressed, but their upper surfaces are minutely tuberculated, and their under ones marked by a tri-radiate ridge. They yet contain sufficient combustible matter to afford a brilliant flame in a burning candle.

Ordinary Meeting, March 9th, 1875.

EDWARD SCHUNK, Ph.D., F.R.S., President, in the Chair.

"On Mr. Millar's Method of finding the Axes of an Ellipse when two conjugate diameters are given," by ROBERT RAWSON, Esq., Honorary Member of the Society.

At the ordinary meeting of the Society, February 9th, 1875, Professor O. Reynolds communicated a paper on "A Method of finding the Axes of an Ellipse when two conjugate diameters are given," by J. B. Millar, B.E.

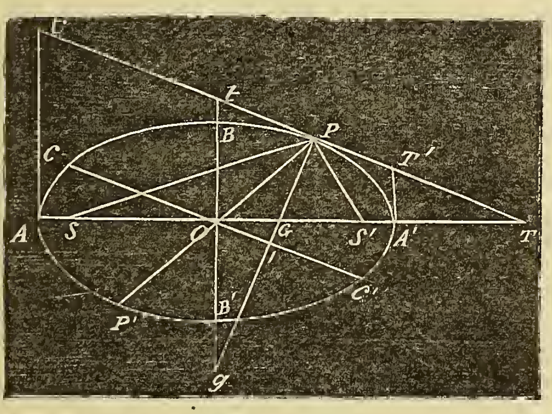
Of this solution of an ancient and useful problem it is necessary to observe that it is accurate, simple, but not new.

It may be found in Waud's Algebraical Geometry, art. 290, page 139. The construction here referred to is the same as that employed by Mr. Millar, with the exception of the generating circle OKEF, which, however, is not necessary in the construction of the principal axes. Waud's solution depends upon the well known property, viz., the equal areas of all parallelograms whose diagonals are conjugate diameters in position and magnitude.

The same construction may readily be inferred from Professor Lowery's solution of a problem by Sir James Ivory, in Leybourn's Mathematical Repository, vol. I, new series, page 175.

Three solutions of this problem are given by Mr. Besant in his Geometrical Conics—art. 216, art. 217, and art. 249, Appendix. The first two of these solutions are not so simple as is the third, which would in all probability have been the same as Mr. Millar's had he taken PE in his figure in the opposite direction. Mr. Besant derives his construction from the investigation of the locus of a fixed point in a given straight line whose extremities move on the legs of a right-angled triangle.

The various properties of the ellipse on which the solution of this problem may depend are as follows, and they may be found demonstrated in most modern works on conic sections :—



The lines AA′ BB′ are the principal diameters, CC′ PP′ are conjugate diameters, PF is perpendicular to OC, meeting the axes in G and g, PT is a tangent at P, and therefore parallel to CC′. At' A′T′ are tangents at A and A′.

$PF . PG = OB^2$.........(1) $PF . Pg = OA^2$.........(2)
$PG . OA = OC . OB$ ...(3) $Pg . OB = OC . OA$ ...(4)
$PG . Pg = OC^2$.........(5) $PF . OC = OA . OB$ ...(6)
$PT . Pt = OC^2$.........(7) $OA^2 + OB^2 = OC^2 + OP^2$..(8)
$At' . A'T' = OB^2$.........(9) $SP . S'P = OC^2$ ....(10)
$Pt' . PT' = OC^2$........(11)

The properties 7, 8, 9, and 10 are true for any conjugate AA′ and BB′.

Emerson, in his Conic Sections, published in 1767, solved this problem by means of property 7. Sir J. Leslie, in his Geometry of Curved Lines, pages 255, 256; and Salmon, in his Conic Sections, art. 179, page 168, fifth edition, have repeated Emerson's solution.

The radius of the generating circle used by Mr. Millar is determined in terms of the principal axes by Wallace in his Conics somewhat in the same manner as that used by Mr. Millar.

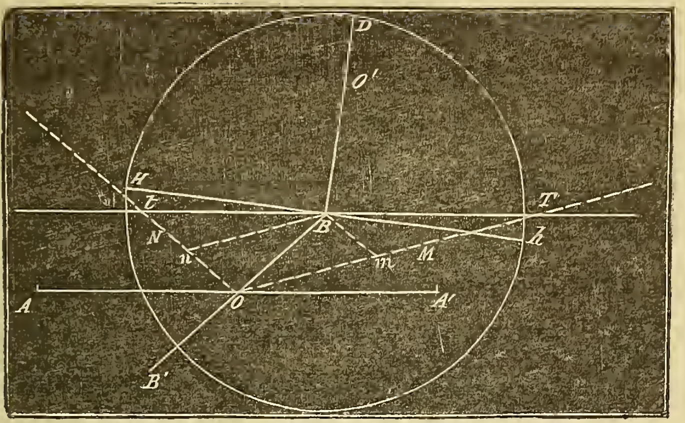
This problem is given as an exercise by C. Taylor, in his Conics, published at Cambridge in 1863, ex. 9, page 90.

Several eminent writers do not refer to it. Amongst this number are Todhunter, Hymer, Drew, Hamilton, Hustler, Bridge, Puckle, and Jackson.

In the Oxford, Cambridge, and Dublin Messenger of Mathematics, vol. III. page 151, R. Tucker, M.A., has given a solution of this problem. The construction of the magnitude of the axes is simple; their directions, however, are not so simple, as they are made to depend upon the focal properties of the ellipse.

This provoked another solution in the same volume, page 227, by R. A. Proctor, B.A., whose construction is very simple indeed. The lines employed by Mr. Proctor are different from those employed by Mr. Millar, but the construction of each is about equally simple.

In all the cases above referred to the construction of the principal axes only is given. The direct construction of any pair of conjugate diameters from the first pair is not considered by any of the above named authors. The following is offered as a solution of this part of the problem. I am not sure it is the simplest that could be devised. It depends upon property (7) when the axes are not the principal axes.



Let AOA′ BOB′ be the given conjugate diameters. Draw BtT parallel to AA′. With the centre B and radius OA draw the circle DHh. In this circle take any radius BD at pleasure, perpendicular to which draw the diameter HBh. Find O′ in BD such that $O'H = O'O = O'h$, make $O't = O'T = OO'$, join Ot and OT. These lines will be conjugate. To find the length of the diameters draw Bm parallel to Ot, and Bn parallel to OT, then $OM^2 = OT \, . \, Om$ and $ON^2 = Ot \, . \, On$.

A simple construction with a circle is usually adopted to determine OM ON geometrically from these two equations.

Mr. Arthur Mc.Dougall, B.Sc., invited attention to a specimen of carbon formed upon the roof of a gas retort, by the decomposition of the hydrocarbon gas by heat. The carbon thus formed resembles graphite in its almost metallic lustre, and it was suggested that its mode of formation might throw some light upon that of graphite. Graphite always occurs in association with rocks which have been subjected to igneous action, and may have been formed by hydrocarbon gases traversing fissures or dykes whilst the sides were in a highly heated state, thus causing a deposit similar to that formed in gas retorts. The fact that in the latter case an increase of pressure causes a greatly increased amount of deposit favours this view, as it is extremely probable that any gases existing in the earth's crust would be in a state of great tension.

"On the Presence of Sulphate of Copper in Water heated in Tinned Copper Boilers," by WILLIAM THOMSON, F.C.S.

A few weeks ago I was consulted with regard to some water which was taken from a copper boiler in a kitchen range, which led me to investigate the case, and, as the results seem to be of vital importance to many, I venture to bring them before your notice.

The range referred to belonged to a large chapel in Manchester, and was employed for culinary purposes in connection with various meetings of the congregation, &c. It was originally formed of two iron boilers, each capable of holding from thirty to forty gallons, with a fireplace between. One of these boilers was cracked, through cold water having been carelessly thrown on the iron after it had been allowed to become nearly red hot. To repair this defect a copper boiler coated with tin was fitted into the cracked iron one. I was informed that this boiler together with the iron one on the other side of the range had been employed for heating water for tea making at one or more meetings, and that some persons complained of feeling ill after tea. Some of the hot water from this boiler was afterwards employed for washing, and as it broke up the soap like hard water and threw to the top a scum which had a bluish colour, suspicion was thrown on it and a sample of the water brought to me for examination. It contained some matter in suspension of a dark colour, which soon subsided and left the water clear. Presuming that if copper were present it would be in suspension and not in solution, I examined the sediment but found it to be free from that metal. I then filtered and examined the clear water.

It contained a large proportion of copper in solution, and gave a distinctly acid reaction to blue litmus paper. I evaporated the water down to a very small bulk and extracted the free acid with absolute alcohol, eliminated the alcohol used, and got it in a concentrated form in a water solution, it charred paper with facility and gave a copious white precipitate with chloride of Barium insoluble in Hydrochloric acid, thus proving it to be free Sulphuric Acid which had acted upon the copper. I then continued my investigation to find the source of that acid. I observed that the boilers on each side of the fireplace were supplied by the same water, (Manchester supply) passing along the same pipe. I collected a sample of that water from the tap used for filling the copper boiler, and took another from the iron boiler on the other side, these samples were evaporated down and tested, but found to contain neither free acid nor copper. I next looked for the acid as a result of the combustion of sulphur in the coal, but as both boilers were entirely separated from the fire by brick work and also covered in on the top, the products of combustion had no chance of finding their way into the boilers, and further had this been the cause I ought to have found free acid in the water of the iron boiler.

On further enquiry, I was informed that after the boiler had been put in, it was well washed with water and afterwards had a solution of washing soda boiled in it and again washed well with clean water. After this treatment, water which was heated in it became highly contaminated with copper and free sulphuric acid.

My experiments up to this time having offered no solution of the problem as to how the water became contaminated, I made enquiries respecting the galvanizing of such utensils, and found that the process followed was this: the inside of the vessel was "pickled" with sulphuric acid, then rubbed with sand to remove oxide, and washed, lastly heated up with chloride of ammonium and block tin rubbed over the surface.

The only explanation which I can offer of this remarkable contamination is, that part of the sulphuric acid used for cleansing before galvanizing had been secreted in the joints formed by the riveting of the sheets of copper together and also between the plates and the rivets, so that when the boiler was washed and heated with a solution of carbonate of soda, it could not enter into the crevices to neutralize the acid during the few hours the soda solution was heated, but which under the subsequent prolonged action of the hot water gradually dyalized out bringing the copper with it.

I called one day at the chapel, and found them using the hot water from this boiler for washing dishes, so that fresh quantities of pure water were being added as the hot water was drawn off. I took another sample of it, and on analysis I found it to contain 3·575 grains of metallic copper to the gallon, equal to 14·056 grains of crystallised sulphate of copper. I consider it well that results such as these should be generally known, as I understand that boilers of this kind are often employed for culinary purposes, and through ignorance of the above facts serious results might accrue.

