PROCEEDINGS

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NOTE.

The object which the Society have in view in publishing their Proceedings is to give an immediate and succinct account of the scientific and other business transacted at their meetings to the members and the general public. The various communications are supplied by the authors themselves, who are alone responsible for the facts and reasonings contained therein.

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CORRIGENDUM.

Page 2, line 16, for: $B = \frac{4\lambda'\lambda}{Ll} mm_1$, read $B = \frac{4\lambda'\lambda}{Llmm_1}$.

PROCEEDINGS

OF THE

LITERARY AND PHILOSOPHICAL SOCIETY.

General Meeting, October 2nd, 1883.

H. E. Roscoe, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

Mr. Frederick James Faraday, of Levenshulme, was elected an Ordinary Member of the Society.

Ordinary Meeting, October 2nd, 1883.

H. E. Roscoe, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

"On the Change produced in the Motion of an Oscillating Rod by a heavy Ring surrounding it, and attached to it by elastic cords," by James Bottomley, B.A., D.Sc., F.C.S.

At a meeting of the Physical and Mathematical Section, on January 16th, Dr. Joule brought under the notice of the members a method which he had devised for damping the small oscillations of a telescope, or any other heavy mass which it is desirable to keep as steady as possible. The arrangement consisted of a heavy ring surrounding the vibrating mass, and attached to it by extensible strings. In this paper the author considers the action of one of these rings in modifying the motion of a rod suspended from a fixed beam by two cords of slight elasticity. m being the mass of the rod and m_1 the mass of the ring, λ^1 the modulus of elasticity of the cords supporting the rod, L the length of each cord, λ the modulus of elasticity of the cords connecting the rod with the ring, l the unstretched length of each of these cords, then x and x_1 denoting the displacements from their positions of rest, of the axis of the rod, and the centre of the ring, the following equations of motion are obtained:

$$m\frac{d^2x}{dt^2} = -2x\left(\frac{\lambda^1}{L} + \frac{\lambda}{l}\right) + \frac{2\delta}{l}x_1.$$

$$m_1\frac{d^2x_1}{dt^2} = \frac{2\lambda}{l}x - \frac{2\lambda}{l}x_1.$$

From these equations by elimination an equation is obtained of the form

$$\frac{d^4x}{dt^4} + A\frac{d^2x}{dt^2} + Bx = 0 \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where $A = \frac{2}{m}\left(\frac{\lambda^1}{L} + \frac{\lambda}{l} + \frac{\lambda m}{lm_1}\right)$

$B = 4\frac{\lambda^1\lambda}{Ll}mm_1$

Assuming $x = Ce^{\mu t}$

Differentiating four times, and twice, substituting in equation (1) and dividing by a common factor we obtain

$$\mu^4 + \mu^2A + B = 0.$$

On examination all the roots of this equation prove to be imaginary. Substituting trigonometrical functions for the impossible exponentials, an equation is obtained of the following form

$$x = P\cos pt + Q\cos qt + R\sin pt + S\sin qt,$$

where $p = \sqrt{\frac{A}{2} - \sqrt{\frac{A^2}{4} - B}}$ and $q = \sqrt{\frac{A}{2} + \sqrt{\frac{A^2}{4} - B}}$.

The parameters P, Q, R, S, are determined by reference to the initial conditions, and V being the initial velocity of the rod we get the following equation:

$$x = \frac{V}{pq}\frac{(q^4\sin pt - p^4\sin qt)}{(q^3 - p^3)}.$$

The remainder of the paper is taken up with a discussion of this equation, and also of the case when there are *n* rings symetrically disposed about the middle of the rod. The subsidence of motion due to internal friction in elastic solids has not been taken into account.

General Meeting, October 16th, 1883.

H. E. Roscoe, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

Mr. Harry Baker, F.C.S., of Owens College, was elected an Ordinary Member of the Society.

Ordinary Meeting, October 16th, 1883.

H. E. Roscoe, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

"On the leaves of *Catha edulis*," by C. Schorlemmer, F.R.S.

In a paper which I read before the Society a few months ago* I stated that the custom of drinking coffee was introduced into Arabia only in the beginning of the fifteenth century. Before this time the beverage made of leaves of kát (*Catha edulis*) was used and is still in use, possessing properties resembling those of strong green tea, only more pleasing and agreeable. From this it appeared to me highly probable that kát contained caffeine, which occurs in tea, coffee, and some other plants, all of which are used as stimulants.

Professor T. Thistleton Dyer, F.R.S., kindly supplied me with fresh leaves of Catha, grown in Kew Gardens. Not a trace of caffeine was found, while, to show its presence in tea, a very few leaves are sufficient.

* Proceedings, April 3rd, 1883.

From the facts it appeared probable that the tea and coffee grown at Kew would not contain it; that, however, was found not to be the case. Its presence could be easily detected in the leaves of *Tea viridis* and *Coffee arabica.*

Through the kindness of Professor Dyer, I have since obtained two genuine samples of Kát, coming directly from Aden, one being labelled "Kát Sabâri," so called as coming from Sabar, a mountain range in Yemen, and the other "Kát Mactari Asháb," as it has long (asháb) leaves. I have examined both carefully, without finding a trace of caffeine or an alkaloïd being related to it. It requires therefore further researches in order to discover the active principle of Catha.

Dr. SCHUSTER, F.R.S., gave an account of Meteoric dust, and exhibited some specimens found in Himalayan Snow.

"On the Duality of Physical Forces," by JAMES RHODES, M.R.C.S.

There are two Primary Forces in the Universe:

1st. Gravitative. Mechanical or weight producing force causing condensation of matter.

2nd. Expansive force causes expansion of matter.

Thus, these forms of motion are distinct and opposite in character in their actions on matter, the one to the other.

The consideration of the above question does not affect the truth of Drs. Meyer and Joule's theory of the mechanical equivalent of heat, but will show that the Mechanical Gravitative, or Weight Force, is not converted into heat, but that owing to the condensation of matter, effected by 772 foot lbs. of this force, a given quantity of expansive force is emitted as 1 degree of heat.

That a body, apparently at rest, still continues to act by its weight, pressure, and condensation to eliminate heat from matters towards the earth's centre. And also the action of gravitative force acting on the sun's photosphere causes the emission of light and transmission through space.

Ordinary Meeting, October 30th, 1883.

J. P. Joule, D.C.L., LL.D., F.R.S., &c., Vice-President, in the Chair.

"On the Action of Water upon beds of Rock Salt," by Thomas Ward, Esq.

During the last century, but more especially within the past few years, a number of interesting phenomena in connection with the action of water on beds of salt have presented themselves in the Salt Districts of Cheshire. I propose in this paper to examine these phenomena, and to show how fresh water acts upon rock salt, and to point out the results of such action:—

The various beds of rock salt, in whatever geological formation they exist, are clearly crystalline deposits from the saturated brine of salt lakes. In the dry season, when a salt lake, owing to the evaporation of a portion of the water, becomes saturated brine, salt crystals form on the bottom, under water, and continue to grow and increase as long as the evaporation continues. This is well illustrated in Lake Sambhur, and a number of similar lakes in Rajputana, also in salt lakes near the Caspian Sea, and in many other parts of the world. As soon as the wet season arrives, and the water from the brooks and rivers, bearing down mud, enters into the lake, the beautiful sharp angles of the crystals of salt become rounded off, and the fine mud enters into all the interstices amongst the crystals, and forms an amorphous mass of salt and clay, which is called rock salt. In some portions of the mass, salt prevails, in others, mud. Rock salt deposits vary from nearly pure salt, such as is mined for trade purposes in Cheshire, and which was evidently deposited when a longer period of dry seasons prevailed, to salt with clay in such a large proportion as to make it doubtful whether to call it clay with salt intermixed or salt with clay intermixed. This latter deposit forms when seasons of excessive rainfall occur, or, if the clay is purely local in the salt bed, it is formed in that portion of the lake nearest the influx of the streams. I show specimens of both kinds. A section of a thick deposit of rock salt gives a good idea as to the greater or lesser amount of rainfall, and of the comparative lengths of periods of little rain and periods of excessive rain. The marls immediately overlying the salt beds show the rainfall to have been more than would allow the lake to become saturated brine.

On the rock salt thus formed I propose to trace the action of fresh water brought into contact with it, and to indicate the results following from such contact. I will examine the action of

(1) *Water in a state of rest.*

(2) *Water descending by gravitation and passing over beds of salt in its course to a lower level.*

(3) *Water descending by gravitation to beds of salt below the surface of the earth, and reappearing as brine springs at the surface, but at a higher level than the salt beds.*

(4) *Natural water set in motion, or its motion accelerated, by artificial means, such as pumps.*

(5) *Water conveyed artificially to deep salt beds, and then pumped up again.*

Under these heads, which, though apparently similar, are really distinct, it will be possible to class all the phenomena exhibited by the action of water on beds of rock salt.

I.—*Water in a state of rest.*

Water at times reaches a bed of salt, and can proceed no further, but remains motionless. This is not a very frequent occurrence, but happens either when there is an irruption of water into a salt mine, which flow of water is stopped before the mine is drowned out; or, when water in greater or lesser quantities finds its way down the shaft. The water in these cases settles itself in the lowest portions of the sole or floor of the mine, and remains there for many years. (The *Sinkwerks* of Ischl and neighbourhood are also examples during the time the water is at rest, but as this water is frequently conveyed to the chambers in the salt artificially, and removed in the same manner, they belong more properly to another section of my subject.) As soon as the fresh water reaches the salt a process of solution commences, and proceeds until the water is fully saturated—that is, until it has taken up about 26 per cent of salt.* The saturation point varies slightly according to the temperature of the water, warm water dissolving slightly more salt than cold. The specific gravity of brine having 26 per cent of salt is 1·2. These numbers are nearly accurate, and easily remembered, though roughly we may adopt the Cheshire formula for saturated brine, viz.: 1 part salt, 3 parts water. In the process of solution the salt is dissolved and the clay is left behind. The surface of the salt is very irregular when the saturation is completed, the masses of clay remaining standing up in ridges or isolated miniature mounds more or less honeycombed. The moment saturation is complete no further action upon the salt takes place, and however long the same body of water remains no further dissolution of salt will occur. If, however, as nearly always must happen, the water slowly evaporates, the salt held in solution recrystallizes upon the salt surface below water and forms a most beautiful crystalline floor or pavement, the crystals of which form perfect semi-transparent cubes,

* In becoming saturated, if it be deep enough to extend up the pillars supporting the roof, it eats them away, and renders the mine insecure. This was the case with Neumann's and Blackburne's mines, in Marston, and to a slight extent with Gibson's mine, in Wincham.

varying in size chiefly according to the time they have been forming. These cubes, though each perfect in itself, form at all angles, and possess no symmetry of arrangement as regards each other, as will be seen by the specimen I produce, which is the growth of over 20 years. It is only under water that the crystals form, for as soon as the surface of the crystal appears above the brine it becomes covered with a saline efflorescence. This efflorescence generally takes the form and appearance of minute cauliflowers. In the Rajputana saline lakes, the surface upon which the salt crystals form being mud—the salt crystals being taken out every year—each crystal forms separately, as will be seen in the specimens I produce from Pachbadra, called "mud salt."

As rock salt if exposed to the weather dissolves, unless great care is taken the crystals soon lose all their sharp angles and form a rounded mass. To prevent this dissolving of the angles it is well to keep the rock salt either in a very dry place or in a saturated solution of brine, it being a common saying in Cheshire, that "the best place to keep rock salt is in brine." I wish this fact to be borne in mind, for it will explain the phenomenon of least solution of rock salt taking place at the brine pumping stations of Cheshire; a fact which puzzles many, and which has led to the propounding of many curious and unscientific theories.

Saturated brine left perfectly motionless, but exposed to the atmosphere, creeps by capillary attraction, and forms a saline incrustation or efflorescence.

II.—*Water descending by gravitation and passing over beds of salt in its course to a lower level.*

This is a case of water in motion passing from a higher to a lower level, and on its way flowing over beds of salt.

In several parts of the world the beds of rock salt lie upon the surface or stand out as hills exposed to the weather. The most important of these are the rock salt mountain of Cardona, in Spain, the Kohat rock salt in North-west India, the Great Salt Range at Kalabagh, Usdum, at the south of the Dead Sea, and in Transylvania numerous beds exposed in the valleys of rivers and brooks in the Carpathian mountains. In England all the beds of rock salt lie at a considerable depth below the surface. In sinking down to these beds, water-bearing strata are almost invariably met with, and when the shaft, passing through the rock salt to the mine either in the lower portion of the first salt bed or in the second bed, is not made perfectly watertight, so as to prevent the upper waters reaching the salt, the same action takes place as in the salt beds exposed to the rains and moisture of the atmosphere.