Professor W. Boyd Dawkins, F.R.S., exhibited a collection of articles of the Neolithic and Bronze ages from the pile dwellings in the Lake of Bienne, lately presented to the Manchester Museum, Owens College, by Joseph Thompson, Esq. He called attention to the fact that the neolithic peoples were the first herdsmen and farmers of whom we have any trace, and stated that to them we owe the introduction into Europe of domestic animals and of cultivated cereals. They were also the first weavers and gardeners. From the southern character of some of the domestic animals such as *Sus palustris*, and of some of the vegetables such as the Egyptian wheat and *Silene Cretica*, it may be inferred that they came from the south, probably from the south-east, from the warmer regions of Central Asia.

With regard to the Bronze age it is a disputed question as to whether the knowledge of bronze was spread by commerce or by conquest. Probably it was spread by both these means. The *art* of the Bronze age can only be traced home to the Etruscans, that mysterious people who are a terror to the philologists, and of whom we know historically that they were powerful by land and sea, that they were famous workers in metal, and possessed of quantities of amber. He therefore thought it probable that the amber trade with the shores of the Baltic, and the tin trade with Spain and Britain, distributed over a large part of Europe, the produce of the Etruscan workshops. On the decay of the Etruscan power the trade was taken up by the Phœnicians, the great maritime people who possessed no distinctive style of art of their own, but manufactured goods for the various markets, like the manufacturers of Manchester and Birmingham. He did not therefore see how the popular view could be maintained that the art of the Bronze age was introduced into Northern and Central Europe by the Phœnicians.

MICROSCOPICAL AND NATURAL HISTORY SECTION.

January 18th, 1875.

JOHN BARROW, Esq., in the Chair.

Mr. JAMES COSMO MELVILL, M.A., F.L.S., read a paper on the Botany of Wilmington, North Carolina, with an especial reference to the habitat of Dionæa muscipula (Ellis). He visited the place in May, 1872, and after passing an extensive sandy tract, N.W. of the city, where grew Robinia hispida, *var, Elliottii*, Lupinus diffusus, Stipulicida Setacea, &c., arrived at a pine barren, beyond which was a marsh, and found Dionæa growing amongst rushes, Helonias dioica, Sarracenia purpurea, and S. flava—it appeared to be very local, even there. The soil seemed of the usual peaty formation common to the pine barren, and it is difficult to account for the plant having so restricted a range. The only insect found entrapped by the leaves was a species of midge. Another very local plant, the *Solidago verna*, grew close by, for which this is the only locality known.

Mr. MELVILL also exhibited a specimen of *Euptychia metableta* (Crosse), a land shell lately discovered in Madagascar, connecting the Genera Cyclostoma and Cyclophorus, and distinguishable from all other land shells by its scalariform variels.

February 15th, 1875.

CHARLES BAILEY, Esq., in the Chair.

Mr. ROGERS exhibited a specimen of *Carex ornithopoda*, Willd., collected by Mr. J. Whitehead in Millersdale, Derbyshire, in July of last year.

Mr. CHARLES BAILEY remarked that this specimen was identical with examples which he exhibited from Saxony and Lower Austria, and that it was a very interesting addition to the flora of the district as well as to that of Great Britain. Its nearest ally was *Carex digitata*, L., but this species is not known to occur in the neighbourhood of Manchester, although found in the extreme north of the county. Its distribution all over Europe is rather perplexing as it is entirely absent from extensive areas; it is rare in France and Luxembourg, and unrecorded for Belgium proper, Holland, and Denmark, It is a Scandinavian species, and common in the Rhine provinces, as well as in Germany, Austria, Russia, &c. In some parts of the Continent the *Carex ornithopoda* is found associated with *Carex digitata,* but whether the former is a stunted, starved form of the latter, as Crépin surmises, or whether they are specifically distinct, are matters for further investigation. The intermixture of closely allied, but distinct, species is by no means infrequent, and their occurrence in immediate association with each other is not necessarily a proof of their common origin. Thus *Erythræa Centaurium* Pers., *E. littoralis,* Fries, and *E. pulchella,* Fries, are frequently found intermixed; *Medicago eu-falcata* and *M. sylvestris,* Fries, grow together on the Norfolk coast, and *Statice Behen,* Drejer, occurs side by side with *S. Bahusiensis,* Fries, in the estuary of the Wyre opposite Fleetwood. The botanist who studies the living plant and notes the habits and surroundings readily separates these and other allied species, and there is little difficulty in differentiating *Carex ornithopoda* from *C. digitata,* its shorter rhizome and cymose spikes being the most manifest characters for identifying it from the last named species. As it may occur in other localities in the district, Mr. Bailey mentioned the following as the more striking characters of the two plants:

	Carex digitata, L.	*Carex ornithopoda,* Willd.
Bracts	Membranaceous	Shorter than those of *C. digitata.*
Female Spikes	Distant; erect; with large fruits	Condensed; curving outwards; lighter in colour, and shorter than in *C. digitata.*
Glumes of Fruits	Attaining the base of the beak	Not reaching the base of the beak.
Beak of Fruit	One-eleventh the length of the fruit	One-fifteenth the length of the fruit—which is a shade smaller than that of *C. digitata.*

A full account of the more minute differences between the two species will be found in Crépin's paper, in Vol. XVIII Mémoires couronnés et autres mémoires publiée par l'Académie de Belgique (1865).

Mr. Sidebotham, F.R.A.S., then read a paper entitled "Notes on the Botany and Natural History of Tenby and the neighbourhood." Specimens of some of the rarer plants found in that locality were exhibited, and critical remarks on the specific identity of some of them were made; also on some of the land shells, of which a good series was exhibited, with some interesting varieties, specimens of which were distributed among the members present.

Mr. Spencer Bickham read an interesting paper on the different kinds of Beehive used in this country, and exhibited specimens.

Special General Meeting, March 23rd, 1875.

EDWARD SCHUNCK, Ph.D., F.R.S., &c., President, in the Chair.

The PRESIDENT said:—The subject which the meeting will have to consider this evening is one of considerable importance. We have met to discuss and come to a decision on a scheme first proposed by the Council and generally approved of by the Society at its annual meeting in April, 1873, a scheme for the incorporation of the Society under the provisions of the Companies Acts 1862 and 1867, and the adoption of a new code of laws which this scheme if carried out will render necessary. This Society, as you are aware, has hitherto occupied the position simply of a private association for the promotion of Literature and Science, having been guided by laws or rules, which have frequently been altered and revised so as to adapt them to altered circumstances. The Laws and Regulations governing the Society at the period of its establishment will be found in print at the commencement of the first volume of the Society's Memoirs, published in 1785. The two chief objects of the Society at that period (when the number of members was limited to fifty) seem to have been the reading of papers on various subjects at its meetings, and the subsequent publication of such of them as the "Committee of Papers" should approve of in its Memoirs, and the "Laws" refer principally to these objects. The secondary objects which the Society had in view, such as the formation of a library, the award of medals to persons of merit, &c., were set forth in the so-called "Regulations." These Laws (the Regulations having in 1790 been incorporated with them) subsequently underwent slight modifications. In 1852 a set of Rules was adopted by the Society, and duly certified in pursuance of the Act of Parliament. In these Rules the "Committee of Papers" is not mentioned, the decision as regards the printing of papers, as well as the management and direction of all the affairs of the Society, "subject to such instructions as may be given from time to time by the Society," being entrusted to the Council. The property of the Society is declared to be "vested in Trustees upon trust for the ordinary members, who shall alone be interested in the property of the Society." During the following years much discussion arose regarding these rules, and the result was the adoption in 1861 of a new code, being that by which the Society has been governed from that time to the present. The set of rules now in force does not differ essentially from the preceding one. A new feature however appears in the shape of an appendix referring to the Sections, which were not in existence at the time the previous set of rules was drawn up.

Without undergoing any change in its character and objects, the Society's sphere of activity has during the last twenty years been considerably enlarged. In addition to the Memoirs which appear periodically it publishes Proceedings, giving an account of what occurs at each of its meetings, and the labours of the Secretaries and the Editor of the Society's publications are consequently more onerous than formerly. Our library is now one of considerable extent and importance, and requires constant attention on the part of the librarian. Several sections have been established for the reading and discussion of papers on subjects with which they are specially concerned. Two societies having no organic connection with ours make use of our rooms for their meetings under certain conditions, and it may be expected that others of a similar character will be admitted to the same privileges. Our property is now of considerable value, and yet under the present regime we are unable to deal with it easily and expeditiously. Under these circumstances it has been considered advisable that the Society should endeavour to attain to a legally recognised position and status, together with greater liberty of action generally, opportunity for which is afforded by the Companies Act, 1867. At the annual meeting of the Society held on the 29th of April, 1873, it was accordingly resolved that the Council be instructed to take steps for procuring the incorporation of the Society under the provisions of the Companies Acts, and to apply to the Board of Trade for permission to omit the word "Limited" from the title of the incorporated Society." At the following annual meeting, held on the 21st April, 1874, the Council in their annual report stated that "steps had been taken for procuring the incorporation of the Society under the provisions of the Companies Acts, but a question having arisen whether it may not be necessary to alter the rules of the Society, it has been thought desirable to obtain counsel's opinion on this point before proceeding further in the matter." The Council having placed the matter in the hands of Mr. H. M. Ormerod, solicitor, the Rules of the Society have been by him, as a necessary preliminary to the application to the Board of Trade, submitted to the revision of counsel, and have been by him re-drawn in the form of the Memorandum and Articles of Association now before you. The wording alone of the rules has been altered, but the spirit has been preserved, and the two combined contain all that is essential in our present set of rules, modified only in accordance with the requirements of the law. The Memorandum and Articles of Association having been submitted to and approved by the Board of Trade, who have granted their licence for the registration of the Society, it now remains for the meeting on behalf of the Society to adopt or reject them as it thinks fit. If the meeting approves of them, after confirming its resolution as to the formation of a company under the Act, the further steps to be taken with a view to registration will follow in due course.

The following resolutions were then proposed by Mr. H. M. ORMEROD, seconded by Professor BALFOUR STEWART, and carried unanimously: —

1. "That this Society be formed into a Limited Company under the 23rd section of the Companies Act, 1867, and by the name of The Manchester Literary and Philosophical Society, and that the Council of the Society be and they are hereby authorised to take such steps in that behalf as they may deem expedient."

2. "That the Memorandum and Articles of Association, draft of which has been approved by the Board of Trade, and is now laid before this Meeting, be and they are hereby approved as the Memorandum and Articles of Association of this Society, when so incorporated, and that the Council do take such steps as may be necessary for procuring the same to be duly executed and duly registered in conformity with The Companies Acts, 1862 and 1867."

Ordinary Meeting, March 23rd, 1875.

EDWARD SCHUNCK, Ph.D., F.R.S., &c., President, in the Chair.

The following letter from Mr. J. B. MILLAR, B.E., was read by Professor REYNOLDS: —

Will you kindly permit me to express, through you, my thanks to Mr. Rawson for the trouble he has taken in comparing the solution which I gave of the problem on the ellipse with those which have been given by the various authors on the subject?

The points on which I relied when venturing to bring the problem under the notice of your Society were, its practical importance; the simplicity of my construction; and the fact that the same solution had not before been published, or if it had, was very little known. On all these points Mr. Rawson has confirmed the correctness of my opinion.

The solutions referred to by Mr. Rawson may, from his point of view, be conveniently arranged into three classes: (1) those which are quite different from mine; (2) one which *might* have been the same had it been done in a different way from what it is; and (3) one by Waud which is the same with one exception. I have not yet been able to find the book containing this last solution, and cannot therefore say how nearly identical the two solutions may be; but as the generating circle is the most important part of my construction, seeing it determines both the directions and lengths of the axes, and as Mr. Rawson says the circle is not introduced in Waud's solution, I cannot but think the exception must be an important one.

It is scarcely necessary to observe that I laid no claim to having discovered a new geometrical principle, but I did think that by looking at the problem from a different point of view from most of the writers on Geometrical Conics I had succeeded in obtaining a solution which was at once simple to execute and easy to remember, and I submit the proper test by which to judge it is to take the compasses and work the problem by the several known methods, when the simplicity of my method as well as its points of difference from the others will become apparent.

"On Discoveries in a Cave at Thayingen, near Schaffhausen," by Arthur Wm. Waters, F.G.S.

Last meeting our attention was drawn by Professor Boyd Dawkins' interesting paper to the large number of settlements which have been found in Switzerland belonging to the Neolithic and Bronze ages. On the other hand traces of earlier inhabitants have only been found as yet in Switzerland in two caves at Salève and Villeneuve, on the west side of the country, and in the cave at Thayingen at the extreme east. In each articles of human workmanship have been found in association with bones of animals.

The examination of this last cave, which is called the "kessler loch," or kettle cave, since the Gipsy tinkers had often used it, was begun in the early part of 1874. It is situated in the Jura limestone, a few miles from Schaffhausen, but since it is rather a hollow in the rock it scarcely deserves the name of a cave. A full description of the fauna found here will shortly be published, with the assistance of Professors Rüttimeyer and Fraas, and until this has appeared it is impossible to give any exact list; but probably the following though not complete will be found correct:—Ursus arctos, Canis lagopus, Gulo borealis, Elephas primigenius, Bos primigenius, Canis vulpes, Lepus variabilis, Arctomys marmotta, Cervus tarandus and perhaps Cervus elephas and Equus. This is very similar to the lists from the other caves, and the animals belong to the upper pleistocene group. Nor does the similarity end in Switzerland, for besides the same animals some of the harpoons and other weapons have an extraordinary resemblance to some from the caves of South France, and sufficient with those of some parts of Germany and South England to show that the same race of men had a wide range.

In the periods which were brought under our notice last meeting we saw that the inhabitants of these dwellings were herdsmen and farmers, who cultivated the land, had several domestic animals, followed the chase, erected houses, skilfully worked stones into implements and afterwards used bronze tools, made pottery, spun and wove flax and bast, with which they made clothes and nets; but when we turn to these earlier cave men, whether in Switzerland or elsewhere in Europe, we find that the life they led was altogether different, for they seem to have been a race of hunters and fishers, with probably no domestic animals, no knowledge of how to cultivate land or to erect themselves dwellings, and the stone tools they used were never polished as in the later periods, but merely chips of flints. Yet these men whose civilization stood so low were able with their simple flint tools to execute engravings on bone and horn with fair skill. The main point of interest connected with the cave to which I am drawing your attention lies in the discovery among the remains from Thayingen of a piece of antler of reindeer with the representation of a reindeer feeding, most faithfully and really artistically carved. There are also two other carvings (of horses) of which no description has yet been published, but I have been told that the execution of one is even much superior to that of the reindeer.

From the paleolithic caves of the Dordogne and Switzerland numerous engravings of animals have been found, but none yet published are as well drawn as the reindeer from Thayingen; but Professor Heim, in the paper* from which I get much of my information regarding the cave, says that he has been informed that just recently M. Piette, juge de paix at Craonne (Aisne), has dug out caves near St. Bertrand, in the Pyrenees, which show the same conditions as those from Perigord in the Dordogne, and that a drawing of a wild goat still more artistic than our drawing from Thayingen has been found there.

From their implements and mode of life the palæolithic race of men is supposed to be represented by the Esquimaux at the present time, and this receives the strongest support from the fact that these people, whose mode of life is very

* Ueber einen Fund aus d. Renthierzeit in d. Schweiz von Prof. A. Heim. Mitt. Antiq. Gesell Zürich 1874. XVIII. 5.

similar to that of the palæolithic man, are in the habit of ornamenting their bone and horn implements in the same way, and the style of designs has much resemblance to that of the Dordogne.

From the cave near Schaffhausen harpoons, and the so-called commandostäbe, which have been shown by Professor Boyd Dawkins to be really arrow straighteners, together with needles or bodkins have been found. The drawing of the piece of antler, with the engraving, were lithographed by Professor Heim with the greatest care and exactness, and every slip of the flint is shown, and measurements of the depth of the lines by an instrument specially arranged for it are given in the work I have referred to. Prof. Heim also argues that the preponderance of animals looking to the left over those looking to the right indicate a probability that the artists drew with the right hand. He concludes by saying, "the race of zoo-artists were in their talents in advance of the means which were at their disposal. In the later races—for example the pile dwellers—the intellectual capacity and the resources in the midst of which the men grew up are more nearly balanced." He also says "that this was a premature attempt of the human genius, and that no partial inconsistent cultivation of a single talent can be maintained for a long period." This last remark does not seem to be borne out, since the similarity of the Esquimaux and paleolithic man is undoubted, and would rather make us consider how persistent a low civilization may remain when there are few extraneous modifying circumstances.

Ordinary Meeting, April 6th, 1875.

EDWARD SCHUNCK, Ph.D., F.R.S., &c., President, in the Chair.

Mr. J. S. Kipping and Mr. W. A. Cunningham were appointed Auditors of the Treasurer's accounts.

"A Study of Peat;" Part I. By R. ANGUS SMITH, Ph.D., F.R.S., &c., V.P.

The author referred to a former paper, in which he stated his belief that calculations as to the age of peat bogs were frequently much exaggerated, and that the more highly combustible bodies called hydrogen and richer hydrogen compounds increased in proportion to age, not by addition to their substance, but by the oxidation of the other parts, and removal of carbonaceous bodies in the brown water.

After referring to the observation of oil from peat and treatment of the subject and its relation to questions connected with coal, by E. W. Binney, F.R.S., he now wished to bring forward certain scientific and certain economic points. Of the former: 1st. The rapid growth of peat, shown partly by collected experience and by numerous quotations. 2nd. The existence of the resins and bodies having a high amount of hydrogen and carbon in new as well as old peats. 3rd. The cause of the rather greater amount in the old, not from formation during decay of the plant, but their greater permanence and insolubility. 4th. The existence of similar bodies in the fresh mosses which form the peat. 5th. The possible removal of all woody fibre by decomposition, leaving only oils and resinous or similar bodies undergoing little if any chemical change. 6th. The reason, viz., that woody fibre produced no highly combustible liquids or solids during its decomposition. 7th. Suggesting that the same idea might be transferred to coal without confining it to any portion of the plant. 8th. The rapid formation of hard peat promoted by the growth of fine mosses, which break down readily into fine powder, whereas strong stems remain long.

Next, certain economic and sanitary points. 1st. The importance of keeping up in certain parts of the country a sufficient amount of peat for the fuel of the neighbourhood. 2nd. The possibility, by proper peat culture, of increasing the growth manifold. 3rd. The question of the removal of the resinous, &c., bodies by solution instead of distillation. 4th. The value of peat as a reservoir of water. 5th. Its value as a rapid grower, if properly cultivated, for filling up wet ground and swamps. 6th. Its subsequent use in removing swamp fever, which was never found, at least in the northern peat bogs, and he believed never in the true peat bog, the cold not being the cause of this.

On recent enquiry, he had found peat which, on good evidence, had grown 30 inches in 44 years, and observers with still better opportunities gave amounts much higher, equal to 88 inches in a similar time. Taking the lower estimate, it seemed clear that Sprengel's statement was correct, that peat grew more combustible matter in an acre than forest trees grew. The specimen in question, from Deeside, on a spur of the Grampians, had a considerable density, viz., 0·92, measuring externally, or a cubic foot weighed 57lbs., whereas a cubic foot of water weighs 62·32. The probably very old peat of a coaly fracture spoken of by several persons is not here alluded to, and did not come under the author's observation. The amount of the wet material that grew in an acre was 2,454 cubic feet in a year, and of the dry material, taking the lowest estimate of 1-6th, 10·2 tons, say ten. The estimated amount for wood in the plains below was considered to be 2½ tons per acre per annum, and this may be high, as Liebig gives only half this amount, and hay and straw, which he considered able to produce the same amount of dry material, do not produce more. The value of the peat and the wood as combustibles would differ little. The value of the ten tons may be considered as equal to four tons of coal. These four tons, then, were grown on land which could scarcely be said to have agricultural value. Of course, all bogs are not always growing at this rate, and there is a limit in time to their increase; on the other hand, by care and proper feeding, we may be able to grow the material much faster than ever it has grown, and the black bogs may become for us rich coal fields, oil wells, and whale fisheries. The fuel is not important for those places where coal is cheap, but there are many places in Great Britain where coal is difficult of transport. Since peat will not bear much carriage, its value is limited in distance, and in many places now without any it would be well to grow along with oat and potato fields a field also of this despised fuel. This is actually done, but it is rarely systematic, and in many places peat is driven out where a portion of land otherwise almost useless might be set aside for it. The systematic fostering of peat so as to increase the produce is advocated for many places, although this may appear absurd in the eyes of those who are desirous of removing entirely all its traces.

The peat which had grown rapidly was fine in texture and became heavy on drying; not of the heaviest kind, as 0·92 is high but not of the highest class. (The lightest peat examined was 0·2.) The first had grown from fine or small mosses, *hypnum* chiefly, and the fineness of the fibre was apparently the cause of the rapid breaking up. It is not time alone then that is always required to make fine dense peat. Large pieces of wood may endure and be preserved long. Henceforth a new classification of peats is necessary, and this is according to the prevailing plant. To grow good peat, all plants with thick stems must be avoided as giving too much woody fibre, rendering the structure too open and the peat too light, as well as giving an inferior amount (in the case of some woods at least) of the resinous and very inflammable bodies, and generally taking too long to form. The great peculiarity of good peat is the oleaginous and resinous matter, to which also wax and fats may be added, as they have been found by some. It has been generally believed that these bodies have been produced during the decomposition of the plant, although one writer, quoted in the paper, considers they were produced by the growing plant. Dr. Smith came to the conclusion that woody fibre could not be shown to produce substances rich in hydrogen, the compounds resulting from its decay were rather of a humous character and not good combustibles. If woody fibre did not leave its hydrogen and carbon in such quantity as to form the resins, &c., of peat, then we must look for the origin in the growing plant. The mosses from which the peat from Deeside was evidently grown were examined, and on drying gave about a fourth of dry matter which readily crumbled into a powder and which contained 1·27 per cent of substances soluble in a light naphtha. It much resembled that obtained from the peat, but was softer, being about the consistence of butter and capable of being distilled so as to give a yellowish substance of the same consistence. Besides this there was 1 per cent of a substance extracted by alcohol, resinous in appearance, fusible, and containing apparently the chlorophyll.