In Kohat there is on an average a solution of two inches of rock salt on the exposed surface annually. In the wet season the rains channel and furrow the surface of the salt bed and then run off in tiny streams of a saline nature to the brooks and rivulets. The clay, always existing in rock salt, prevents some portions from being eaten away, and the salt presents not one even smooth surface as might be supposed, but a channeled and columned or fluted surface in parts, with here and there marly protuberances or ledges. In Transylvania the solution of the salt by water percolating through the thin layer of earth which in many parts covers it causes landslips which leave the face of the rock salt exposed. The quantity of salt dissolved by rain in these exposed salt beds is not nearly so much as might be expected, for the rain runs down the face of the rock too quickly to become saturated. At Cardona we are told that the mountain loses only four feet in 100 years, or about half an inch per annum. The eating or destroying force of fresh water when directed continuously over a salt bed has been taken advantage of at Varangeville, near Nancy, in mining rock salt. A fine stream of fresh water is turned upon the rock salt; this soon cuts a small channel in the salt, which widens and deepens to such an extent that large blocks of salt easily become detached. Unfortunately for the miners by this method, the water running too quickly to become saturated passes away to the sole of the mine and there completes its saturation, very frequently undermining the pillars left to support the roof of the mine and causing great destruction.

In the Cheshire salt district enormous damage has been caused by water passing from the upper strata over the surface of the first salt bed and down the face of the salt exposed in the shaft to the mine below. Nearly all the oldest mines have been destroyed in this way. These mines were in the upper bed of rock salt, which was discovered in 1670 but not worked for a number of years after this. In 1781 the lower bed of rock salt was discovered, and a year or two after this mines were worked in the lower bed and those in the upper bed gradually abandoned. The history of the neighbourhood of Northwich from about 1750 to the present time is a constant repetition of the falling in of old mines. In almost every case known this was caused by water. The sinking takes place near the shaft, which is naturally the weakest place, and at first resembles a well but continually enlarges in size till it is 50, 60, or even 100 feet in diameter. After this the sides crumble down till the hole chokes at the bottom and a funnel or crater remains which in time fills with water and becomes one of the numerous pits in the neighbourhood of Northwich known as rock pit holes. I have recently had several opportunities of seeing the process in action. Water trickling down a shaft in Wincham—still standing—has channeled the rock salt so deeply that in parts it has the appearance of the columns of a church or cathedral. The cavities or flutings are in many places several feet deep, and the shaft, instead of being 4 to 5 feet in diameter, is from 12 to 15 feet. In one part there is a bed of marl which remains as a protuberance all around the shaft. Above and below—but especially below—the salt is much eaten away. The water is now prevented from running down, consequently the dissolving action is suspended and the shaft remains to show the cause of the destruction of so many other shafts.* Another shaft (Platt's Hill) recently collapsed. Just prior to falling in, it was inspected and the rock salt was found to be eaten away to a distance of from 30 to 40 feet from the centre of the shaft, and a huge cavern or cavity, many feet high, was left. This soon collapsed, and now, although men were employed for several months filling in earth to keep the hole choked and to prevent it drawing in a neighbouring tramway, it still keeps sinking, showing that solution by water is yet going on. About 200 yards from Platt's Hill—in a district called Dunkirk—another shaft collapsed nearly two years ago. This was a brine shaft. The fresh water found access to the rock salt and dissolved it, leaving a huge cavity. The shaft sank suddenly, taking in the surface and burying the pump trees, &c. I have just finished lining with bricks, set in cement, a portion of a shaft in which fresh water had commenced to attack the rock salt. Here the shaft being new and the water small in quantity, the damage has been but slight. So needful is it to prevent the water running over the rock salt and causing serious damage, that owners of salt mines which have not been worked for more than 20 years are yet obliged to pump up weekly, or at longer intervals, the water caught in reservoirs placed in the shaft for this purpose. The old mines being abandoned and the shafts timbered across and filled in, were in process of time forgotten. Solution by water, however, has been going on and the rock salt has

* The marl mixed with the rock salt fell to the bottom of the shaft where it forms a large heap, whilst the partly saturated water formed pools on the floor of the mine in which beautiful salt crystals are now forming.

been eaten away around the shaft and huge cavities formed. Two instances of collapse from this cause in the immediate neighbourhood of Platt's Hill mine have occurred within the last 14 years. The last one, about 5 years since, is the most extensive subsidence of its kind known near Northwich. The existence of an old mine on the spot had been quite forgotten. The greatest enemy the miner of rock salt has to contend with is the fresh water. It is dangerous whether in small or large quantities. At times it has burst in in large quantities and drowned out the miners, destroying the mine. This was frequently the case in the early days of salt mining, but has not been common of late. As, however, it does not spring from the solution of the salt, there is no need to refer further to it.

III.—*Water descending by gravitation to beds of salt below the surface of the earth and reappearing as brine springs at the surface, but at a higher level than the salt beds.*

This is by far the most common form of water acting upon beds of salt, inasmuch as the greater number of salt deposits lie at considerable depths below the surface of the ground. It is not however every bed of salt that is acted upon by water, nor does the water act upon every portion of a salt bed. The marls which invariably accompany rock salt are very frequently water-tight, and then we have what the Cheshire miners call a "dry rock head." In Cheshire the first bed of rock salt is almost always reached by the water, whilst the second bed, separated by about 30 feet of very hard marl (commonly called "stone") from the first bed, the water never reaches.

Brine springs, or saline springs, are common in most parts of the world, and almost invariably indicate the presence of beds of salt not far off. There are however in Germany and in India very weak brine springs which most probably derive their salinity from rocks and earths containing salt intermixed but not in the form of rock salt strata. The more nearly saturated a salt spring is, the more certain is it that the bed of salt is very near. In most cases salt springs were known for ages before the rock salt beds from which they originated were discovered. In England salt was manufactured from the springs by the Romans, whilst the first rock salt was only discovered in 1670. In Germany numerous springs were known and worked from the earliest times, whilst it is only in the present century that the chief beds of salt have been found by boring. At Lüneberg, in Hanover, a spring of brine nearly saturated had been known for ages, as also at Halle, in Saxony: both are mentioned as the best in Germany, in Vol. I. of Philosophical Transactions, 1665-1666; yet it is only within the last few years that the rock salt has been discovered at these places. In almost every country we have the same report made. In America brine springs were known long before the salt beds were discovered. Along the Carpathian mountains, from Roumania to Poland and Hungary, rock salt is used in preference to white salt, indicating in the first place that the beds of salt lie near, as a rule, to the surface, and that brine springs were not so numerous and strong as to be worth the trouble of evaporating when salt could be got so easily out of mines. However, generally speaking, salt springs preceded salt mines, and almost all the towns whose names indicate connection with salt, such as the 'Wiches' in England: Droit*wich*, Nant*wich*, Middle*wich*, North*wich*: in Germany, the various towns with *Salz*, *Sulz*, and *Hall*, as *Salz*wedel, *Salza*, *Sulz*, *Hall*, Reichen*hall*, &c., were connected with salt springs. The great majority of natural brine springs are weak or not nearly saturated. Scarcely one fully saturated brine spring flowing away naturally is or has been known to exist. Those in England on the average, as far as can be learnt, were stronger than most of the continental ones, though in no case fully saturated. A casual remark made in the letter of Adam Martindale, in which he describes the discovery of rock salt in Cheshire in 1670, viz.: "a rock of natural salt, from which issues *a vigorous sharp brine, beyond any of the springs made use of in our salt works,*" shows that the natural springs were not fully saturated. This is borne out by a recent analysis of springs at Nantwich, none of which are fully saturated. It would be easy to give a list of scores of springs in Germany varying from 1 per cent upwards, the bulk being 7 to 12 per cent.* Now, as the strength of a brine spring indicates the amount of action upon the salt bed from which it derives its saline matter, and this together with the quantity of water discharged by it, the amount of salt abstracted, we have as it were certain standards to measure the natural action of water upon salt beds. As but few salt springs are fully saturated, so few run very copiously. It may be taken as an axiom that the more copious the spring is, the less salt is there in it. The strongest springs do not always reach the surface or do but gently ooze over it. The old Northwich spring is described early in the 17th century in Camden's Britannia as "a most plentiful and deepe brine pitte." Again, Camden, speaking of Middlewich and Northwich, says, "Brine or salt water is drawn out of pittes." At Nantwich, Dr. Jackson, in 1688, says, "In two places within our township the springs break up so in the meadows as to fret away not only the grass but part of the earth, which lies like a breach, at least half a foot or more lower than the turf of the meadows and hath a salt liquor oozing as it were out of the mud but very gently." Dr. Brownrigg, in 1748, says in his Treatise on "The Art of Making Common Salt," p. 95, "The salt springs

* Quenstedt, in "Klar und Wahr," p. 240, says "However much boasted of the springs of North Germany may be, they have not saturated brine, only a single one on the Lüneberg Heath, in Hanover, is nearly saturated."

in England and other countries are most of them wells or pits of different depths, in some of which the brine stagnates and never rises to the top, but flows out at the top of other wells when it is not drawn out for use." From an examination of Karsten's "Lehrbuch der Salinenkunde," a most valuable treatise, it may be concluded that *natural brine springs are rarely saturated, and that saturated springs rarely run to waste or flow copiously.* I am confirmed in this by a friend, a Deputy Salt Commissioner of India, who has visited nearly all the salt districts of Europe as well as India.* It will be evident from the facts given that nature's operations on subterranean salt beds are not of a violent character, but quiet and gradual; hence it is that we so very rarely are able to trace the wasting away of the salt beds by subsidences on the surface. After a lengthened and careful research I have not met with any clear and distinct evidence of any surface subsidence caused by natural brine springs. Undoubtedly there is waste by the water but it is so small and so gradual that in a lifetime it is not perceptible. Were there any perceptible waste shown by the surface subsiding it must have been mentioned in some of the various works treating on salt.† I here may mention that Ormerod, and after him several other geologists, have attributed the formation of the Cheshire meres to the action of fresh water on the underlying beds of salt, and the escape of the brine springs into the streams. This is merely a hypothesis which other geologists dispute. I think the thing possible, but I doubt very much its probability. However, I will not discuss the matter here. Again, in Kohat, on the

* He says, "I do not know of a single case of a saturated brine spring running to waste, and I never saw or heard of such a thing in the trip I took through Europe expressly to vist all the salt sources."—R. M. Adam.

† R. M. Adam says, "In reply to your enquiry I have to say that I have never seen or heard of brine springs which flow into rivers or into the sea causing subsidence of the land."

Afghanistan frontier, there are large "pot holes" of a crater shape in the rock salt district, and these have been attributed to the solution of the underground salt.* One great difficulty that occurs to me is that the meres in Cheshire and the "pot holes" in Kohat are all completed works. There are no meres and pot holes as far as I can learn now forming naturally. I say "naturally," for I shall soon have to speak of artificial *meres* and "pot holes" also, though not in Kohat, being formed at the present time. An attempt was made recently before a Committee of the House of Commons, and in a paper read before the British Association by a well-known geologist, to prove that the great subsidences occurring in some parts of Cheshire are caused by fresh water reaching the salt beds, becoming saturated, and escaping in springs. This was an attempt to demonstrate that nature is progressing by leaps and bounds at the present time, after having through previous historic ages lain practically dormant, although there can have been no alteration whatever in the real agent or in its action during the whole period.

It is not difficult to understand why natural brine springs should as a rule be weak, or if strong not copious. The same rule applies to a brine spring as to any other spring. The source which causes the outflow must be at a higher level than the outflow itself. In the case of brine the source must be higher in proportion to the salt content of the spring. The specific gravity of saturated brine as compared with fresh water is as 12 to 10; consequently it needs a column of 12 feet of water to balance a column of 10 feet of brine. That is supposing, of course, that we had an inverted perfect syphon, and not reckoning friction. However, we never have a perfect syphon, and

* As these "pot holes" are formed in a district where the rock salt is at the surface and crops out, and where the drainage of the water forms springs at a lower level, they properly belong to the preceding section.