The author believed that these bodies produced the similar matter in the peat, or rather were the matter itself with little or no change. In the peat it had been hardened, perhaps by oxidation or perhaps by the removal of the more fluid portion by water. In this way he explained the possibility of having a flow of oil from a peat moss. When the substances in the plants themselves were of a more fluid character, the removal of the woody fibre and absorbing humous bodies would set them free, and the fusibility or otherwise of the substances at ordinary temperatures would depend on the plants. The oil formed by distilling the resinous bodies obtained from the peat was of a light yellow. Its true character has not been fully determined, but the analysis gave—carbon 83·86 p.c., hydrogen 12·70.

The author inclined to believe that there is a great variety of oils and solid hydrocarbonaceous bodies, if not true hydrocarbons, in the plants, which so far as he knew had not been examined. The resins of the peat had been carefully examined by Mulder.

The author had not found any of the coaly peat spoken of by some authors. It might readily be supposed that when the woody fibre was removed various compounds insoluble in water would remain and account for fossil resins, ozokerit, &c. A similar action might produce coal although the plants forming peat and coal were different and most probably the climate, and the idea of Prof. Morris (see Prof. Huxley and Prof. Dawkins on coal) that the bituminous part of coal was composed of spores and sporangia primitively supplied with resinous or oleaginous matter would so far agree with the above reasoning, although in forming peat we cannot confine ourselves to the spores, so far as the author knew at least, when wood is present having resin dispersed in it. Perhaps the same may be said of coal.

The author spoke of the great value of peat as a water reservoir in a country demanding so much water, which did not always require to be bright, and of the possibility in many positions of clearing it as it was leaving the mosses. Water reservoirs could thus be grown at a cheap rate in many spots, instead of being banked in or dug at a great expense, although growing might require perhaps more time. A reservoir formed of peat 10 feet thick would hold as much as a water reservoir of the usual kind 8 feet deep, or say 7½, and still be easily walked over.

The capacity of growing possessed by peat was so great, if the results found can be readily attained in many places, that in suitable situations it might be used for filling up swamps and making dry surfaces, for after rising to a certain height the top easily drained and left a part dry.

Swamps were sources of fever and ague. True peat bogs never were, so far as the author knew, and probably the growing of peat would render many places healthy which could not otherwise easily be made so. Gases from peat mosses it is intended to examine more fully, and also many peat-forming plants.

PHYSICAL AND MATHEMATICAL SECTION.

Tuesday, March 2nd, 1875.

E. W. Binney, F.R.S., F.G.S., Vice-President of the Section in the Chair.

"Rainfall at Old Trafford, Manchester, in the year 1874," by G. V. Vernon, F.R.A.S., F.M.S.

The rainfall during 1874 was 34·095 inches and fell upon 203 days. The total rainfall was 1·617 inches below the average of the last 81 years, and 4·280 inches above the fall for 1873.

January had a rainfall above the average; February below, March considerably in excess; April, May, June, and July were all considerably below the average, June and July unusually so, the deficiency for these four months amounting to 5·540 inches below the 81 years' average; August and September were above the average, September slightly below the average; November and December were above the average, especially November, the fall in that month reaching nearly 5 inches. April was the driest month of the year.

The rainfall for the first quarter of the year was 1·248 inches above the average; for the second and third quarters the fall was 3·762 inches and 0·408 inches below the average; and the last quarter 1·305 above the average.

The dry weather of April, May, June, and July appears to have suited the grain crops, which were remarkably large, and were no doubt greatly favoured by the extraordinary weather during the two last weeks of April, the temperature of which were 9·7° and 7·0° above the average 25 years.

Rain-gauge 3 Feet above the Ground and 106 feet above the Level of the Sea.

Quarterly Periods. 1873.	Quarterly Periods. 1874.	1874.	Fall of Rain.	Average of 81 years.	Difference.	No. of Days' Rain-fall in 1874.	Quarterly Periods. 81 years.	Quarterly Periods. 1874.	Quarterly Periods. Diff.
			inches.	inches.	inches.		inches.	inches.	inches.
		January...	3·525	2·556	+0·969	18			
48	47	February.	1·589	2·376	—0·787	11	7·233	8·481	+1·248
		March.....	3·367	2·301	+1·066	18			
		April	0·999	2·030	—1·031	15			
43	40	May........	1·395	2·285	—0·890	17	7·156	3·394	—3·762
		June.......	1·000	2·841	—1·841	8			
		July........	1·771	3·549	—1·778	14			
64	55	August....	4·345	3·520	+0·825	20	10·383	9·975	—0·408
		Sept'mber	3·859	3·314	+0·545	21			
		October...	3·758	3·897	—0·139	25			
43	61	November	4·851	3·778	1·073	17	10·940	12·245	+1·305
		December	3·636	3·265	0·371	19			
198	203		34·095	35·712	—1·617	203	35·712	34·095	—1·617

"Results of Rain-gauge Observations, made at Eccles, near Manchester, during the year 1874," by Thomas Mackereth, F.R.A.S., F.M.S.

The rain fall of 1874, though reaching about the average for this district, is exceptional in several ways. The rainfall for the past three years has unusual characteristics, that of 1872 was remarkable for its excess, being one of the wettest years on record, that of 1873 was rather remarkable for its deficiency, and it may be said of the fall of last year that it was remarkable for both its deficiency and excess.

Though, as I have said, about the average amount for the year fell, there was a great deficiency throughout the spring and summer months as far as to the end of July. The thunderstorms which occurred in August seem not only to have been the precursor of the excesses of rainfall which followed, but also of a very rapid decline of temperature which continued with slight variations till it culminated in the very low temperature at the end of the year. The drought of April and May was accompanied by severe frosts that completely destroyed the fruit crops of this district at least. The number of days on which rain fell during the past year is greater than the average. But this excess is less in proportion to the amount of rainfall in the wet portion of the year than the deficiency in the dry portion, pointing again to the law which I showed to exist in the amount and frequency of rainfall, in a paper I read on the subject before the Section in the last session. The following table shows the results obtained from a rain-gauge with a 10in. round receiver placed 3ft. above the ground :—

Quarterly Periods		1874.	Fall in Inches.	Average of 14 Years.	Difference.	Quarterly Periods.	
Average of 14 years.	1874.					Average of 14 Years.	1874.
Days.	Days.						
		January	3·261	2·813	+0·448		
52	56	February	1·464	2·194	—0·730	7·498	7·716
		March	2·991	2·491	+0·500		
		April	0·919	1·995	—1·076		
46	44	May	1·956	2·076	—0·120	6·686	3·764
		June	0·889	2·615	—1·726		
		July	2·136	3·051	—0·915		
53	60	August	5·767	3·280	+2·487	10·371	11·380
		September ...	3·477	4·040	—0·563		
		October.........	4·091	4·258	—0·167		
57	61	November ...	5·111	3·270	+1·841	10·529	12·371
		December......	3·169	3·001	+0·168		
208	221		35·231	35·084	+0·147		

In the next table are given the results obtained from rain-gauges of two different kinds, placed in close proximity in the same plane, and 3 feet from the ground. The one has a 10in. round receiver, and the other a 5in. square receiver. The large receiver had an excess over the small one in nearly all the drier months of the year. There were six months when the large one had the excess, and six months when the small one had it. The excesses in either case are exceedingly small, very few of them reach $\frac{1}{10}$ of an inch for the month. The greatest excesses are in the small gauge, and those in the wettest months of August, October, and November. There appears quite an unusual monthly excess in December in the small gauge. It attained to more than half an inch; but the conditions under which it happened are altogether abnormal. Most of it was melted snow. It fell heavily, fitfully, and often curiously intermixed with large and small flakes. This I offer as a suggestion as to the cause of the excessive difference in last December between the fall in the two gauges. An average fall of both gauges over a period of seven years shows only a little over $\frac{1}{10}$th of an inch of excess in the larger receiver; thus the two gauges may be taken as good checks upon each other.

1874.	Rainfall in inches in 10in. round receiver 3ft. from ground.	Rainfall in inches in 5in. square receiver 3ft. from ground.	Difference.	From 1868 to 1874. Average of 7 years' rainfall in inches in 10in. round receiver 3ft. from ground.	From 1868 to 1874. Average of 7 years' rainfall in inches in 5in. square receiver 3ft. from ground.	Difference.
January	3·261	3·219	+·042	3·026	3·011	+·015
February	1·464	1·440	+·024	2·137	2·099	+·038
March	2·991	3·011	—·020	2·406	2·441	—·035
April	0·919	0·863	+·056	2·008	1·977	+·031
May	1·956	1·903	+·053	1·913	1·876	+·037
June	0·889	0·872	+·017	2·355	2·317	+·038
July	2·136	2·096	+·040	2·793	2·776	+·017
August	5·767	5·971	—·204	3·272	3·251	+·021
September	3·477	3·538	—·061	3·866	3·821	+·045
October	4·091	4·192	—·101	4·976	4·968	+·008
November	5·111	5·225	—·114	3·154	3·190	—·036
December	3·169	3·708	—·539	3·288	3·350	—·062
	35·231	36·038	—·807	35·194	35·077	+·117

In the next table I give the results obtained from two exactly similar gauges, placed at different heights from the ground, and free from every interference. Each gauge has a 5in. square receiver, and the one is placed 3 feet and the other 34 feet above the ground. The total fall in the one 3 feet from the ground was 36·048 inches, and in the one 34 feet from the ground it was 28·201 inches for last year. The difference between the fall in the two gauges is 7·847 inches, or about 22 per cent less rain fell in the higher than in the lower gauge. In the same table I give the average fall in the same gauges for seven years, and by comparing the results it will be found that the average difference between the fall in the two gauges is about 18 per cent.

1874.	Rainfall in inches in 5 in. square receiver 3 ft. from ground. 1874.	Rainfall in inches in 5 in. square receiver 34 ft. from ground. 1874.	From 1868 to 1874.	
			Average fall of rain in inches for 7 years in 5 in. square receiver 3 ft. from ground.	Average fall of rain in inches for 7 years in 5 in. square receiver 34 ft. from ground.
January.........	3·219	2·339	3·011	2·160
February	1·440	1·170	2·099	1·586
March...........	3·011	2·301	2·441	1·911
April	0·863	0·672	1·977	1·689
May..............	1·913	1·849	1·876	1·704
June.............	0·872	0·699	2·317	2·062
July..............	2·096	1·823	2·776	2·463
August	5·971	4·758	3·251	2·718
September......	3·538	2·773	3·821	3·243
October.........	4·192	3·264	4·968	4·090
November......	5·225	4·248	3·190	2·473
December......	3·708	2·305	3·350	2·695
	36·048	28·201	35·077	28·794

The following table gives the ratios of the excesses of rainfall at 3 feet from the ground over the amount measured at 34 feet from the ground. I produced this kind of table for the first time last session, and I then showed that these ratios for the rainfall of 1873, and for the average of six years, were almost identical. The last year presents a very different result. Not only is the ratio of each month very divergent from the average, but the ratios of the totals are very different. I must, however, observe that both the mean monthly and the mean annual values of six years, and the same means of seven years, have similar if not identical ratios. When, however, the mean monthly ratios are examined it will be found that the greatest difference of the fall happens in May. The six years' average places this difference in June. Before it can be seen to which of these months it really belongs, a larger area of averages is required. The fall of 1874 places it in May. Both the six and the seven years' average place the least difference in January, and this in a most marked manner. On the theory then, as I have pointed out before, that the excess of rainfall in the lower gauge is due to the particles of invisible vapour in the air between it and the higher gauge coalescing with the falling raindrops, the result seems to show that in the spring and early summer months there is relatively less of this vapour in the air below a height of 34 feet, and that there is relatively more of it in the winter months, and particularly in January. Hence the maximum of dry air on the ground is in May or June, and the minimum in January. The time of this maximum is also the time when the maximum of ozone is found.

Monthly and Annual Ratios of the Excess of Rainfall Measured at 3 Feet from the Ground over the Amount Measured at 34 Feet from the Ground.

	Ratios of such Rainfall for 1874.	Ratios of such Rainfall for an Average of 7 years from 1868 to 1874.
January	·726	·717
February	·812	·755
March	·764	·782
April	·778	·854
May	·966	·908
June	·801	·889
July	·869	·887
August	·796	·836
September	·783	·848
October	·778	·823
November	·813	·775
December	·621	·804
Annual ratios...	·792	·823

In the next table I give the fall of rain for 1874 during the day from 8 a.m. to 8 p.m., and the fall during the night from 8 p.m. to 8 a.m. The results obtained from this table show another exceptional character of the rainfall of last year. Hitherto every year since I have made this comparison the total fall for the year in the day time has exceeded the total fall during the night. But during the past year the reverse has taken place and that to a large extent. In 1873 the total excess of the day over the night fall was 2·846 inches, or about 18 per cent, whilst during the last year almost the reverse happened, for the night fall exceeded the day fall by 2·692 inches, or about 15 per cent.

1874.	Rainfall in inches from 8 a.m. to 8p.m.	Rainfall in inches from 8 p.m. to 8 a.m.	Difference between Night and Day fall.
January	1·357	1·862	+0·505
February	0·619	0·821	+0·202
March	0·958	2·053	+1·095
April	0·367	0·496	+0·129
May..............................	0·767	1·136	+0·369
June	0·602	0·270	—0·332
July..............................	0·447	1·649	+1·202
August	3·114	2·857	—0·257
September....................	1·953	1·585	—0·368
October	2·119	2·073	—0·046
November	2·668	2·557	—0·111
December	1·702	2·006	+0·304
	16·673	19·365	+2·692

In the next table I present the average day and night fall for a period of seven years. The results of this table continue, notwithstanding the reversal of last year, to confirm the experience of previous years, that the day fall exceeds the night fall as far as the amounts of the whole year are concerned. The same curious fact presents itself in this table which is presented in a similar table of the previous two years. It is this: that an average excess of night rainfall occurs in January, February, August, September, November, and December. The total excess of the fall during the day is very slight, though some of the monthly differences are very large, being in some cases as much as 100 per cent.

AVERAGE OF SEVEN YEARS, FROM 1868 TO 1874.

1874.	Rainfall in inches from 8 a.m. to 8 p.m.	Rainfall in inches from 8 p.m. to 8 a.m.	Difference between Night and Dayfall.
January.........	1·326	1·684	+0·358
February	0·876	1·222	+0·346
March	1·316	1·125	—0·191
April	1·148	0·828	—0·320
May	1·143	0·733	—0·410
June	1·326	0·990	—0·336
July	1·532	1·244	—0·288
August	1·602	1·648	+0·046
September	1·799	2·021	+0·222
October	2·560	2·407	—0·153
November......	1·553	1·637	+0·084
December......	1·484	1·866	+0·382
	17·665	17·405	—0·260

MICROSCOPICAL AND NATURAL HISTORY SECTION.

Monday, March 15th, 1875.

Professor W. BOYD DAWKINS, F.R.S., in the Chair.

The Honourable J. Leicester Warren, M.A., was unanimously elected an Associate, and Mr. Arthur William Waters, F.G.S., a Member, of the Society.

Mr. CHARLES BAILEY exhibited a series of slides illustrating the structure of Natural and Artificial Cork.

Mr. JAMES COSMO MELVILL exhibited a specimen of Coquina Stone from the quarries of Anastatia Island, St. Augustine, East Florida. This specimen was taken from the castle of St. Mark, the earliest recorded building in the United States, 1565 A.D., which is entirely built of Coquina; the shells found in it appear to be chiefly those of *Arca incongrua* and *Ostrea virginica*, both species still living in the Western Atlantic.

Mr. T. S. Peace exhibited a series of curious varieties of *Helix nemoralis*, *H. hortensis*, and *H. hybrida*.

Dr. Alcock showed a Greenland Bullhead (Cottus *Grœnlandicus*, which was taken in November, 1872, amongst stones at low water on the shore of the Menai Straits. He stated that, so far as he knew, it is the first example met with on the coasts of Britain, the two specimens previously recorded, and noticed by Couch, having been captured in Dingle Harbour, County of Kerry, in Ireland, in the month of November, 1850.

Annual Meeting, April 20th, 1874. 5

Dr. SCHUNCK, F.R.S., F.C.S., President, in the Chair.

The following Report of the Council was read by one of the Secretaries :—

The Council have the satisfaction to report that the proceedings taken for procuring the Incorporation of the Society under the "Companies Acts, 1862 and 1867," in accordance with the resolution passed at the Annual Meeting held on the 13th of April, 1873, have been completed, and that a Certificate of Registration of the Incorporation of the Society was granted by the Registrar of Joint Stock Companies on the 22nd of March, 1875. Copies of the Memorandum and Articles of Association have been printed for distribution among the members of the Society.

The Treasurer's account shows that the expenditure during the year ending March 31st, 1875, was £57 3s. 10d. in excess of the income. This excess, however, is attributable to extra expenses for providing new book-shelving, rearranging the library, binding a large number of books, and preparing a new catalogue.

The number of ordinary members on the roll of the Society on the 1st of April, 1874, was 171, and 8 new members have since been elected; the losses are—deaths, 4; resignations, 5; and defaulters, 2. The number on the roll on the 1st of April instant was, therefore, 168. The deceased members are Thomas Standring, Sir William Fairbairn, Bart., T. T. Wilkinson, and Robert Hyde Greg.

Sir William Fairbairn, Bart., F.R.S., LL.D., who died on the 18th of August last, was born at Coldstream, near Kelso, on the 19th of February, 1789. At the age of 16, his father being then engaged in managing the Percy Main Colliery Company's farm, in the neighbourhood of Newcastle-on-Tyne, he was articled as an engineer for five years to the owners of the Percy Main. Thus began a career which, while protracted to an unusual length, has certainly been as remarkable for success and usefulness as any which this remarkable age has furnished. As several very complete biographical notices of Sir William Fairbairn have already appeared, particularly those written by Mr. Smiles and Sir Thomas Fairbairn, it is unnecessary here to enter into the incidents of his life.

After travelling as a journeyman mechanic for nearly four years, during which time he worked in London, in the south of England, and in Dublin, he settled in Manchester as a working millwright in 1814. In 1817 he and James Lillie commenced business on their own account, and having obtained employment first of all from Mr. Adam Murray, soon distinguished themselves by the attention and ability with which they conducted their business.

At this time Fairbairn was instrumental in effecting a revolution in mill machinery—in the means of communicating power. Hitherto engineers were accustomed to aim at slow motion, and this necessitated the use of very heavy shafts and large drums, which were for the most part made of wood or cast iron. Fairbairn, with true instinct, saw that by increasing the speed of the shafts he might reduce their size and employ wrought iron instead of cast iron or wood. He was enabled to carry out his improvements in a new mill belonging to Mr. John Kennedy, and their success completely established the reputation of Fairbairn as an engineer. He continued to introduce improvements in mill machinery, particularly in the construction and working of water wheels; and so early as 1830 his opinion seems to have been sought far and wide.

In 1829 he undertook some experiments on the traction of boats on the Ardrossan Canal, which led to his constructing in Manchester an iron vessel, which appears to have been the third sea going vessel ever constructed of iron. The success of this vessel induced him to commence iron ship building, and in 1835 he opened a yard at Millwall, which was one of the first iron shipbuilding yards in the world, and from which has been turned out the largest ship yet produced, viz., the Great Eastern, constructed by Mr. Scott Russell, who subsequently purchased the yard from Mr. Fairbairn.

Although Sir William Fairbairn early took an interest in many scientific enquiries and has published many papers his by far most important work has been the extension of the use of iron as a material for construction. He early looked upon it from a scientific point of view, and commenced making systematic experiments. In 1837 he presented the British Association with a report "On the strength and properties of cast iron from the hot and cold blasts;" and he subsequently co-operated with Mr. Eaton Hodgkinson in a series of experiments on the strength of iron, which were made at Fairbairn's works. These experiments were on a scale such as had never before been attempted. They were conducted with extraordinary practical skill, and owing to the high scientific attainments of Mr. Hodgkinson, were so thorough and complete that in many respects they have left little to be desired, and are still the principal data which engineers rely upon.

Perhaps the work for which Sir William Fairbairn is best known, and which sprang directly out of his experience in shipbuilding and in the use of iron, was the assistance which, in connection with Mr. Hodgkinson, he rendered to

Robert Stephenson in the designing and construction of the Britannia tube.

Although it has been the subject of an unfortunate dispute to whom the merit of this great work belongs, yet owing partly to the researches of Mr. Smiles, the country knows enough to insist on assigning to all three a full share of merit, for it is clear that each of them performed his work in a perfect manner. Sir William Fairbairn claimed to have originated the idea of a cellular structure for the tube, and he from the first advocated the plan of a simple tube without chains, which plan was eventually adopted with such success.*

Judged, however, by the light of subsequent experience, this plan, although it has in every respect fulfilled the most sanguine hopes, is not better than certain others; and it appears that recently but few tubular bridges have been constructed, while of the plans which have been adopted in place of it, some much more nearly approach to Stephenson's original idea of a tube supported by chains or a stiffened suspension bridge. Thus the fact that Sir William Fairbairn succeeded in persuading Stephenson to adopt his plan, must be looked upon as an instance of the extraordinary force of character and readiness of mind to which as well as to his ability Sir William Fairbairn owed his success.

Although not now much used for bridges, the cellular method is largely used in ship building. The Great Eastern is built on this plan, as are almost all our ships of war.