the friction is generally very great. Fresh water in passing through the earth to a bed of salt does not usually make its way direct. Most beds of salt are overlain by beds of impermeable marls, though here and there occur water bearing and permeable strata. Naturally these latter strata become waterlogged, and when the fresh water reaches the salt and becomes saturated, before it can issue as a spring at the surface, it has to pass through the waterlogged strata, and so becomes weakened and mixed with fresh water. If every particle of fresh water that would naturally find its way to and pass over the salt bed did so, and then went on its way and passed out at a spring, there would be great waste; but owing to the specific gravity of brine being greater than that of water there is constantly a body of brine on and near the salt bed, whilst the water flowing down and then out of the spring flows over the top of this brine. Fresh water does not mix quickly with brine unless there is rapid motion equivalent to stirring up. Nothing is more common in the salt districts than after heavy rain to run the "fresh," as it is called, off the brine reservoirs. As then the whole of the fresh water does not reach the rock salt, but the greater portion of it mingles with the upper layer of brine and flows off, having only partially diffused itself with the lower layer, there is no violent action and wasting of the rock salt, and consequently no perceptible result on the surface indicating destruction of salt below. After a careful examination of all the evidence attainable as regards England I cannot find one clear instance of any waste of salt, causing subsidence, by the natural brine springs of the districts. Three cases were recently mentioned before the Committee appointed by the House of Commons on the Cheshire Salt Districts Compensation Bill. The first was in 1533, near Combermere Abbey; the second in 1657, near Bickley, in Cheshire; the third in 1713, at Weaver Hall, near Winsford, in Cheshire. The first was "a pease of a hill having trees on hit." This formed a "pitte" which in Leland's time had yet "salt water, but much filth is faullen into it." This was clearly but a small pit, of which no trace now remains. The one at Bickley was a hole "30 yards over." The brine was at some depth, as it was drawn out "with a pitcher tied to a cart rope." This choked up and is not known now. The third, at Weaver Hall, began by a hole of 2 yards in diameter and 12 feet deep at the utmost. When the sides crumbled down and formed a slope, "the chasm became nine yards in diameter yet not so many feet deep, and full of salt water." As these holes were similar in their nature to many that have fallen in of late years, since brine pumping has so largely increased, and as although they are not close to salt manufacturing districts, yet two were not far from Nantwich, the great salt place of the middle ages, and one near to Winsford and Middlewich, we may conclude that salt manufacturing may have had as much to do with them as simple brine springs. However, if we allow them to have been the result of the brine springs naturally flowing into the streams, we are only strengthened in our assertion that natural springs rarely cause any subsidence perceptible in a generation. In the space of about 250 years, from 1533 to 1780, only these three instances are recorded. From 1750 downwards rock salt mines have collapsed as before mentioned: but of the cause of these sinkings or fallings in there has never been any doubt. After 1780 there can equally be no doubt that the sinkings which began to show themselves were directly connected with our next cause, viz.:—

IV.—*Water existing naturally but set in motion, or its motion accelerated, by artificial means, such as pumps.*

Under this head we shall meet with the most remarkable effects of water upon beds of salt. It has been seen that nature, when left to herself in dealing with salt beds, rarely if ever produces violent results. If we suppose the state of affairs to be such as mentioned under our last head, viz., water percolating through overlying earths and reaching beds of salt, there becoming saturated or partly saturated, and finally reaching the surface again in more or less saturated brine springs, we shall have the position of things when man comes upon the stage. He, not finding the springs to flow copiously enough, proceeds to raise the water artificially. In the earliest days, when the manufacture of salt was very small, the brine was reached out of the well or pit made round the small spring that formerly ran away into the neighbouring brook or river, by means of buckets. As the manufacture increased other springs were sought out, and if none existed naturally, shallow pits or wells were dug as at Northwich. Soon pumps were used, first worked by hand, then by windmills, as we see on old maps; and finally by steam engines. As soon as man commenced to take away more water than naturally ran away in springs, the action of the subterranean water was quickened, and the state of quietude that naturally existed became disturbed. The fresh water that travelled slowly over the saturated brine overlying the bed of rock salt, now mixed with it and became stronger, the water being more agitated. In almost all salt districts, and especially those of Cheshire—to which I shall confine myself as affording the best possible examples,—the brine or salty water permeated all the overlying strata and was met with very near the surface whenever the marls, &c., were broken. In fact, brine could be obtained almost anywhere by sinking to a little depth. Dr. Lister, in 1683, says "Sink on either side of the river, you will scarce miss of brine." Brownrigg, in 1744, says, when "the brine is so weak that it can no longer be wrought to profit, they then sink pits in other likely places, and seldom fail of meeting with strong brine." In 1769, in a "Description of England and Wales," it says, "the pits seldom exceed four yards in depth, and are never more than seven." In Holland's "General View of the Agriculture of Cheshire," published in 1808, we have an excellent description of the brine springs: he says, "At Nantwich the brine is met with about ten or twelve yards from the surface." At Winsford it was necessary to sink 55 to 60 yards to reach brine, but when found "it has its level 12 yards from the surface." At Northwich the level of the brine was "about 20 yards from the surface." In 1865, Mr. John Thompson, of Northwich, an authority on the subject, wrote, "Fifty years ago I well remember the brine springs, when at rest, more than thirty yards higher than they now are, when at rest. I know also that the lowering of the brine head has been gradual but constant, year by year, with some variations, arising, no doubt, from the larger or smaller quantity used." Coming down to the present time the brine is very low, being in Winsford and Northwich nearly at the level of the rock salt bed, and many of the shafts are nearly exhausted. It is quite evident that the enormous supply of brine that had accumulated during countless ages and which filled up nearly the whole of the Cheshire salt basins has been pumped down, and brine is now being consumed as fast as produced, whilst many pans are not worked owing to its scarcity. I will now try to trace the course of a drop or a stream of fresh water from its first origin as rain till it comes up the brine pump as brine. It may be pretty safely taken for granted that, speaking generally, the rainfall supplies the fresh water. (In the Northwich district, as I shall point out, there is another way by which fresh water reaches the salt bed.) The rain percolating through and amongst the overlying strata at last reaches the bed of rock salt. Judging from the strata immediately overlying the salt—most part of them impermeable marls—it would seem that much of the water must reach the salt bed at what may be called its subterranean outcrop, or the edges of the salt. No sooner does water reach the salt bed than it proceeds to dissolve the salt, and as the various brine pumping centres keep up a constant and rather rapid motion in the brine, all the particles of water come into contact with the salt or become diffused with the particles that have been in contact, so that by the time the water approaches the pumping centres it has become fully saturated, and ceases to cause any further solution of salt. The constant removal of the saturated brine and its replacement by what was fresh water at the commencement causes a destruction of the surface of the salt, and consequently a lowering of the whole bed of salt. This lowering does not occur equally over the whole surface, but the streams run in channels which they have dissolved out for themselves, exactly as the rains draining off the surface of the land form rivulets, brooks, &c. These channels gradually get wider and deeper. The overlying earths follow the decreasing salt bed, and the surface of the ground conforms to the surface of the salt. Thus we have all over the salt district hollows or synclinals. These sinking portions develop most rapidly in the neighbourhood of streams, for the flexure of the marls and earths, in following the wasting salt surface, causes cracks and rifts, down which the fresh water finds its way and accelerates the action going on below. In time the land sinks below the level of the river, and the fields immediately adjacent become covered with water, and large lakes form, like the Upper and Lower Flashes at Winsford, and the Top of the Brook at Northwich, which cover more than 200 acres of land, and have formed within the last 60 years. In places where there are no streams the natural surface drainage is interfered with and small lakes form, as at Billinge Green and Winnington, near Northwich, and what is called the Ocean, near Winsford. Again, where the marls are thick and tenacious, they remain suspended for a long time, whilst the water is surely and rapidly eating away the underlying rock salt. At last the cavity becomes too large for the marls to bear the overlying earths up, and they fall, taking in a large area of ground, and leaving large holes, like the Marton Hole, that fell in in 1871 (of which I gave an explanation in "Nature" in Feb., 1872), and another in the same district on Bark House Farm, in Sep., 1879.* In the Northwich salt district some portions are literally honeycombed with old rock salt mines; when the fresh water in its course to the pumping centres passes over the layer of rock salt forming the roof of the mine, in course of time it eats the whole away, and the upper earths fall into the old mine, leaving an enormous crater-like pit, as may be seen in Wincham, near Platt's Hill old mine, and several other places in the immediate neighbourhood. When the brine stream in its course comes to the shaft of an old mine it runs down it and fills the mine. All over the Dunkirk district of Northwich, and in Marston, there are pits of this description full of brine. When these enormous reservoirs, covering at least 80 acres in the above districts, are nearly pumped out, it frequently happens that the streams above find a way down into them and cause great destruction, as is the case in Marston, where a lake of at least twelve acres has been formed in this way during

* A large number of small holes 9 or 10ft. in diameter, andfrom a few feet to 10 or 12 in depth, have fallen in near Northwich, taking in roads, river banks, and parts of fields.

the last ten years; and in the Dunkirk district of Northwich, the scene of the great subsidence of 1880, when the water not only found its way into the old Dunkirk mines, but broke into the salt mine called Platt's Hill (which was being worked) by a weak place in the dividing wall of salt, and flooded the mine, over fifteen acres in extent, causing enormous destruction on the surface in the immediate neighbourhood. The ground is still rapidly sinking in both these districts, and the area of the lakes is increasing daily. If there are any buildings on the sinking ground they soon present fissures and cracks, and literally fall to pieces. The amount of property destroyed in this way is enormous. It would make my paper far too long to point out all the ruin and destruction caused in the salt districts by the solution of the salt and its pumping up in the form of brine for its manufacture into white salt.

In Germany, when the brine is not strong enough, *i.e.* not fully saturated, boreholes are put down to the salt, by which means the brine becomes of full strength. As most of the German salt works are on a very small scale compared with those in England, and scattered over an enormous area, instead of being concentrated in one or two spots, as in Cheshire, the results of brine pumping have not shown themselves on a very extensive scale. In Cheshire salt had been made for ages before any visible subsidences occurred; but when about 1780 the manufacture increased, then visible subsidence manifested itself, and in direct proportion as the manufacture has increased so has the sinking, till now it extends over an area of several square miles.

V.—*Water conveyed artificially to deep salt beds and then pumped up again.*

Of late years, owing to beds of salt being discovered having no brine on them, *i.e.* that the rainfall had never reached, a new method of obtaining brine has been resorted to. A borehole is made to and into the bed of salt, and lined with tubing to prevent the earths falling in. The lower tubes are perforated. Inside this tube is placed another of smaller diameter. Fresh water is poured into the annular space between the tubes and finds its way to the salt, which it immediately dissolves, and so becomes saturated brine. This brine rises up the inner tube in the proportion of 10 feet to every 12 feet of fresh water between the tubes. The pumps are put down the inner tube and the brine pumped up for manufacture. This plan is a very modern one, and only carried out in a few districts, though it is being resorted to more largely every day. In parts of Wurtemburg, where the rock salt lies deep and there is no natural brine, the method has been used longest. In describing this plan of getting the salt Quenstedt says, "Klar & Wahr," p. 243—"Our boreholes are decidedly the cheapest, but they are a species of Robber Mine, where the fresh water at great depths eats away the salt where it can the most easily reach it. Subterranean cavities must originate which will become dangerous." Near Nancy, in France, this system has been pursued for some time, and at Middlesborough Messrs. Bell Brothers have been extracting salt during the past year in this way from a depth of over 1,200 feet. In April last Mr. T. H. Bell read a paper before the Cleveland Institution of Engineers, describing this method of getting or mining salt. In the discussion which arose one of the most interesting questions was as to the probability of the land sinking owing to the abstraction of the salt by the water. It was stated that at or near Nancy, a sinking had taken place, the shaft collapsing. Now, it is quite certain that water acting as we have seen it does must inevitably eat away or dissolve the rock salt in the immediate vicinity of the pipe first, and as the pumping goes on and the salt is abstracted, either the water will eat away the surface of the salt on the line of junction between the salt and the overlying marls, and thus lower slowly but surely an extensive surface of salt, or it will form round the pipe itself a large and deep cavity, which will enlarge itself continuously.* I am inclined to think that both results will occur, for the pressure of a column of 1,200 feet of water will force the water into every cranny and crevice amongst the marls, and, as in Cheshire, the surface of the salt is sure to be dissolved. Again, as the fresh water will issue from the boreholes, the salt in the immediate neighbourhood is sure to be dissolved, as the suction up the inner pipe will cause a strong current downwards and bring the water into contact with the surrounding salt. No more dangerous method of mining salt can be resorted to, for the cavity thus made will be in time more extensive and deep than any ordinary mine, and the overlying earths will be destitute of all support, such as pillars give to mines. As this system has hitherto been only used where small quantities of salt are made, and but for a limited period of time, it is not safe to argue that as but little subsidence has yet occurred little will occur in the future. In Germany, Quenstedt, after speaking of the danger, consoled himself by saying, "In Wurtemburg, owing to the thickness of the overlying Muschelkalk, the danger is very small." In Middlesborough they say—"Owing to the thickness of the overlying sandstone the danger is but small." It is to be hoped if the

* Where there is much marl in the rock salt it will fall to the bottom of the cavity formed by the water and choke the blast-holes in the pipes, as it did in Marshall's brine shaft in Dunkirk. This is a contingency Middlesboro' may expect, as there is much marl in the salt.

manufacture goes on that this trust in the sandstone may prove safe, but as it is not solid sandstone, but, according to the section given by Mr. Bell, sandstone with layers of marl at intervals, it is not well to put too great trust in it. The longer the pumping continues—if any large quantity of salt is abstracted—the more dangerous and destructive will the subsidence be when it does occur.

Although this method of mining by water let down a pipe is comparatively modern, yet the action of water on salt beds has been taken advantage of in Austria in the Salzkammergut for obtaining the salt. I give an epitome of what Dr. Schleiden says in his work, Das Salz. Referring to Aussee, he says "the peculiar nature of this salt mountain demands a special method of working it. It is not advantageous to search for and hew out the scattered small masses of rock salt, therefore they get the salt by so-called Sinkwerks (or artificial salt lakes in salt mines). They make large chambers in the mountain and allow them to fill with natural water or convey it to them artificially. It remains until it is saturated. The bottom of the chamber is not thoroughly dissolved because the saturated brine which rests upon it can take up no more salt. The side walls are attacked by the water, and this attack is encouraged, and the salt is rapidly dissolved in the roof as soon as the water touches it, but this is not usually allowed or else the roof would soon fall into the pit. The brine thus formed in these 'sinkwerks' is led by pipes to the salt works."

A similar method is employed at Dürrenberg, in Saxony, where the rock salt is much mixed with clay; but very elaborate precautions are taken to prevent mischief arising from this method of mining rock salt by fresh water.

At Northwich it has not been found necessary to put water down artificially, for, owing to the numerous mines and subsidences of land, the ground is rifted and fractured, and no sooner has the brine pumper exhausted one of the old mines, or even only partially exhausted it, than the water from the overlying brooks or pits finds its way down and fills up the cavity once more. These downrushes of fresh water are doing a vast amount of damage, and in the course of a few years a large portion of the districts known as Dunkirk and Marston, in the proximity of these reservoirs, will be completely destroyed and under water.

I have only attempted to generalise the vast body of facts bearing upon the subject of this paper, but I think it must be clear that fresh water is always destructive to rock salt whenever it comes in contact with it; but that, except the beds of salt lie above the general level of the country and its drainage system, and are exposed either as mountains, or as partial outcrops in valleys, no destruction perceptible occurs, and in the cases of rock salt thus occurring the waste is comparatively small and harmless. On the other hand, whenever man, either by utilising the natural springs, or sinking fresh shafts to the underlying brine and causing a more rapid circulation of the underground waters that reach the salt beds, or where there is no natural brine—pouring down water upon the salt bed and pumping it up as saturated brine—interferes with the operations of nature, waste is more rapid and surface damage increases in the direct ratio in which man accelerates the ordinary natural operations. Where man only utilises the amount of brine running to waste in springs his operations produce no visible surface effects; it is only when he causes a purely artificial state of affairs that mischief follows. Having in a former paper traced the growth of the surface damage side by side with the growth of the salt manufacture in Cheshire, I will here make no further reference to the matter, but will conclude by pointing out that the growing demand for brine will inevitably lead to the destruction of much surface property in all salt districts of any extent, and this action of fresh water upon beds of salt will ere long call for some regulation by the State.

Ordinary Meeting, November 27th, 1883.

H. E. ROSCOE, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

The President stated that among other institutions that had come under the notice of the Commissioners for enquiring into the state of Technical Education, was the Industrial Society of Mulhouse, and he gave from official sources some account of the organization and work of the Society.

"On the Fungus of the Salmon Disease—*Saprolegnia ferax*," by H. MARSHALL WARD, M.A., Fellow of Christ College, Cambridge.

We are informed, in the 21st Annual Report of H.M. Inspectors of Salmon Fisheries, that since its first appearance in 1877 in certain rivers flowing into the Solway Firth the disease above named has extended rapidly and widely, and in 1880 appeared in North Wales. Salmon affected by the disease show signs of languor, feed badly, and, when severely-diseased, die. The external signs of the disease are greyish discolorations of the skin on the head, jaws, fins, and other parts of the body. These ash-coloured patches often extend over considerable areas, and the skin affected may be rubbed off, and bleeding sores be exposed, causing great uneasiness and irritability to the fish.

The papyraceous, ash-coloured mass of the grey patches consists in the main of the fungus to be described. This is reproduced very rapidly, and may be cultivated on the bodies of ordinary flies. The specimens I have examined were thus cultivated from masses supplied through the kindness of Mr. Murray of the British Museum. My object being to describe the fungus and its life history, and not to discuss the question of its relation to the disease itself, as my results confirm those published by Prof. Huxley in a recent number of the Quart. Journ. Microscop. Soc., I may pass over my disappointment at being unable to show specimens of diseased salmon at this time of the year.

Contact of the diseased salmon with a dead fly in fresh water for 24 hours or less results in infection of the latter, and very fine silky filaments are soon observed to shoot forth in all directions from the body of the fly into the water. If proper precautions are taken, the silky filaments soon form multitudes of reproductive bodies, by which new flies may be infected.

The filaments radiating out from the body of the fly are thin tubes with very delicate cellulose walls and coarsely granular watery protoplasm. They branch both outside and inside the matrix, thus extending the fungus, somewhat as a bamboo is spread beneath the surface of the earth by means of stolons, and a fig-tree, outside, by means of aerial roots.

After attaining a certain degree of development, the end of an external branch swells up into a club-shaped body, which becomes separated off by a septum from the rest of the tube: the protoplasm in this club-shaped "*zoo-sporangium*" then becomes cut up into numerous minute "*zoo-spores,*" which remain for a short time closely packed in the case like small shot in a cartridge. Suddenly, however, the end of the club-shaped "*zoo-sporangium*" bursts, and these "*zoo-spores*" pass rapidly out into the surrounding water, each as a pear-shaped mass of protoplasm, rapidly moving by means of two cilia at the *end.*

After a short time—often within 10 to 15 minutes—this active "*zoospore*" becomes quiescent, loses its cilia, rounds off into a sphere, and develops a delicate membrane: it remains thus resting for some hours. It then opens by a minute pore, and its protoplasmic contents pass out again as a "*zoospore*"—but this time of a different shape, resembling a kidney, and with two cilia at the *side.* Other differences in detail also exist.

In this second active stage the "*zoospore*" moves about for a time, and then once more comes to rest. It then germinates, *i.e.*, throws out a delicate tube, into which its contents pass. If this occurs on the fly's exterior, the tube enters the body, feeds on the matters there, and grows into a new fungus plant.

Besides this mode of rapid asexual multiplication, however, this fungus exhibits a totally different form of reproduction.

Certain lateral branchlets swell up into bodies, each resembling a grape attached by a short stalk: the protoplasm inside any one of these becomes arranged into relatively large spheres, or into one large sphere. These spheres are the eggs of the organism—corresponding to the eggs of an animal—and are termed "*oospheres.*" The membrane of the grape-like structure containing them ("*oosporangium*") becomes thick and firm and peculiarly marked. Each of these eggs becomes later surrounded by a firm resistent membrane and is then termed an "*oospore*": these "*oospores*" persist for weeks and months in the rotting matrix, and so provide for reproduction under circumstances fatal to the more delicate "*zoospores.*"

I have succeeded in obtaining by cultivation a very fine crop of these "*oospores*" or eggs, and they appear to have ripened normally without fertilisation. They are not common, and the opportunity of seeing actual specimens of them has seemed of sufficient importance to warrant my bringing the matter forward here.

Besides drawings and diagrams, I have specimens under the microscope of all the stages of this fungus—a most interesting member of a highly important group.

Ordinary Meeting, December 11th, 1883.

BALFOUR STEWART, LL.D., F.R.S., in the Chair.

"On the Quantification of the Predicate, and on the Interpretation of Boole's Logical Symbols," by JOSEPH JOHN MURPHY. Communicated by the Rev. ROBERT HARLEY, M.A., F.R.S.

If a student, after hearing his first lecture on crystallography and the geometry of polyhedra, were to say to his teacher, "You have not made it clear to me whether the cube is derived from the octohedron or the octohedron from the cube"; this would not be a stupid question, but it would show a puzzled state of the understanding; and of course the reply would be, "Whichever you please; either form may be equally well regarded as the fundamental and the other derived from it."

The question of the "quantification of the predicate," which was raised by Sir William Hamilton of Edinburgh, seems to admit of a somewhat similar reply.

That question may thus be stated:--Whether is the fundamental form of proposition the equation, "x and y are identical:" or the predication, "x is y," without implying that y is x? The former is the reply given by Sir William Hamilton; the latter, by Aristotle and logicians generally.

When we use notation instead of language, we write the equation

$$x = y$$

and the predication

$$x < y$$

When we write an ordinary predication with the quantified predicate, we may express it in language by "x is part of y" and in notation by

$$x = y - p$$

where p is so much of y as is not x. Boole sometimes, and Jevons always, express the same predication by

$$x = xy.$$

But though this is in form an equation, it does not in reality quantify the predicate; it is only the translation of the ordinary predication

$$x < y$$

into a different and for some purposes preferable notation.

Sir William Hamilton showed, though he was not the first who discovered, that the propositions of the ordinary logic admit of a twofold interpretation, in extension and in comprehension. For instance, the proposition, "Man is an animal," if interpreted in extension, will be "The class man *is included in* the class animal;" but if interpreted in comprehension it will be, "The attributes of the man *include* the attributes of the animal." When we interpret in extension, x and y mean things or classes of things, and the copula means identity:—when we interpret in comprehension, x and y mean attributes, and the copula means co-existence.

The foregoing appears to be self-evident; and it appears to follow, that when we interpret in extension, and assert that "x is included in y," or, as Sir William Hamilton expresses it, "all x is some y," we quantify the predicate, and the appropriate notation is

$$x = y - p.$$

But when we interpret in comprehension, and assert that "the attributes of x include those of y," or, as Mill expresses it, "attribute x is a mark of the attribute y," we do not quantify the predicate, and the appropriate notation is (retaining the form of an equation)

$$x = xy.$$

In the former of these two contrasted notations the relation between the whole and the part is symbolized by the addition and subtraction of terms; in the second, the co-existence of attributes is symbolized by the combination of terms. They consequently show to the eye how the attributes become more numerous as the class becomes smaller. For instance, the following syllogism, "Man is an animal; an animal is an organism; therefore man is an organism" will be thus expressed in the two notations:—

$$x = y - p \qquad x = xy$$

$$y = z - y \qquad y = yx$$

$$x = z - q - p \qquad x = xyz = xz$$

These relations may be further illustrated by considering the interpretation of Boole's operation of abstraction, or logical division. Abstraction is the inverse of combination, or logical multiplication, and it consists in removing part of a definition.

Let us express the proposition "Man is the rational animal" by

$$m = ra$$

To every multiplication correspond two divisions, which here give

$$\frac{m}{a} = r \text{ and } \frac{m}{r} = a$$

whereof the meaning is that "Man without the animal attributes is a being of pure reason," and "Man without reason is a mere animal." These abstractions relate only to the combination of attributes, and have no interpretation relating to the extent of classes; in other words, they can be interpreted only in comprehension; while addition and subtraction, on the contrary, can be interpreted only in extension.

The subject of the mutual relation of classes as to inclusion and exclusion, total and partial, is of such vast importance that it appears to be often believed to cover the whole ground of logical science; but this is by no means the fact, even if we confine our view to elementary logic, and exclude the logic of relative terms. There are propositions of the form

$$x = y - p$$

which can be interpreted in extension only, and have no interpretation in comprehension;—such as "Lothian is part of Scotland;" or "hydrogen is a constituent of water." These have all the most generally recognized properties of propositions, and may enter into syllogisms, thus:—"Lothian is part of Scotland; Scotland is part of Great Britain; therefore Lothian is part of Great Britain." And there are also propositions of the form

$$x = xy$$

which admit of interpretation in comprehension only, and not in extension. To this class belong hypothetical propositions, with the syllogisms formed from them, such as:—"If he can discredit this witness, he will obtain a verdict; if he obtains a verdict, his position will be established; therefore if he can discredit this witness, his position will be established."

Mr. Harley added the following remarks:—

Mr. Venn, in his Symbolic Logic, sets forth his view of what is meant by the Quantification of the Predicate thus: "Whereas the ordinary forms of proposition leave it uncertain whether we are speaking of the whole predicate, or part only, in affirmation, and decide that we must be speaking of the whole predicate in negation; we thus leave four possibilities unrecognised: that in fact we may think the predicate, either as a whole or as a part, and *must* think it as one of the two, in both affirmation and negation alike. Moreover, since what exists in thought should be expressed in words, a really complete scheme of propositions demands, and is satisfied by, eight forms." This is a very clear and succinct statement of what Hamilton calls the "thorough-going quantification of the predicate." But it may be observed that many who accept Hamilton's principle refuse to recognise the validity of one or more of his forms, special objection being taken by some of his disciples to the forms, 'Some x is not some y,' and 'No x is some y.' But the essential point insisted upon by all quantifiers of the predicate, is this, that the extent of each of the two terms of a judgment is known, and should therefore be expressed in language; in other words, that to the predicate, as well as to the subject, a quantitative sign should be affixed, to indicate whether the whole, or part only, of the term is meant. "Every notion," says Baynes, in his New Analytic of Logical Forms, "holding the place of predicate in a proposition must have a determinate quantity in thought." The whole controversy turns on the question whether this is so or not; for it will be admitted that in Formal Logic what exists in thought should be expressed in words. To me it seems that the quantification of the predicate is not a necessary law of thought, but merely a symbolic convention, and not a very useful convention either. A man may know that 'x is y,' and yet not know, perhaps not have the means of determining, whether x is the whole, or part only, of y. We may write 'all x is y' in the form 'all x is some y,' provided we understand 'some' to mean *some at least, possibly all.* But this is not to 'quantify the predicate' in the Hamiltonian sense.