In 1862 Sir William Fairbairn conducted, in conjunction with Mr. T. Tate, a series of experiments on the density of saturated steam, which form a very valuable addition to our knowledge of that subject.

Sir William Fairbairn was elected a member of this Society in 1824, and was president from 1855 until 1860. In 1860

* Smiles' "Lives of the Engineers," Vol. III., note on p. 474.

he received a royal medal of the Royal Society for his scientific services; and at the meeting held in Manchester in 1861 he acted as president of the British Association. He was the recipient of numberless honours both English and foreign; and in 1869 her Majesty created him baronet in acknowledgment of his scientific services.

Besides the numerous papers which he contributed to the memoirs of this and other societies he published several larger works well known to engineers. Until the very last he took an active interest in scientific questions and in promoting scientific education. He was one of the founders of the chair of Engineering at Owens College.

The author of this notice who had the privilege of knowing Sir William Fairbairn during the later years of his life, desires to bear witness to the constant gentleness, geniality, and kindliness of this distinguished man, who was at all times ready to interest himself in whatever interested those about him.

Mr. Robert Hyde Greg, who died on the 21st of February last, at Norcliffe Hall, was born in September, 1795, in King-street, Manchester. He completed his education in Edinburgh, where he made the acquaintance of Sir Walter Scott. On leaving college he travelled in Spain, Italy, and the East, and subsequently published some critical notes on his travels. He appears to have been at Madrid dining with Sir Henry Wellesley when the news came of the Duke of Wellington's victory at Waterloo. In early life Mr. Greg took a leading part in politics, and was elected for Manchester in 1839. He was one of the founders of the Manchester Mechanics' Institution, and was a member of the Geological Society.

He was elected a member of this Society in 1817, and he contributed several papers on literary subjects, amongst which is an important paper "On the Site of Troy and the Trojan Plain," published in the Memoirs for 1824, and another "On the Round Towers of Ireland," published in the same volume.

On account of his advanced years, Mr. Greg had for some time retired from public life, and had devoted himself to agricultural pursuits, and the cultivation of his estates at Norcliffe, and at Coles Park, Herts.

Mr. Greg was a zealous horticulturist, and his grounds at Norcliffe have long been celebrated for their extensive collection of trees and shrubs, many of which are of great interest. His especial favourites were the coniferæ and rhododendrons, and amongst the former are individual specimens which are unequalled in this neighbourhood for their age and dimensions, some of them having been planted nearly 40 years ago.

Acting upon the authority given by a resolution of the Society, passed at the last annual meeting, the Council have granted permission to the Scientific Students' Association to hold their meetings and place their library in the Society's buildings on condition of their paying £1 a meeting to the Treasurer of the Society, and £5 a session for the services of the attendant, Mr. Roscoe.

At a Council Meeting, held December 15th, 1874, Mr. R. D. Darbishire brought forward a request from the "Association for the promotion of the Education of Women," that the Society would allow them the use of the meeting room on the condition of their paying for it, when it was resolved "That the 'Association for the promotion of the Education of Women' be allowed the use of the meeting room of the Society on condition of their paying £1 a meeting, with suitable remuneration to the attendant."

The following papers and communications have been read at the ordinary and sectional meetings of the Society during the present session :—

October 6th, 1874.—“On the Ossiferous Deposit at Windy Knoll, near Castleton,” by Rooke Pennington, Esq., LL.B.

“On some teeth from a fissure in Waterhouses Quarry, in Staffordshire,” by Rooke Pennington, Esq., LL.B.

“On the Animals found in the Windy Knoll Fissure,” by Professor W. Boyd Dawkins, F.R.S.

“On the Extent and Action of the Heating Surface for Steam Boilers,” by Professor Osborne Reynolds, M.A.

October 20th, 1874.—“On Two Remarkable Pieces of Iron Furnace Cinder, containing Crystals of Fayalite,” by William H. Johnson, B.Sc.

“On a Specimen of Stigmaria, having the Medulla perfectly preserved,” by E. W. Binney, F.R.S., F.G.S., V.P.

“On the Conditions under which Palæolithic Implements are found in River-Strata and in Caves in association with the extinct Mammalia,” by Professor W. Boyd Dawkins, F.R.S.

“On a Colorimetric Method of Determining Iron in Waters,” by Mr. Thomas Carnelley, B.Sc., communicated by Professor H. E. Roscoe, F.R.S.

November 3rd, 1874.—“On the Corrosion of Leaden Hot-Water Cisterns,” by Professor H. E. Roscoe, F.R.S., &c.

“On an Improvement of the Bunsen Burner for Spectrum Analysis,” by Mr. F. Kingdon, Assistant in the Physical Laboratory, Owens College.

“Some Notes on Pasigraphy,” by Henry H. Howorth, Esq., F.S.A

“On the Existence of a Lunar Atmosphere,” by David Winstanley, Esq.

November 17th, 1874.—“Some Remarks on Dalton’s First Table of Atomic Weights,” by Professor H. E. Roscoe, F.R.S.

“Action of Light on certain Vanadium Compounds,” by Mr. James Gibbons. Communicated by Professor H. E. Roscoe, F.R.S.

“On Basic Calcium Chloride,” by Harry Grimshaw, F.C.S.

"On the Structure of Stigmaria," by Professor W. C. Williamson, F.R.S.

December 1*st*, 1874.—"Some Doubts in regard to the Law of Diffusion of Gases, by Henry H. Howorth, Esq.

December 7*th*, 1874.—"On Œcophara Woodiella," by Joseph Sidebotham, F.R.A.S.

December 15*th*, 1874.—"Some Particulars respecting the Negro of the Neighbourhood of the Congo, West Africa," by Watson Smith, F.C.S.

"Analysis of One of the Trefriw Mineral Waters," by Thomas Carnelley, B.Sc. Communicated by Professor H. E. Roscoe, F.R.S., &c.

December 29*th*, 1874.—"On a Case of Reversed Chemical Action," by James Bottomley, B.Sc.

January 12*th*, 1875.—"On the Sewerage of Towns and the Pollution of Rivers and Streams," by E. W. Binney, F.R.S., V.P.

"On the Action of Rain to Calm the Sea," by Professor Osborne Reynolds, M.A.

"On the Stone Mining Tools from Alderley Edge," by Professor W. Boyd Dawkins, F.R.S.

"Archaic Iron Mining Tools from Lead Mines near Castleton," by Rooke Pennington, LL.B.

January 18*th*, 1875.—"On the Botany of Wilmington, North Carolina," by James Cosmo Melvill, M.A., F.L.S.

January 26*th*, 1875.—"A Descent into Elden Hole, Derbyshire," by Rooke Pennington, LL.B.

"Certain Lines observed in Snow Crystals," by Arthur Wm. Waters, F.G.S.

February 2*nd*, 1875.—"Results of Meteorological Observations taken at Langdale, Dimbula, Ceylon, in the year 1873," by Edward Heelis, Esq. Communicated by Joseph Baxendell, F.R.A.S.

February 9*th*, 1875.—"A Method of Finding the Axes of an Ellipse when two Conjugate Diameters are given," by J. B. Millar, B.E. Communicated by Professor O. Reynolds, M.A.

"Note on the late Mr. James Wolfenden, of Hollinwood," by E. W. Binney, F.R.S., V.P.

February 15th, 1875.—"On Carex ornithopoda," by Charles Bailey, Esq.

"Notes on the Botany and Natural History of Tenby and the neighbourhood," by Joseph Sidebotham, F.R.A.S.

February 23rd, 1875.—"On some specimens of a strong arenaceous shale containing numbers of macrospores of Lepidodendron," by E. W. Binney, F.R.S., V.P.

March 2nd, 1875.—"On the Rainfall at Old Trafford, Manchester, during the Year 1874," by G. V. Vernon, F.R.A.S., F.M.S.

"Results of Rain-Gauge Observations made at Eccles, near Manchester, during the Year 1874," by Thomas Mackereth, F.R.A.S., F.M.S.

March 9th, 1875.—"On Mr. Millar's Method of Finding the Axes of an Ellipse when two Conjugate Diameters are given," by Robert Rawson, Esq., Honorary Member of the Society.

"On a Specimen of Carbon resembling Graphite formed upon the roof of a Gas Retort," by Arthur McDougall, B.Sc.

"On the Presence of Sulphate of Copper in Water heated in Tinned Copper Boilers," by William Thomson, F.C.S.

"On a Collection of Stone and Bronze Articles from the Pile Dwellings in the Lake of Bienne," by Professor W. Boyd Dawkins, F.R.S.

March 23rd, 1875.—"On Discoveries in a Cave at Thayingen, near Schaffhausen," by Arthur Wm. Waters, F.G.S.

March 30th, 1875.—"Photography as applied to Eclipse Observations," by Alfred Brothers, F.R.A.S.

April 6th, 1875.—"A Study of Peat, Part I.," by R. Angus Smith, Ph.D., F.R.S., V.P.

Several of the above papers have already been printed for the forthcoming volume of the Society's Memoirs, and others have been passed for printing. It is expected that the printing of the new volume will be completed before the commencement of the ensuing session.

The Council consider it desirable to continue the system of electing Sectional Associates, and a resolution on the subject will be submitted at the annual meeting for the approval of the members.

The Librarian reports that he has forwarded to the various societies with which we correspond Vols. 8, 9, 10, 11, 12 of our Proceedings and Vol. 4 of Memoirs. The Library has been re-arranged; a large number of volumes have been bound; additional shelves have been added; the catalogue has been completed, and will shortly be ready for the printer. The number of societies with which we correspond continues nearly the same as last year.

DR. SAMUEL BROUGHTON, TREASURER, IN ACCOUNT WITH THE SOCIETY FROM APRIL 1ST, 1874, TO MARCH 31ST, 1875. CR.