Mr. Murphy appears to think that when we interpret a proposition in extension, we necessarily quantify the predicate, and that it is only when we interpret it in comprehension that we do not quantify the predicate. He appears also to hold that Boole's literal symbols represent not classes but qualities of things, and that because Boole's notation is thus to be interpreted intensively, therefore the doctrine of the quantification of the predicate finds no place in Boole's system. This is a view which I cannot adopt. I admit that before we can quantify the predicate, we must interpret in extension, for quantity relates to extent; it says, how much, the whole or part only. But I do not admit that when we interpret in extension we necessarily quantify the predicate. We may write the proposition 'x is y' in the form 'x is part of y,' if by 'part' we understand part at least, possibly the whole; and we may express the proposition symbolically by the equation, $x=y-p$, if it be granted that o is a possible value of p. But this is not to quantify the predicate.

Boole expressly stipulates that his literal symbols, x, y, &c., shall stand for either classes or qualities of things; in other words, that they shall admit of interpretation either in extension or in comprehension. Mr. Murphy appears to limit them to the latter interpretation, while, curiously enough, a recent writer on the Algebra of Logic (Miss Ladd, now Mrs. Fabian Franklin) says of one of Boole's forms, "It is suited only to a logic of extension, and it would be difficult to interpret it intensively" ("Studies in Logic," by members of the John Hopkins University, p. 50). The truth is that Boole's symbols may be interpreted either in extension as classes, or in comprehension as qualities, or without reference to either classes or qualities, extension or intension, as objects or 'units of thought,' this last being the interpretation given by Professor Adamson in his article on Logic in the new edition of the "Encyclopædia Britannica" (vol. xv., p. 801).

Boole writes the proposition, 'all x is y' in the form $x=\frac{0}{0}y$, or $x=vy$, where $\frac{0}{0}$ or v is "an indefinite class symbol," subject to the same fundamental law as the other symbols, namely, $v^2=v$. From this equation he deduces, by the elimination of v, the equation $x=xy$, which is the form in which Jevons always writes the universal affirmative proposition. In general, the symbol $\frac{0}{0}$ or v indicates that *all*, *some*, or *none* of the class to whose expression it is affixed must be taken; but there are cases in which its meaning is necessarily restricted. The subject is a very large one, and I cannot discuss it here. Mr. Venn has suggested that where the class is wholly indefinite, the symbol $\frac{0}{0}$ should be used; and that where it is partially defined, or defined as meaning *not none*, v should be used.

The idea that Boole's system starts from the doctrine of the quantification of the predicate, as Jevons affirmed, or that it is in any way bound up with that doctrine, has been effectually disposed of by Mr. Venn. He says truly, "If the wit of man had sought about for some expression which should unequivocally and even ostentatiously reject this unfortunate doctrine, what better could be found than $x=\frac{0}{0}y$ for such a purpose? So far from quantifying the predicate by specifying whether we take *some* only or *all* of it, we select a form which startles the ordinary logician by the uncustomary language in which it announces that it does not at all mean to state whether some only, or all, or even *none*, is to be taken." Mr. Venn, in his Symbolic

Logic, has discussed the Boolian method with a fulness and ability that leave little or nothing to be desired.

Mr. WILDE exhibited some volcanic dust which fell at Batavia, to the depth of three inches, from the great eruption of Krakatoa on August 27th last. Dr. Burghardt had made a microscopic examination of the dust, and found it to consist of augite and several minerals fused into glassy and amorphous globules. Some of the larger globules were highly magnetic and indicated the eruption of ultra basic lavas from great depths below the earth's surface.

Mr. Wilde also exhibited some glassy lava from the great volcano of Kilauea in Hawaii, and was known as "Pele's Hair,"—Pele being the name of the goddess of the mountain. The volcanic substance was abundantly produced by the rapid passage of gases through the liquid lava, particles of which were shot into the air, leaving glassy filaments behind them.

For the specimen of filamentous lava shown, Mr. Wilde was indebted to Mr. F. Melland, who had recently visited the crater of the volcano of Kilauea.

General Meeting, January 8th, 1884.

H. E. Roscoe, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

Mr. Charles Hopkinson, Mr. Charles Herbert Hurst, Mr. Arthur Smithells, B.Sc., Mr. Frederick Tertius Swanwick, all of Owens College, Mr. Alexander Hodgkinson, B.Sc., M.D., of Claremont, Higher Broughton, and Mr. Leopold Larmuth, of Owens College, were elected Ordinary Members of the Society.

General Meeting, January 22nd, 1884.

H. E. Roscoe, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

Rev. H. London, M.A., of High Leigh, Cheshire, was elected an Ordinary Member of the Society.

Ordinary Meeting, January 22nd, 1884.

H. E. Roscoe, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

"On a New Variety of Halloysite from Maidenpek, Servia," by H. E. Roscoe, LL.D., F.R.S., President.

This mineral, one of the few peculiar to Servia, was given to me by Mr. James Taylor, lately a resident at Maidenpek.

It is a very soft (h=2·5) whitish green non-crystalline mineral, having a conchoidal waxy fracture. It is translucent in thin films but opaque in mass, and adherent to the tongue. Its specific gravity is 2·07. On exposure to air it loses a portion of its combined water, and becomes of a dead white colour and more opaque. The greenish tint is due to the presence of small quantities of copper oxide (1·11 per cent).

The following analyses show that this is a more highly hydrated variety than most of the specimens of Halloysite hitherto examined, and that it corresponds to the formula $Al_2O_3 2SiO_2 + 5H_2O$.

Analysis of Halloysite from Maidenpek :

	I.	II.	Mean.
Al_2O_3	32·81	32·58	32·69
SiO_2	37·59	37·70	37·64
H_2O	28·59	28·27	28·43
CuO	1·11	—	1·11
	100·10	—	99·87

The calculated composition for the above formula is :

Al_2O_3	32·86
SiO_2	38·37
H_2O	28·77
	100·00

A specimen of a similar mineral from the same locality was found by Tietze to contain :

$Al_2O_3(Fe_2O_3)$	25·20
SiO_2	44·96
H_2O	29·50
	99·66

Corresponding nearly with the formula $Al_2O_3 3SiO_2 + 6H_2O$. Showing a distinct difference in the relation of alumina to silica from that existing in the specimen in question.

"On a Method of mounting Electrical Resistances," by Arthur Wm. Waters, F.G.S., &c.

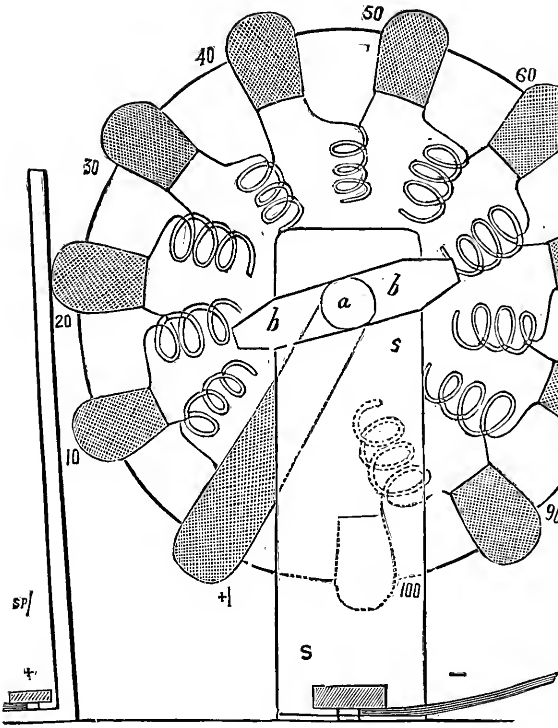
A short time ago I came to the conclusion that there was a strong probability of the variations in the electrical resistances of the human body, giving some indication as to how various climatic changes affected different constitutions. This idea forced itself upon me in consequence of an investigation concerning the changes of the body temperature, as affected by meteorological conditions, having brought out the interesting fact, that the average changes in the 5 to 6 p.m. clinical temperature of a sufficient number of invalids* follows the curve of the absolute moisture or of the temperature, both of which are very similar.

Dr. Stone's results, as published in "Nature," gave a definite direction to the idea, and then, when considering how I could carry out what I purposed, I saw that I must first have an instrument by which measurements could be rapidly made and changes easily followed, and if possible, the current should not be broken by altering the measure.

The ordinary resistance box with plugs cannot be used sufficiently rapidly and is unsuitable. I, therefore, adopted the plan of mounting the resistance reels on an ebonite disk, with a metal axis (a) running at each end in brass supports S. This support has a binding screw at the base and the current is thus led away from the axis. Round the border of this disk German silver flanges† or bosses are attached and one of these (x) is connected by a stout strip of copper to the axle. Between this and the next boss a resistance coil of fine German silver wire wound double on a small reel is attached, and between each of the other bosses a similar coil is placed and the two ends severally soldered to

* The measurements were made for the purpose by consumptive people in Davos.

† These flanges overlap on each side and therefore present to the spring a continuous surface the width of the disk.



the adjoining German silver projection. The disk is revolved by means of a bone or ebonite handle *b*, and these bosses are thus brought against a strong spring (*sp*) up which the current is led. If the flange connected with the axle is brought against this spring then there is practically no resistance, but if any other flange is against the spring then the current must pass through one or more reels of resistance. As figured it would go through two reels of 10 ohms each, and if it went through all the reels we get a total of 100 ohms. As arranged, one boss does not leave the spring until the next is in contact.

The complete instrument consists of four such disks similarly mounted and put into connexion, and on the first disk the reels are 1 ohm, on the second 10, and on the other two 100 and 1,000 respectively, so that they are read off like a gas meter, and thus a resistance from 1 ohm to 11,110 ohms can be read directly, and by mounting the commutator and the permanent arms of the Wheatstone bridge on one board, we get a very compact instrument, and have all the handles within easy reach for rapid change. About 7 centimeters will be found ample for the diameter of the disk, and the whole apparatus may be mounted on a board about 45 centim. long and 10 centim. wide.

The arrangement of resistances is much the same as in slide resistances, and the plan of arranging these in a circle has been used for medical purposes, but I am not aware of the resistances themselves being made to revolve though I have not had any opportunity of investigating all the plans previously adopted. It seems to me, however, that in cases where only amateur or imperfect workmanship is available, that this will be found the simplest plan, and also, I think that when compactness and rapidity of action are important this form may often be found useful, and, therefore, describe it although there is no new principle involved.

One such disk may also be used when a galvanic current is being applied for medical purposes, in which case the current is made to first pass through a high resistance of several reels, and then without contact being broken the resistance is brought down to null. In such cases it may be found advisable to make the first resistance much lower than the last.

PHYSICAL AND MATHEMATICAL SECTION.

January 15th, 1884.

ALFRED BROTHERS, F.R.A.S., in the Chair.

"Note on Bouguer's Optical Essay on the Gradation of Light," by JAMES BOTTOMLEY, B.A., D.Sc., F.C.S.

In several papers on colorimetry which I have read before this Society, I have frequently had occasion to refer to the hypothesis, that as the length of an absorbing medium increased according to the terms of an arithmetical progression, the intensity of the light diminished according to the terms of a geometrical progression. I had not then been able to trace this hypothesis back farther than the writings of Sir John Herschel, but had some grounds for supposing that it might have been given earlier, and more especially by Bouguer. Lately, after much enquiry, there has come into my hands a small treatise entitled Essai d'Optique sur la gradation de la lumière, par M. Bouguer, professeur royal en Hydrographie. Paris, 1729. From this work it appears that the honour of having first enounced the hypothesis belongs to Bouguer. In many otherwise excellent treatises on Physics and Optics the subject of the absorption of light is either neglected or scantily treated, and the claims of Bouguer seem to have nearly passed out of recognition; yet he may assuredly claim herein a position correlative with that assigned to Snell, or Huygens, or Newton, in those departments of Optics of which they laid the foundations. The treatise contains no experimental verification of the hypothesis, nor any suggestions for carrying out such experiments. He was aware that the subject afforded a vast field for future enquiries, and with regard to his own work he modestly states in the preface, C'est vrai que mes recherches sont poussées si peu loin qu'elles laissent encore une vaste champ à tous ceux qui voudront perfectionner cette matière. Mais ne sçait-on pas que les arts les plus simples ont eu leurs différens âges, et que ce seroit comme étouffer dans le berceau les découvertes qu'on peut faire dans la suite, que de mépriser toutes les premières tentatives, sous prétexte que ce ne sont encore que de foibles commencemens ?

In the last section he has also considered the intensity of light which has passed through a medium which is not of the same density throughout. By geometrical reasoning he arrives at the conclusion that the curve of intensity (the *gradulucique* as he terms it) has this property; its subtangent multiplied by the density is equal to a constant. Expressed in the language of the differential calculus this gives rise to a differential equation similar to the one which I obtained by a different method and gave last session in a paper read before the Society, on the intensity of light which has traversed a medium wherein the density is some function of the distance traversed. Except in the consideration of the intensity of light which has passed through the atmosphere, Bouguer has made very little use of this highly general theorem, for, says he, in most cases we do not know what is the law of density. This may be so, but by assuming the density to be some function of the distance, we may deduce some interesting and valuable results.

"On the Effects of Solar Radiation in Atmospheric Vapour," by the Rev. THOMAS MACKERETH, F.R.A.S., F.R.Met.Soc.

Two facts are well known and understood, viz. that solar radiation is the cause of terrestrial evaporation, and that as the vapour so produced in the air condenses and spreads as cloud, the effects of solar radiation upon the surface of the earth are impeded. And it is also well known that invisible vapour from the effects of solar radiation is constantly present in the air in the clearest and bluest skies. But it is not known, as a fact, to what height this invisible vapour attains in the air, for it is certainly present very far above the highest ascents that aeronauts have made.

Much attention has, of late years, been given to the observations and recording of the hours of sunshine. Of course in such records the remaining hours of the day represent the time during which the sun's disc was not visible on account of the presence of cloud or thick vapour. Still these records have not been turned to any useful account, nor do they reveal any hitherto unknown law arising from the shining of the sun.

Now there remains some unexplained cause for the difference of the readings of two solar radiating thermometers, one placed *in vacuo*, and the other exposed to the direct action of the air in front of the sun, notwithstanding the many theories or assumptions respecting it. It can hardly be supposed that the decrease of solar radiation on the surface of the earth is in consequence of the mere inability of the solar radiating force to penetrate the cloud. It is quite true, however, as has been noted, that in the presence of cloud there is a decrement on the earth of direct solar heat. But the question arises, what has become of the apparently lost solar energy? From our knowledge of the effect of such force upon water it cannot be unreasonable to assume that when the radiating solar force acts upon an intervening cloud it will tend to its higher evaporation, and so draw it upwards or disperse it into invisible vapour. This is illustrated by the effect which a hot iron plate has upon escaping steam. If a hot iron plate be placed amongst escaping steam, it will be found that for a considerable distance around the plate the steam is rendered invisible, and being rendered hotter by the plate, it ascends higher in the air than it otherwise would do, and re-appears as almost invisible vapour a considerable distance from the plate.

This being so, it will happen that if the solar radiating force become stronger at one time than another, at such periods the deeper or higher, and rarer will become the amount of the invisible vapour of the air. And this will be so, notwithstanding the fact that atmospheric vapour is mostly condensed and precipitated as rain.

Now it happens that the more the daylight has been free from cloud or dense vapour as thick haze or fog, the greater has been the difference of the reading between a solar radiating thermometer exposed before the sun in free air and one mounted *in vacuo*. That I might, as far as possible, be satisfied, that this difference was due almost entirely to skies free from cloud during the sun's presence, I observed carefully the readings of the two thermometers on days during which I was certain the sun's disc was never seen at my station at all. And after a correction which I instituted and applied to the readings of the thermometer *in vacuo*, and which I deemed sufficient to account for the difference of temperature recorded by it in the presence of cloud, I considered both thermometers as reading from a common Zero. After this I found that the readings of the two thermometers, the correction being applied, were closer according to the kind of blueness of the sky through which the sun shone. If the blue were tinged with a kind of grey, and the more it was so tinged, the nearer the readings of the two thermometers were to each other, and the bluer the sky the wider were the readings apart. The durations of sunshine did not affect the difference to any great extent, unless they were very short periods. Hence I arrived at the conclusion that the difference of the reading of the two thermometers indicated an evaporating power of the sun upon the cloud or vapour in the air, thereby causing it to become rarer, and more and more invisible, and so to rise from the lower to the higher regions of the atmosphere. As the air thus became clearer solar radiation on the surface of the earth became intensified and more direct, and this I have called "direct sun-power."

This "direct sun-power" is very different from the difference of the power of solar radiation in summer and in winter, in latitudes of the middle of the temperate zones. For whilst in our latitude the difference between the extreme summer and winter mean temperatures amounts to about 90 per cent of the winter temperature, the difference between the extreme "direct sun-power" of summer and winter is 1,300 per cent of that of the winter.

The following table represents this "direct sun-power" under assumed numbers between 0·0 and 36·0. And these numbers were assumed because in no case hitherto has the difference of the readings of the two thermometers exceeded 36 deg. Fahr. The numbers therefore in the following table represent the relative values of this "direct sun-power" for the last five years reduced to their mean values for each succeeding three months of the year.

	1879.	1880.	1881.	1882.	1883.
January... February.. March ...	6·4	6·3	5·5	6·3	10·3
April ...... May ...... June	18·7	20·8	17·8	21·3	22·4
July ...... August ... September	17·7	17·6	16·7	20·4	22·6
October ... November December	4·7	3·4	5·3	6·5	7·0

From the above table it will be seen that the solar radiating "direct sun-power" was far the greatest throughout the year 1883.

That this energy becomes potent according to the increase of solar activity will appear if the values of the above table be compared with the mean values in degrees of Fahr. of ordinary solar radiation as registered by a black bulb thermometer *in vacuo.* These values are given for the past five years, and reduced to their means for each succeeding three months of the year.

	1879.	1880.	1881.	1882.	1883.
January... February March ...	63°9	64°7	54°3	61°2	65°1
April ...... May ...... June	93·3	99·6	96·4	99·8	100·3
July ...... August ... September	96·8	105·4	98·9	102·9	106·3
October... November December	60·1	58·2	61·2	61·9	63·8

The past year of 1883 has been remarkable for its manifestation of solar energy. Again and again within that time sun-spots have been visible to the naked eye, to say nothing of the far greater number that the telescope has revealed. And that this solar activity has been gradually increasing to a maximum is evident from the mean values presented in the foregoing table. But that table bears testimony also to the increase cf the power of the solar evaporation of cloud, and thence of invisible vapour, into the higher regions of the air, and which must have been greatest during the past year. This will in some degree account for the heavy and continual fogs, and the excessive fall of rain during the last three months of that year. For when the solar force is minimised by the indirect action of the sun on the atmosphere, which in our latitudes must take place in the latter months of the year, the accumulated vapour, whether visible or invisible, must fall to the earth and appear as fog or rain.

The following table represents the rainfall in inches for for the last three months of each of the years named, and each is placed under the mean annual temperature of solar radiation for the year, and beneath the amount of each is placed the ratio which it bears to the rainfall of that year.

1879.	1880.	1881.	1882.	1883.
78°·5	82°·0	77°·8	81°·5	84°·0
inches 10·797	inches 17·367	inches 16·323	inches 17·334	inches 17·773
ratio ·190	ratio ·358	ratio ·279	ratio ·280	ratio ·342

Whilst this table does not bear testimony directly to cloud evaporation, it still shows that the ratio of rainfall for the last three months of the past year was excessive.

"On the Recent Coloured Skies at Sunset and Sunrise," by the Rev. THOMAS MACKERETH, F.R.A.S., F.R.Met.Soc.

If the air were deprived of all the vapour which arises from water, it is almost a certainty that the various hues seen in the sky would disappear. That water is a refractor of light is well known, and the beauties arising therefrom appear in the marvels of the rainbow. And what is vapour derived from water but the particles of water expanded by heat and rarefaction? Hence, there is no reason why the refractive power of water may not be maintained by its vapour with a difference proportionate to the dispersive power of the vapour. This is illustrated by the prismatic appearance at the edges of clouds when the light of the moon is freely and fully poured forth through breaks amongst them, and is incident upon the edges of those of different altitudes and approximate to the path of the rays. Of course the colours are pale and diffused in such a case, because the light of the moon is pale, and the clouds not only refract but disperse the force of the light.

If, therefore, the light of the sun should fall so obliquely upon cloud or vapour that the refrangibility could be seen, there would necessarily appear more or less of the prismatic colours, but of course dispersed according to the density or rarity of the vapour, or to the extent and direction of its presence and diffusion.

In the middle of the afternoon of Nov. 29th last year, the sky being apparently very clear, I went to my transit instrument to ascertain the time from the meridian passage of the star *Alpha* Aquilæ. But imagine my surprise when the star utterly failed to appear in what seemed a clear blue sky. I carefully examined all the adjustments of the instrument and my reckonings, and found all quite correct; and my clock is never more than a very few seconds in error. As the sky appeared unusually blue I stepped out of the observatory to see the whole sky, and to ascertain, if possible, the cause of the non-appearance of the star. I then found that over and in the neighbourhood of my meridian the sky was almost an indigo blue, and immediately from it to the south west it was tinged with green. As the sun went down clouds gathered on the horizon, the sky vapours became more visible, and there could be distinctly traced from behind the clouds where the sun had set up to the zenith all the principal prismatic colours. This was the finest display of all the colourings that have recently appeared in the sky. I naturally attributed the blue and green to the presence of an unusual amount of the vapour of water in the higher regions of the sky. Of course we are all aware what other causes have been assigned for this unusual phenomenon.

If these colours arose from the refraction of the vapour of water in the air, two things were requisite; first, that this vapour must, during these appearances, have been present at a very unusual height in the atmosphere; and, second, there must have been an excessive quantity present relatively near the earth. That such was the case may appear from what has been shown in my paper "On the Effects of Solar Radiation in Atmospheric Vapour." That all, or at any rate, the higher prismatic colours might be visible, it was requisite that this vapour should extend to a great height, and it is shown that this then was possible.

But as the phenomenon wore on the blue and green disappeared, and there remained only the deep red and a reflected light rose colour. The red always appeared, as it usually does, on the horizon, especially when much visible vapour is present in the neighbourhood of the setting or the rising sun. But every time these red and rose colours were visible they seemed to spring up from behind a mass of cumulus cloud in front of where the sun had set or was about to rise. And when the sky over the cumulus was carefully examined a light vapour was quite discernible, which could only be ascribed to the higher evaporation of the cumulus. That this light vapour was over or above the cumulus, and consequently higher than it in the sky, was obvious, and, therefore, could only have originated in it. There seems no room to doubt that this was the case; and this evaporation taking place in the greatest angle of refrangibility, the light passing through it would be seen as various shades of red. This red was nearly always reflected though much dispersed, and rendered a beautiful rose colour by other light clouds in the sky which happened to be lying in the line of the rays that passed through the vapour from the cumulus. The blue and the green would disappear as the otherwise invisible vapour condensed and descended into the lower regions of the air; and this doubtless caused the continuous fogs that prevailed more or less from the 7th of December. The red and yellow, and sometimes the light rose colour, are still visible when the sky is not overspread with nimbus, and when it is comparatively clear in the neighbourhood of the rising and setting sun. This is easily accounted for if we take into account the present high temperature, together with the tremendous amount of visible vapour which prevails, and the consequent great amount of cloud evaporation that must be going on immediately above the lowest cloud region of the atmosphere.

Corrigendum.

Page 2, line 16, for $B = \frac{4\lambda'\lambda}{Ll} mm_1$ read $B = \frac{4\lambda'\lambda}{Llmm_1}$

Ordinary Meeting, February 5th, 1884.

Charles Bailey, F.L.S., in the Chair.

"On the Introduction of Coffee into Arabia," by C. Schorlemmer, F.R.S.

In two papers, which I read on April 3rd and October 16th, before this Society, I mentioned that the custom of drinking coffee originated with the Abyssinians, who cultivated the plant from time immemorial. In Arabia it was not introduced until the early part of the fifteenth century; before this time the beverage made from the leaves of the kât was generally used, and is still in use.

A few weeks ago I received a letter from Professor W. T. Thiselton Dyer, F.R.S., in which he says: "Possibly the inclosed extracts from an old book of the last century may interest you."

"The point is that the introduction of the use of coffee from Persia, in the 15th century, seems to have led to the neglect of khat."

"Your interesting observation as to the absence of caffeine in the latter, would perhaps show that the change from one to the other had a physiological significance."

This appears very plausible. I hope to be able to obtain a larger supply of khat, in order to find out its active principle.

The extracts which Professor Dyer sent me are as follows:

A Historical Treatise of the Original of Coffee. London, 1732 (pp. 308—310).

Jem al Adin Abu Abdallah, Mohammed Bensaid, surnam'd *Al Dhabhani* (because he was a native of *Dhabhan,* a small town of *Arabia Fœlix*), being *Mufti** of *Aden*, a famous town, and part of the same country, about the middle of the 9th age of the *Hegirah*, and of the 15th of our Lord, had occasion to make a voyage to *Persia*. During his stay there, he found some of his countrymen who took coffee, which, at first, he took no great notice of; but at his return to *Aden*, his health being impair'd, and calling to mind the coffee, which he had seen taken in *Persia*, he took some, in hopes it might do him good. Not only the Mufti's health was restor'd by the use of it, but he soon became sensible of the other properties of coffee; particularly, that it dissipates heaviness in the head, exhilarates the spirits, and hinders sleep without indisposing one.

Coffee first in use at *Aden*, the capital city of *Arabia Fœlix*.

The *Arabian* author adds, that they found coffee so good, that they entirely left off the use of another liquor, which was in vogue at *Aden*, made of the leaves of a plant call'd *Cat*, which cannot be supposed to be the *The*, because this writer says nothing which might favour that opinion.