		£ s. d.	£ s. d.	£ s. d.
1874. April 1.	—To Balance from Last Year			599 4 11
,,	Members' Contributions:			
	172 on Roll, at £2 2s.	361 4 0		
	Less Compounders .... 4 } ,, Members Deceased .. 3 } 22 at do... ,, ,, in Arrears..15 }	46 4 0		
			315 0 0	
,,	Arrears Received 4½		9 9 0	
,,	5 Members Elected in 1873, to Dec., at £2 2s.	10 10 0		
,,	3 ,, ,, 1874, to Mar., at £1 1s.	3 3 0		
		13 13 0		
	Less 2 in Arrears, at £2 2s.	4 4 0		
			9 9 0	
,,	8 Admission Fees, at £2 2s.	16 16 0		
	Less 2 in Arrears, at £2 2s.	4 4 0		
			12 12 0	
,,	1 Admission Fee in Arrear		2 2 0	
,,	3 Associates, Microscopical Section, at 10s.		1 10 0	
,,	Sale of Publications:			
	Proceedings	1 10 0		
	Memoirs	0 17 0		
			2 7 0	
,,	Sundry Income:			
	Sectional Contributions—			
	Microscopical Section	2 2 0		
	Physical ,,	2 2 0		
			4 4 0	
,,	Bankers' Interest		14 19 11	
,,	Geological Society—½ year's rent, to March, 1874		7 10 0	
,,	Scientific Students—½ year's rent, to Christmas		11 10 0	
				390 12 11
,,	Interest on £1500 from the Owens College for Natural History Society, to December 25, 1874—Less Income Tax			59 8 9
				£1,049 6 7

General Balance:

Compound Fund		98 15 0
Natural History Fund, last year	64 16 10	
,, ,, ,, this year	59 8 9	
	£124 5 7	
Less Voted by Council for Purchase of Books	100 0 0	
		24 5 7
General Balance		419 0 6
		£542 1 1

				£ s. d.	£ s. d.
1875. March 31.	—By Charges on Property:				
	Chief Rent			12 15 10	
	Insurance			7 0 0	
	Property Tax			5 13 4	
					25 9 2
,,	House Expenditure:				
	House Tax			2 2 6	
	Water, Gas, Candles, and Coal			21 0 3	
	Cleaning and Petty Expenses			6 4 2	
	Tea, Coffee, at Meetings			17 15 1	
					47 2 0
,,	Administration Charges:				
	Wages of Keeper of Rooms			57 4 0	
	Attendance on Sections and Societies			5 9 0	
	Postages and Parcels			22 0 0	
	Stationery, Circulars, Stamps			11 0 1	
					95 13 1
,,	Publishing:				
	Memoirs, Printing, and Engravings			9 12 6	
	Proceedings Printing			50 14 6	
	Editor of Memoirs and Proceedings			50 0 0	
					110 7 0
,,	Library:				
	Periodicals			24 18 5	
	Dr. Kestenberg—Assistance			4 0 0	
	Voted by Council for Binding, Shelves, &c.		100 0 0		
	Expended—Binding	50 10 1			
	Shelves	18 4 9			
	Assistant	30 0 0			
			98 14 10	98 14 10	
	Balance Unexpended		1 5 2		
	Subscription to Ray Society			1 1 0	
					128 14 3
					407 5 6
,,	Natural History Section—Voted by Council for Purchase of Books				100 0 0
	Balance in Manchester Bank			496 5 6	
	,, Treasurer's Hands			45 15 7	
					542 1 1
					£1,049 6 7

12th April, 1875.—Audited and found correct,

W. P. CUNNINGHAM.

J. O. KIPPING.

On the motion of Dr. ROSCOE, seconded by Mr. CUNNINGHAM, the Report was unanimously adopted.

On the motion of Dr. ROSCOE, seconded by Mr. BINNEY, it was resolved unanimously :—

"That the system of electing Sectional Associates be continued during the ensuing Session."

The following gentlemen were elected officers of the Society and Members of the Council for the ensuing year :—

President.

EDWARD SCHUNCK, PH.D., F.R.S., F.C.S.

Vice-Presidents.

JAMES PRESCOTT JOULE, D.C.L., LL.D., F.R.S., F.C.S.
EDWARD WILLIAM BINNEY, F.R.S., F.G.S.
ROBERT ANGUS SMITH, PH.D., F.R.S., F.C.S.
REV. WILLIAM GASKELL, M.A.

Secretaries.

JOSEPH BAXENDELL, F.R.A.S.
OSBORNE REYNOLDS, M.A.

Treasurer.

SAMUEL BROUGHTON.

Librarian.

FRANCIS NICHOLSON, F.Z.S.

Of the Council.

CHARLES BAILEY.
ROBERT DUKINFIELD DARBISHIRE, B.A., F.G.S.
WILLIAM BOYD DAWKINS, M.A., F.R.S., F.G.S.
HENRY ENFIELD ROSCOE, B.A., PH.D., F.R.S., F.C.S.
ALFRED BROTHERS, F.R.A.S.
BALFOUR STEWART, LL.D., F.R.S.

The reading of the paper entitled "A Study of Peat," 1st Part, by R. ANGUS SMITH, Ph.D., F.R.S., V.P., was concluded.

PHYSICAL AND MATHEMATICAL SECTION.

Annual Meeting, March 30th, 1875.

Alfred Brothers, F.R.A.S., President of the Section, in the Chair.

The following gentlemen were elected officers of the Section for the ensuing year:—

President.
E. W. BINNEY, F.R.S., F.G.S,

Vice-Presidents.
ALFRED BROTHERS, F.R.A.S.
JOSEPH BAXENDELL, F.R.A.S.

Treasurer.
SAMUEL BROUGHTON.

Secretary.
G. V. VERNON, F.R.A.S., F.M.S.

"Photography as applied to Eclipse Observations," by Alfred Brothers, F.R.A.S.

Since 1860, when photography was first applied to eclipse observations, almost every eclipse of the sun has been photographically recorded—from 1860 to 1868 for the purpose chiefly of determining the nature of the red prominences; and in 1870 and 1871 to ascertain whether the corona is an appendage of the sun or an effect produced in our own atmosphere. Previous to 1870 the ordinary telescope, uncorrected for the chemical rays, had been almost exclusively used. But in 1870 it was determined to adopt a properly corrected photographic lens, and by a graduated series of exposures to obtain if possible the whole pictorial effect. This method was successful, and has been adopted in all eclipse work since. That more suitable apparatus has not been employed may be due to the fact that the funds provided by the Government, the Royal and Royal Astronomical Societies, for the observation of the various eclipses have either all been spent at the time, or the balances have been returned. As good work has been done with the apparatus referred to, it may be asked why anything different should be used. It was by mere accident that a lens of a certain kind was used in 1870, no other suitable was to be had, and the image obtained with it is small. Photography was not employed during the eclipse of 1874, almost the only observer on that occasion being the Astronomer Royal at the Cape of Good Hope, Mr. Stone, who observed with the spectroscope under the most favourable conditions, and it is much to be regretted that no photographs were obtained. On the occasion of the recent eclipse no preparations were made until the invitation from the King of Siam was received, and then, as on almost every occasion since 1868, all arrangements have been hurriedly made. No apparatus for obtaining a picture of the corona different from what has been previously used was employed, and consequently no superior result may be anticipated. The lenses used in 1870 and since for photographing the corona give an image of the sun of about $\frac{3}{10}$ths of an inch in diameter, and although suitable for small pictures, such lenses cannot be said to be the best for the purpose. I would suggest therefore that at least three achromatic lenses of 5 or 6 feet focal length, corrected for the actinic rays, should be constructed, with all suitable apparatus, so as to be ready for use when required. The light of the corona is sufficiently actinic to produce good pictures when an instrument of long focus is used—it is only a question of time in the exposure and accuracy in the adjustment of the driving clock apparatus attached to the equatorial mounting. There cannot I think be any doubt that under favourable atmospheric conditions some features of interest would be revealed during every eclipse, and it is undesirable to allow any eclipse of the sun to occur without some attempt being made to record such phenomena permanently by means of photography. It seems to me also equally certain that pictures of greater dimensions such as the instrument suggested would give would be proportionally more valuable than any hitherto obtained.

The photographic process used has always been the wet collodion. It might be advantageous to use daguerreotype plates, but I see no reason why both methods should not be employed.

MICROSCOPICAL AND NATURAL HISTORY SECTION.

April 12th, 1875.

JOSEPH BAXENDELL, F.R.A.S., in the Chair.

Mr. ARTHUR W. WATERS, F.G.S., presented the section (for the cabinet) with the following slides:—

Diatomaceous earth from Billin, in Bohemia, full of Gallionella distans. Ehr.

Diatomaceous earth from Berlin.

Spicules of Alcyonium digitatum, from Brighton.

Dr. ALCOCK read a paper on the occurrence of Hyperia Galba, and Lestrigonus Kinahani, crustaceans parasitic upon Medusæ, at Southport, on a sand bank called the "Seldom seen" Bank.

A paper was read on the Mollusca, &c., inhabiting Cymmeran Bay, Anglesey, by Mr. JOHN PLANT, F.G.S., &c.

Cymmeran Bay is a deep indent on the western coast of Anglesey. At the head of the bay is the strait which separates the small island of Holyhead. The bay at the widest part is five miles wide, from the small islet of Meibion, south, to the Rhoscolyn beacon islet, north. The head of the bay is an immense sand, over which a small stream finds its way to the sea. The north and south shores are rocky crags, and long islets of jagged and rough rocks occur at intervals in the bay, making it a source of danger to any vessels that drift from the channel, or in a fog lose their course and sail with the strong western winds right into the bay.

In places where the high cliffs have been worn away the shore is shallow and has miles of firm sand, whilst these sands are fringed with sand dunes, which inland stretch away in barren and wild commons with small bosses of rocks. The district is rarely visited by strangers, and altogether is a wild, stormy, and mainly uncultivated district. The rocks are grand for geological study; they are black slates, shales, serpentines, quartzites, granites, and conglomerates of Cambrian age. The last rocks are mines of the most valuable knowledge for the study of primitive rocks of pre-Cambrian age.

The sandy shores are extensive at the head of the bay; with continuous winds from the west and south the breakers are fearfully heavy, and the sea so rough that no boat from the shore can be launched by the fishermen for many weeks together; calms are rare and uncertain, so that fishing is precarious; at low tides a fine expanse of shore is exposed, as dry and as level as a bowling green, with the bosses of black and bright green rocks striking out of the level.

The conchologist would be greatly disappointed if he paid but a brief visit to the shores. He might walk all day and conclude that the sand was extensive but as barren of shells as a snowdrift. But with leisure and perseverance parts of the shore are found to be teeming with some species, and in the rocky pools and quiet caverns and corners many rare specimens are to be found. At present my list of species of shells embraces eighty, but the list will be extended this year, when closer attention is paid to the specimens brought up by the dredgers.

The list of fishes comprises all that I have identified; no doubt there are many others caught in the bay.

SOME OF THE FISHES CAUGHT IN CYMMERAN BAY.

1. Spinax acanthias, spined Dog fish, caught during the herring season and at times amongst the rocks.
2. Raia clavata, Thornback Ray, not uncommon, is caught to cut up for baiting the Lobster pots.
3. Aculeatus marinas, Fifteen-spined Stickleback, in the rocky pools.
4. Latrax Lupus, Bass, caught in great numbers during summer, about the rocks; they are good eating.
5. Sparus aurata, common Sea Bream.
6. Trigla lyra, Piper Gurnard, occasionally caught out in the bay.
7. Scomber vulgaris, Mackerel, the fishing trawlers meet with shoals out in the channel, opposite the bay.
8. Gobius niger, Rock Goby, rare.
9. Labrus tinea, Ballan Wrass, found about the rocks in the bay.
10. Morrhua vulgaris, the Cod, the commonest fish in the bay.
11. Merlangus pollachias, Pollack Whiting, common during the summer.
12. Merlangus carbonarius, Coalfish, common along all the coast.
13. Ammodytes tobianus, Sand Launce, rather scarce.
14. Platessa vulgaris, the Plaice, uncommon in the bay.
15. Platessa limanda, the Dab, abundant in summer.
16. Solea vulgaris, the Sole, rare.
17. Clupea Harengus, the Herring, found passing the bay out in the channel.
18. Salmo salar, the Salmon. The salmon is caught in numbers in calm warm weather in summer, in the bay; it also runs up the river Crigyll to spawn, and is found in Lake Maelog.
19. Murœna conger, Conger Eel, caught with bait in the bay.