Since this was written, Mr. W. Elborne, of the Owens College, called my attention to a paper by Mr. James Vaughan, Civil and Port Surgeon at Aden, who states that some estimate may be formed of the strong predilection which the Arabs have still for kât, from the quantity used in Aden alone, which averages about 280 camel loads annually. He adds that he is not aware that Kât is used in Aden in any other way than for mastication; from what he has heard, however, he believes a decoction resembling tea is made from the leaf by the Arabs in the Interior.†

Mr. Vaughan gives also some abstracts from de Lacy's *Chrestomathie arabe*, in which it is stated on the authority of some Arabian authors, that coffee was not introduced into Arabia by Mohamed Dhabhani, as it was generally stated,

* An order of Priests amongst the Mahometans, which may be call'd their Bishops.

† Pharm. Journ. Trans. xii., 268 (1852—1853).

but by the learned and godly Ali Shadeli ibn Omar. In the days of Mohamed Dhabhani, Kât, which previous to that time was used, had disappeared from Aden. "Then it was that the Sheik advised those who had become his disciples to try the drink made from the *Boonn* (coffee-berry), which was found to produce the same effect as the *Kât,* including sleeplessness, and that it was attended with less expense and trouble. The use of coffee has been kept up from that time to the present."

As the custom of drinking coffee originated in Abyssinia, it appears more probable that it was introduced into Arabia from this country, and not from Persia.

My friend, Professor Theodores, has informed me that the beverage made from the Boonn is called *Kahwa.* This word is derived from *Ikha,* dislike or distaste, *i.e.* for eating and sleeping.

Ordinary Meeting, February 19th, 1884.

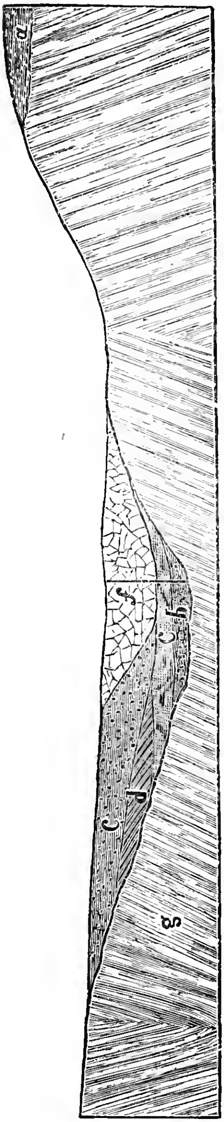
H. E. Roscoe, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

Mr. J. Cosmo Melvill, F.L.S., and Mr. J. A. Bennion, F.R.A.S., were appointed Auditors of the Treasurer's Accounts.

"Notice of the Geology of the Haddon District, eight miles south west of Ballaarat, Victoria," by F. M. Krausé, Professor of Geology in the School of Mines, Ballaarat. Communicated by the President.

The specimens of fossil fruit and wood, etc., from Haddon, intended for transmission to Professor Roscoe, will be found described in Baron von Mueller's Memoirs of the Geological

Survey of Victoria, copies of which are enclosed with the specimens. The litho. plates give detail sections of a shaft where fossils were obtained; but as this does not explain the general structure of the country in which the fossil-bearing pliocene beds occur, I have prepared the subjoined geological section from a survey recently made by me. This will supplement the information given in the printed memoirs.



a. Coarse, well-rounded quartz pebble drift containing gold in flat scales. The gold is of inferior value (20 carat) to that occuring in deposit *b* (23 carat), and the grains are in many places discoloured by a film of ferro-manganese. The deposit, of *Lower Pliocene* age, is of small extent, a mere outlier, or remnant, of a once widespread marine drift.

b. Auriferous, waterworn-quartz-pebble drift, in part cemented by iron sulphide into a pyritous conglomerate. This is a fluvial deposit in the bed of an old river channel (or "Lead" as the Australian miner terms it). In it occur the fruit of spondylostrobus, phymatocaryon, penteune, etc.

c. Sandy drift with trunks, upwards of 3 feet in diameter, of sub-fossil cupressinous conifer wood (possibly spondylostrobus), junks of lignite, and irregular bands and patches of earthy brown coal. The wood, as well as the xylocarps of deposit *b*, are frequently partly or wholly connected into pyrites, in which analysis invariably detects the presence of gold.

This, together with the overlying shale bed *d*, may be set down as a lacustrine or, at all events, a still-water deposit, and is, no doubt, due to interception of the river current by the lava flow.

d. Soft sandy shale full of myrtaceous leaf impressions. These leaves have not yet been described.

The beds *b*, *c*, and *d* I have classed as *middle pliocene.*

e. Clay drift with angular and sub-angular quartz pebbles; contains the lower jawbones and loose teeth of *perameles nasuta*, identical, I believe, with that of the New South Wales cave breccia, and closely allied to the living "long-nosed bandicoot." This deposit is contemporaneous with the lava flow, as it is found now overlying the basaltic rock, then underlying it, and again abutting against it. I assign to both the age of *upper pliocene.*

f. Dolerite lava, 60 to 80 feet in thickness; the upper crust is vesicular, the main mass a granular rock rich in specular iron, and containing olivine, spherosiderite, and aragonite, but, as far as I have observed, no zeolites.

g. Soft, grey and yellow clay shales, slightly micaceous, having joint and bedding planes coated with scaly chlorite.

These shales, alternating with coarse-grained ferruginous sandstones, are of *Lower Silurian* age. They are traversed by numerous quartz veins and lenticular patches of quartz, but these are generally so thin and irregular that no mining operations have hitherto been carried on to test their auriferous character.

The removal of the gravel drift *b* has engaged the labour of numerous large mining companies for years past. The gravel drift, known by miners as "wash dirt," has yielded as much as an ounce of gold to the ton of stuff.

List of specimens transmitted to Prof. Roscoe, F.R.S., to illustrate the geology of the Haddon District, 8 miles south-west of Ballaarat.

From deposit marked b on section.

1. Xylocarps of spondylostrobus, penteune, &c.

From deposit c.

2. Sub-fossil wood; portion of the identical specimen histologically examined by Baron v. Mueller, and depicted on plate xx. of his Memoir.

3. Junk of sub-fossil wood.

From deposit b.

4. Fossil-wood, partly converted into pyrite.

From deposit d.

5. Myrtaceous leaves in sandy shale.

From deposit b.

6. Auriferous quartz conglomerate cemented by iron sulphide.

From deposit g.

7. Lower Silurian clay shale.

8. Quartz vein in Lower Silurian shale.

From veins in Lower Silurian rocks in the neighbourhood of Ballaarat.

9. Auriferous quartz in plumbaginous shale with pyrites.

10. Auriferous quarts with sphalerite and galena; shows lithomarge (?) casing.

11. Auriferous arsenopyrites disseminated in quartz.

12. Coarse grains of native gold in quartz.

13. Filiform grains of native gold in milky quartz.

14. Native gold with galena, arsenopyrites, and chalcopyrite in quartz.

15. Native gold in limonite (transmuted pyrites) in quartz.

From deposit f.

16. Basalt, with aragonite, portion of the core of a diamond drill.

Ordinary Meeting, March 4th, 1884.

H. E. Roscoe, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

A paper was read "On the Production and Purification of Gaseous Fuel for Industrial Purposes, with the results of several large Applications of a System," by W. S. Sutherland, Esq., of Birmingham. Communicated by Francis Nicholson, F.Z.S.

General Meeting, March 18th, 1884.

H. E. Roscoe, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

Mr. J. B. Dancer, F.R.A.S., was elected an Honorary Member of the Society; and Mr. Ald. Joseph Thompson an Ordinary Member.

Ordinary Meeting, March 18th, 1884.

H. E. Roscoe, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

The President stated that he had much pleasure in laying on the table the first volume of the collected scientific papers of their eminent member Dr. Joule. This volume of 667 closely printed pages, published at the cost and by the Council of the Physical Society of London, the members of the Literary and Philosophical Society will welcome as a fitting tribute to the life-long and far-reaching scientific labours of their eminent townsman and friend. Wren's great work of St. Paul's cathedral was said to be his fittest monument, and so of this volume we may add "Si monumentum quæris inspice," for it contains the whole of the experimental work accomplished by Joule alone from his first paper on an electro-magnetic engine, published in Sturgeon's "Annals of Electricity," and dated January 8, 1838, to the last of his researches summing up the most important of his life's work, viz. "A new Determination of the Mechanical Equivalent of Heat," from the Philosophical Transactions of the Royal Society exactly 40 years afterwards. Between these two communications this volume contains no less than 102 original papers, some long and some short, and some of course of greater interest and importance than others, but all exhibiting that clear insight into the phenomena of nature, that original habit of thought, that power of careful and exact experimentation, and withal that modesty of style and expression, which characterise our distinguished friend. Many of these papers, and some of the most important of them, have been communicated to this Society, and are simple reprints from our memoirs; and in this fact the Society has just ground for congratulation. This volume ends most appropriately with a simple number—Joule's most accurate determination of the mechanical equivalent of heat, viz., 772·55. No words could be so eloquent to those who can appreciate the value of these few figures, and who understand the difficulty of their experimental determination.

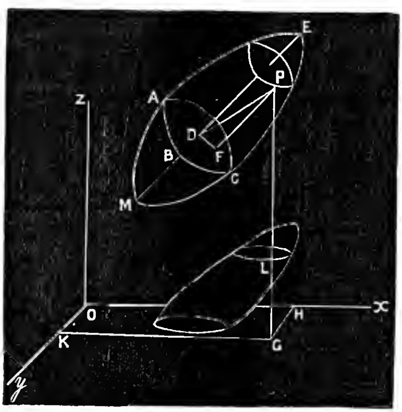
On the motion of the PRESIDENT, seconded by Professor REYNOLDS, it was resolved that a letter of congratulation be addressed to Dr. Joule on the publication of the first volume of his Memoirs by the Physical Society of London.

"On the Equations and on some Properties of Projected Solids," by JAMES BOTTOMLEY, D.Sc., B.A., F.C.S. (abstract).

On a former occasion I brought before the Physical and Mathematical Section of this Society a proposition in projection, in which it was shown how by the composition of two projections, namely, of that of a line on a line, and of that of a plane area on a plane area perpendicular to the aforesaid line, we could derive from a solid three solids with axes perpendicular to three planes and of variable volume; the variation being subject to the condition that the sum of the three volumes is constant and equal to that of the primitive solid. I now propose to solve the following problem, given the equation to the primitive solid to deduce that of a derived solid.

Let the equation to the primitive solid referred to three rectangular areas be

$$F(x, y, z) = 0.$$



Let ABC be the primitive plane which is fixed in the solid, and DE an axis perpendicular to this plane, and which may be called the primitive axis. Let P be a point situated on the intersections of the solid by a plane parallel to the primitive plane. Draw PG perpendicular to the plane x, y; on PG take a length LG so that

$$LG = PF\cos\gamma$$

γ being the inclination of the primitive axis to the axis of z. Then L will be a point on the derived solid. Also we have

$$PF = PD\cos DPF$$

DPF is the angle between PF and PD, PF is parallel to the primitive axis, and its direction cosines will therefore be

$\cos\alpha$, $\cos\beta$, $\cos\gamma$. Let a, b, c be the coordinates of the point D. Then the direction cosines of the line DP will be

$$\frac{x-a}{\mathrm{PD}},\ \frac{y-b}{\mathrm{PD}},\ \frac{z-c}{\mathrm{PD}}.$$

Therefore we have

$$\cos\mathrm{DPF} = \frac{(x-a)\cos\alpha + (y-b)\cos\beta + (z-c)\cos\gamma}{\mathrm{PD}}$$

Also we have

$$x = \mathrm{KG}$$
$$y = \mathrm{HG}$$
$$z = \mathrm{PG}$$

Let ξ, η, ζ denote the coordinates of the corresponding points on the derived solid, then

$$\xi = \mathrm{KG}$$
$$\eta = \mathrm{HG}$$
$$\zeta = \mathrm{LG} = \mathrm{PD}\cos\mathrm{DPF}\cos\gamma$$

Hence we obtain

$$\xi = x$$
$$\eta = y$$
$$\zeta = \cos\gamma\{(x-a)\cos\alpha + (y-b)\cos\beta + (z-c)\cos\gamma\}$$

Hence the equation to the derived solid will be

$$\mathrm{F}\left(\xi,\ \eta,\ \frac{\zeta}{\cos^2\gamma} - \frac{(\xi-a)\cos\alpha + (\eta-b)\cos\beta}{\cos\gamma} + c\right)$$

or if z be given as an explicit function of x and y

$$z = \phi(x,\ y)$$

then the derived solid will be

$$\zeta = \cos\gamma((\xi-a)\cos\alpha + (\eta-b)\cos\beta - c\cos\gamma) + \cos^2\gamma\phi(\xi,\ \eta)$$

The remainder of the paper consists of a proof by means of these substituted coordinates of the relation

$$\mathrm{V}_z = \cos^2\gamma\mathrm{V}$$

and so, of the equation

$$\mathrm{V}_x + \mathrm{V}_y + \mathrm{V}_z = \mathrm{V}$$

which was given in a previous paper, and a discussion of some other properties of projected solids.

"Notes on the Meteorology and Hydrology of the Suez Canal," by Dr. W. G. Black, F.R.Met.S. Communicated by Joseph Baxendell, F.R.A.S.