20. Sygnathus, Pipe fish, sometimes cast on shore.
21. Petromyzon marinus, Sea Lamprey, caught in the pools.

Hydrozoa. Pulmonigrada. Rhizostoma Cuvieri, large mushroom-shaped jelly fish, 14 inches diameter.

Physalia pelagica, Portuguese Man-of-war.

Sea Anemone, common smooth species, "Actinia mesembryanthemum."

SHELLS. CLASS I.—ACEPHALA.

Fam. IV.—Corbulidæ.

1. Corbula nucleus (2 specimens), rare.

Fam. VII.—Solenidæ.

2. Solen siliqua, rare.

Fam. IX.—Tellinidæ.

3. Psammobia Ferroensis, very rare.
4. Tellina crassa, common.
5. „ solidula, common.
6. „ fabula, rare.
7. „ tenuis, rare.
8. Syndosmia alba, rare.
9. Scrobicularia piperata, not numerous.

Fam. X.—Donacidæ.

10. Donax anatinus, very common.

Fam. XI.—Mactridæ.

11. Mactra solida, common.
12. „ stultorum, semi-common.
13. „ subtruncata, rare.

Fam. XII.—Veneridæ.

14. Tapes decussata, common.
15. „ palustra, uncommon.
16. Cytherea Chione, $\frac{1}{2}$ valve.
17. Venus striatula, very common.
18. „ fasciata, uncommon.
19. Artemis exoleta, semi-common.

Fam. XIII.—Cyprinidæ.

20. Cyprina Islandica, rare.

Fam. XIV. —Cardiadæ.

21. Cardium rusticum, common.
22. „ edule, common.
23. „ Norvegicum, rare.

Fam. XV. – Lucinidæ.

24. Lucina flexuosa, ½ specimen, very rare.
25. „ Leucoma, semi-rare.

Fam. XIX.—Mytilidæ.

26. Mytilus edulis, semi-common.
27. „ barbata, rare.
28. „ tulipa, rare.

Fam. XX.—Arcadæ.

29. Nucula nucleus, rare.

Fam. XXII.—Ostreadæ.

30. Pecten varius, common.
31. „ maximus, uncommon.
32. „ Danicus (1 specimen), very rare.
33. Anomia ephippium, semi-common.
34. Ostreas edulis, common.

Beds of oysters upon rocky and shingly bottoms are found to extend about eight miles, running from Cymmeran Bay to beyond Rhoscolyn to the north; great numbers are sent to the Manchester market.

CLASS IV.—PROSOBRANCHIATA.

Fam. XXVII.—Chitonidæ.

35. Chiton cinereus, rare.

Fam. XXVIII.—Patellidæ.

36. Patella vulgata (and others), common.
37. „ pellucida.
38. Acmea virginea, rare.
39. „ testudinalis, common.

Fam. XXIX.—Dentaliadæ.

40. Dentalium dentalis (Holyhead), rare.

Fam. XXX.—Calyptræidæ.

41. Pileopsis Hungaricus, rare.

Fam. XXXI.—Fissurellidæ.

42. Fissurella reticulata, rare.
43. Emarginula reticulata.

Fam. XXXIII.—Trochidæ.

44. Trochus ziziphinus, very rare.
45. ,, striatus.
46. ,, cinerarius.
47. ,, umbilicatus.
48. ,, magus, rare.
49. Phasianella pullus, common.

Fam. XXXVII.—Lillorinidæ.

50. Littorina littorea, common.
51. ,, rudis, ,,
52. ,, littoralis, ,,
53. Rissoa crenulata, 1 specimen.
54. ,, costata, few.
55. ,, striata ,,
56. ,, parva, numerous.
57. ,, labiosa, few.
58. ,, cingillus, few.
59. ,, ulvae, 1 specimen

Fam. XXXVIII.—Turritellidæ.

60. Turritella communis, rare.

Fam. XXXIX.

61. Aporrhais pes-pelicani, Holyhead, 1 specimen.
62. Cerithium reticulatum, rare.

Fam. XLI.—Pyramidellidæ.

63. Chemnitzia elegantissima, rare.
,, fenestrata, rare.
64. Odostomia plicata, rare.

Fam. XLII.

65. Natica monilifera, very rare.

Fam. XLV.—Muricidæ.

66. Murex erinaceus, not very common.
67. Purpura lapillus, common.
68. Nassa reticulata, not very common.
69. Buccinum undatum, not common.

70. Fusus Islandicus (broken), rare.
71. Trophon clathratus, rare.

FAM. XLVI.—CONIDÆ.

72. Mangelia turricula, very rare.
73. „ rufa, rare.
74. „ nebula, rare.
75. „ costata, rare.
76. „ septangularis, rare.

FAM. XLVII.—CYPRÆADÆ.

77. Cypræa Europæa, common.

FAM. XLVIII.

78. Cylichna cylindracea (Holyhead 1), rare.
79. „ obtusa, rare.

Sponges—very few, common species.

Foraminefera—Polymorphina, Biloculina Lagena, Dentalina.

Zoophytes—few ordinary species.

Medusæ—seen in the luminous waves in the autumn—jelly fish and Portuguese man-of-war.

Hydrozoa—The most interesting of these beautiful creatures found in the bay are the crimson winged jelly fish, "*aurelia aurita,*" chiefly in the summer season, and the large species, *Rhizostoma Cuvieri,* in the spring. Many of the specimens I examined this Easter had a diameter of 14 inches, and weigh about 10lbs. They present a most exquisite appearance when alive, and are fine examples for dissection and study.

The Medusæ are in myriads in late summer, and give the bay a luminous and flashing star-like aspect on warm nights. The rarest and most striking of the Hydrozoa is *Physalia pelagica,* one of the Portuguese men-of-war. After a south-western gale, it is frequently met with by the oyster dredgers floating into the bay, and some of them are ultimately driven on shore amongst the rocks. I have found large specimens, the bladder being 8 inches long, and the inferior appendages 24 inches. I know of no creature of the sea which is so exquisitely tinted with changing prismatic colours as this floating glassy bubble presents, and in my enthusiasm to examine into its structure, I had to suffer from the acute stinging secretions which in handling a Physalia is abundantly given out by the soft thread-like appendages; my hands and arms became inflamed, and it was several hours before the pain was allayed, leaving itching for days after.

I was not able to preserve any specimens in a recognisable form; they dry up to a mere skin and gelatinous film.

Starfishes—scarce, common Crossfish (uraster rubens), parts of Echinus, common.

Anelida—serpula (phyllodoce luminosa, lob-worm).

Crustacea—Lobster, abundant, edible Crab, common, very few others; Shrimp scarce.

Cirripedia—Acorn barnacle (Balani), fringing all the rocks to the line of high tide, and Lepas anatifera, occasionally.

The Anemones are abundant on the rocks and small pools, but the species are all common, such as *mesembryanthemum.*

Annual Meeting, May 3rd, 1875.

H. A. Hurst, Esq., in the Chair.

The following gentlemen were elected Officers of the Section for the Session 1875-76 :—

President.

W. BOYD DAWKINS, F.R.S., &c.

Vice-Presidents.

R. D. DARBISHIRE, B.A., &c.
CHARLES BAILEY.
THOMAS ALCOCK, M.D.

Treasurer.

HENRY ALEXANDER HURST.

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J. COSMO MELVILL, M.A., F.L.S.

Council.

JOSEPH BAXENDELL, F.R.A.S., &c.
SPENCER H. BICKHAM, Jun.
JOHN BARROW.
JOSEPH SIDEBOTHAM, F.R.A.S.
A. W. WATERS, F.G.S.
ALFRED BROTHERS, F.R.A.S.
THOMAS COWARD.

The following is the list of Members and Associates :—

Members.

Alcock, Thomas, M.D.
Bailey, Charles.
Barrow, John.
Baxendell, Joseph, F.R.A.S.
Bickham, Spencer H., Jun.
Binney, E. W., F.R.S., F.G.S.
Brockbank, W., F.G.S.
Brogden, Henry.
Brothers, Alfred, F.R.A.S.
Cottam, Samuel.
Coward, Edward.
Coward, Thomas.
Dale, John, F.C.S.
Dancer, John Benj., F.R.A.S.
Darbishire, R. D., B.A.
Dawkins, W. Boyd, F.R.S.
Deane, W. K.
Gladstone, Murray, F.R.A.S.
Heys, William Henry.
Higgin, James, F.C.S.
Hurst, Henry Alexander.
Latham, Arthur George.
Maclure, J. W., F.R.G.S.
Melvill, J. Cosmo, M.A., F.L.S.
Morgan, J. E., M.D.
Morris, Walter.
Nevill, Thomas Henry.
Piers, Sir Eustace.
Rideout, W. J.
Roberts, William, M.D.
Sidebotham, Joseph, F.R.A.S.
Smart, Robert Bath, M.R.C.S.
Smith, Robert Angus, Ph.D., F.R.S., F.C.S.
Vernon, George Venables, F.R.A.S.
Williamson, Wm. Crawford, F.R.S., Prof. Nat. Hist., Owens College.
Wright, William Cort.
Waters, A. W., F.G.S.

Associates.

Hardy, John.
Hunt, John.
Labrey, B. B.
Linton, James.
Meyer, Adolph.
Peace, Thos. S.
Percival, James.
Plant, John, F.G.S.
Rogers, Thomas.
Ruspini, F. Orde.
Stirrup, Mark.
Tatham, John F. W.
Warren, Hon. J. B. Leicester.
Waterhouse, J. Crewdson

The Microscopical and Natural History Section of the Manchester Literary and Philosophical Society in Account with the Treasurer, H. A. Hurst.

Dr.

1875.	£	s.	d.
To Zoologist to 1861	5	0	0
,, Chairs and Rotating Table	6	2	0
,, Microscopical Journal	3	15	0
,, Subscription to Parent Society	2	2	0
,, Sundry Books—J. Friedlander	34	4	0
,, ,, J. Rowsell	6	7	6
,, Printing	2	14	6
,, Subscription to Microscopical Journal	0	16	0
,, Teas and Postages	4	2	4
,, Balance at Bank	104	19	8
	£170	3	0

Cr.

1874.				£	s.	d.
May 23. By Balance at Bank				43	19	9
1875.—Subscriptions :						
Four Arrears	£2	0	0			
Ten Associates	5	0	0			
Thirty-six Members	18	0	0			
				25	0	0
Received on account of interest on Grant from late Natural History Society				100	0	0
Interest allowed by Bank to Dec., 1874				1	3	3
				£170	3	0

Examined and found correct,

(Signed) Arthur Wm. Waters, Thos. Coward, } Auditors.

H. A. Hurst.

1875.

May. By Balance at Manchester and Salford Bank, St. Ann's-street £104 19 8