The observations of the meteorology of the stations on the line of the Suez Canal were taken by the officers of the Canal and Telegraph Departments of the Canal Company for two years, from June, 1866, to June, 1868, and before the opening of the canal to the waters and navigation. The observations embraced those of the barometer, thermometer, and hygrometer, and have been tabulated out by months, and the means and ranges made out of each set for the three stations of Port Said, Ismailia, and Suez.

At Port Said the mean barometer was 29·94in., and its range for the period only ·33in.; the mean thermometer was 68°·9 F., but the range was as much as 26° F., from 82°·1 in July to 56°·3 in February. The mean hygrometer was 71, with a small range of only 3 in consequence of the vicinity of the sea.

At Ismailia the mean barometer was 29·92in., with a like small range of only ·34in., from the absence of storms; the mean thermometer was the same, or 68°·9 F., but with a higher range of 28°, from its inland situation and drier air, from 82°·5 in July to 54°·5 in February. The mean hygrometer was here lower at 68°, but with a higher range of 19, from 58 in June to 77 in December, which is probably due to the presence of the neighbouring desert.

At Suez the mean barometer was only 29·95in., with a like small range of only ·31in.; the mean thermometer was at 69·5, somewhat higher than that at the other stations, from being further south and surrounded with hills, and with a high range of 27, from 83°·1 in July to 55°·5 in February. The mean hygrometer was at 64, or much less than at the other stations, with a still higher range of 23, from 49 in May to 72 in December, due to the neighbouring desert and its clear sky and dry air.

On summarising the tables for the estimation of the general climate of the canal and district, the mean barometer was found highest in the winter months of November (30·06in.), December (30·04in.), January (30·07in.), and February (30·10in.), and lowest in the summer months of July (29·76in.) and August (29·78in.), owing to the variation in the positions of the zones of high and low pressure over Egypt in the winter and summer isobaric lines. The mean thermometer at all the stations was highest in the summer months of

July (82°·8) and August (81°·3), and lowest in the winter months of December (57°·3), January (56°·3), and February (55°·4), contingent with Egypt lying within the zones of 80°—90° in the summer, and of 50°—60° in the winter isothermal lines. The mean hygrometer at all the stations was highest in the winter months of November (71), December (74), January (73), and February (70), and lowest in the summer months of May (60·3), June (60·7), and July (60), which is probably due to the presence or absence of the winter rains or Nile floods over the Eastern flats of the delta. There would appear to be no records of the amounts of the winds, or of the quantities of the rainfall, or the specific gravities or temperatures of the waters of the lakes in the district of the canal, which would all have been of great scientific interest in considering the conditions of the climates before and after the opening of the Suez Canal for navigation.

It seems stated that N. winds prevail generally over all the others in the district, blowing from the Mediterranean sea; but at Port Said the winds incline frequently to the W., or even S.W. ones are observable in the winter, coming from across the delta of Egypt. At Ismailia the prevailing winds are N. and N.N.E., and in the spring they blow sometimes from the S.W.; but in the summer the direction lies invariably from N.N.W. to N.N.E., and are called the Etesian winds. At Suez the conditions of the winds are like those of Ismailia, with, in addition, some sea breezes from the direction of Suez bay. It is also generally stated that the rains are more frequent now than they were before the canal works were begun, and thick fogs are very often now encountered on the lakes, as dense as any in London or Paris.

"Notes on the Hydrology of the Suez Canal for 1871-2."

The following remarks on the nature of the waters of the Suez Canal, as they are affected by physical or climatal conditions, are prepared from five sets of observations taken in five voyages through it during the months of February, March, April, October and November. They refer to their specific gravities and temperature, and also to that of the air on board ship at the time, and the direction of the wind at the time prevailing. These particulars have been drawn out in diagrams showing their state for nearly every mile or so of the route through, and they thus bring out special curves of increasing or diminishing density and temperature of the canal water, from the Mediterranean to the Red Sea. Also the whole set of records have been summarised both horizontally by voyage for the totals and means, and perpendicularly for nearly every mile for the same, and general means have been calculated for the entire set added together.

For the voyage in February, the results are mean specific gravity of canal water 1·0416, temperature of water mean 60°·9 F., temperature of air on board, maximum 67°·3, minimum 60°·3, mean 63°·8. Winds, S.W. and N. (On land, M.T. 55°·4, Hy. 70.)

For March, the water shows a specific gravity mean 1·0408, temperature mean, 65° F., temperature of air and direction of winds not recorded, but were probably prevailing from N.E. and N.W. (On land, M.T. 63°·2, Hy. 66·6.)

For April, the canal water had a mean specific gravity of 1·0434 and mean temperature of 70°·1 F., no record of air or winds, which were probably N., N.W., W. (On land, M.T. 65·8, H. 63.)

For October, the water showed a mean specific gravity of 1·0345, and mean temperature of 76°, whilst that of the air on board was maximum 77°, minimum 71°, mean 74°, and the winds were from N.E. and N.W. (On land, M.T. 72°·4, Hy. 66·6.)

For November, the water had a mean specific gravity of 1·0392, and a mean temperature of 69°; no record of air or winds, which were probably N.W., N., S. (On land, M.T. 64°·5, Hy. 71.)

The general totals and means comprise 15 days' sailing, 450 miles, 150 observations, specific gravity 1·0399, temperature of canal water, 68°·2 F., temperature of air on deck, 68°·9 F., on land, M.T. 69°·12, Hy. 68.

These may usefully be compared with the general means of observations on the outside seas, the Mediterranean and Red Seas.

The Mediterranean shows a mean specific gravity in its eastern basin of 1·029—30, and a mean temperature of 63°—66° F., or less than those of the canal; and the air at Port Said, on land, has a mean temperature of 68°·9, or about the same as that of the canal.

The Red Sea is stated to have a mean specific gravity in Suez Bay of 1·027, or less than that of the canal water, and a mean temperature of 71°, or higher than the same; and the air at Suez, on land, has a mean temperature of 69°·5, or somewhat higher than that of the canal.

The mean temperature at Ismailia, on land, appears to be 68°·9 F., or about the same as that of the canal.

These points tend to show that the warmth of water and air of the canal probably come from the Red Sea, and not from the land nor from the Mediterranean Sea, and that this is borne along its waters by various currents and tides from the south to the north end.

The mean density of the canal water exceeds that of the outside seas at either end by 1·039 to 1·027, and the cause of this increase has been generally believed to be due to the increased evaporation of the water of the canal by the increased sun's heat and dryness of the air of the country.

Now the highest mean density of the canal water was found in April, 1·0434, coincident with moist N.W. winds from the Mediterranean, and low mean humidity of 63 from the absence of Nile floods over the eastern delta.

The lowest mean density was seen in October, 1·0345, coincident with dry N.E. winds, higher mean humidity of 67 from moisture of the air by the Nile floods being out over the flats of the adjacent country.

According to scales of mean temperatures on land the greatest density from evaporation ought to occur in July, which has a mean temperature at the stations of 82°·8 F., and the least density to be found in February, with its mean temperature of 55°·4 on land. On the contrary, the highest mean temperature of the canal water was found in October, 76°, coincident with mean temperature of air of 74° on the ship, and of 72° for the month on land, which were both below the other.

This point further shows that the canal water probably derives its heat, as before mentioned, from the Red Sea, where the temperature of the water in its middle region of 18°20′ N.L. rises to 80°, and at the southern end to 84° in 10°—12° N.L., and not from the land air.

The lowest mean temperature of the water was found in February, 60°·9 F., coincident with temperature of the air on the ship of 63°·8 at the time, and of mean temperature of the air on land for the month of 55°·5. This, again, corroborates the previous paragraph, and shows that the warm current from the south warms also the ship and the air over the canal, and affords an explanation of the now dense fogs that prevail over the lakes and channels of the canal in the autumn months, when the land air is becoming cooler than the canal air.

In comparing density with temperature of the canal water and air, we find that the greatest mean density, 1·0434 in April, does not coincide with the greatest temperature of water, 76° in October, nor of air, 74° then. On the other hand the least mean density tabulated does correspond with these factors, 1·0345 in October, which again shows that the variations in density of the canal waters do not depend on rising and falling of temperatures of water or air.

According to the tables of hygrometrical observation the greatest density of the canal water ought to be in July, when the land air was at 82°·8 mean temperature, and lowest humidity at 60 on land; and the lowest mean density ought to occur in December, when the land air temperature was at 57°·3, and the highest humidity at 74·3 on land.

The correspondence of the greatest density of the water, 1·0434 in April, with the low humidity of 63 in April on land, would point to a great source of the desiccation of the canal, as also the fact that a higher humidity of 67·6 occurs in October, with the lesser density then of the water of 1·0345.

In the absence of observations for the remaining seven months of the year, and of sufficient records of the winds, rains, and currents on the canal, it would be premature to attempt to define the real causes of the alterations in the condition of the canal water at different periods of the year.

It may, however, be surmised that there does not appear to be any correspondence between the climate of the land and that of the canal which passes through it, and that the latter rather influences the former, and carries additional heat and moisture to be radiated and dissipated through the other in the vicinity.

The Sweet or Nile Water Canal also runs alongside the salt water one, but there are no records, as yet, of temperatures or specific gravities, or whether they are different at different times of the year, as those of the other are shown to be. There is no doubt but it would bring additional river water and air moisture to the line of the canal, and react more or less upon the latter according as the periods of the flooding or ebbing of the river Nile would fill it more or less with fresh water.

It should also be repeated that the variations in the density of the canal waters do not appear to be dependent on the variations of temperature in the outside seas, as in that case they would be highest in summer and lowest in winter. On the other hand, they are of higher degree of density in the spring months, and lower in the autumn months, so that it is likely that the cause may probably have to be sought for in the physical conditions of the canal itself, irrespective of the climate of the isthmus of Suez or of that of the adjacent seas.

Ordinary Meeting, April 1st, 1884.

H. E. Roscoe, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

Mr. Brothers, F.R.A.S., described the Woodburytype and Stannotype processes. He said that Mr. Woodbury's first idea was to produce photographs in gelatine relief to imitate porcelain relief pictures, but he found that by using a low relief the image could be pressed into soft metal, and from the impressed image prints on paper could be obtained in gelatine combined with pigment of any colour. Pictures of this kind could be made so closely imitating ordinary silver prints that it was difficult to detect the difference. Owing to the difficulty of obtaining plates with perfectly flat surfaces and the great pressure required to produce the impression in metal, the size of the Woodburytype picture was limited. It occurred to Mr. Woodbury that a gelatine negative having sufficient relief could itself be printed from, but as the use of fluid gelatine for the prints would soften the negative, it was necessary to protect the surface, and for this purpose he covers the negative with thin sheets of tinfoil, which is passed between indiarubber rollers, which cause the thin metal to take the impression of the negative completely, and the glass plate (which is of the ordinary thickness) bearing the negative covered with tinfoil could now be used as the ordinary Woodburytype plate, and printed from in the same way. Mr. Brothers showed some of the original Woodburytype prints, and from a metal plate showed the method of printing—the plate being a portrait of Mr. Woodbury. A Stannotype plate was also shown and prints side by side, with silver prints from the same negative.

MICROSCOPICAL AND NATURAL HISTORY SECTION.

October 8th. 1883.

J. COSMO MELVILL, M.A., F.L.S., President of the Section, in the Chair.

Mr. Henry Hyde, of 2, Ellesmere Street, Regent Road, Salford, was elected an Associate of the Section.

Mr. CHADWICK exhibited slides of Halecium—Halecinum and Bugula turbinata, both mounted with the tentacles fully extended, and explained the method of preparation, Kleinenberg's picric acid solution being used for the first, and absolute alcohol for the second.

Mr. C. BAILEY exhibited specimens of Naïas Major all collected by Mr. Arthur Bennett, at Hickling Broad East, Norfolk. Also living specimens of Caulinia alaganensis, Poll., and Chara (coronata) Brannii, Gmel., from the neighbourhood of Reddish.

November 5th, 1883.

J. COSMO MELVILL, M.A., F.L.S., President of the Section, in the Chair.

Mr. HYDE exhibited specimens of Typha Angustifolia and Typha Latifolia, found growing together in a pond near Shrewsbury.

Also Strawberry flowers gathered during the week, in a garden near Sale, where nearly the whole bed was in flower.

Mr. MELVILL exhibited specimens of the curious Beetle Mormolyce Phyllodes (Hagenback), from Java, and read the description given in the Rev. J. G. Wood's "Insects Abroad."

Mr. Rogers exhibited a number of Plants collected by his son, Mr. Leo Rogers, on the track of the Canadian Pacific Railway, between Winnipeg and the Rocky Mountains.

December 3rd, 1883.

J. Cosmo Melvill, M.A., F.L.S., President of the Section, in the Chair.

Mr. Rogers mentioned that he had been making enquiries as to the prevalence of earth worms in North America from his son, Mr. Leo Rogers, who had travelled from Winnipeg to the Rocky Mountains, and seen large tracts of country ploughed up, and from naturalists and farmers working near the line of the Canadian Pacific Railway, and they all concurred in the statement that the common earthworm was not met with in Manitoba and the North West territories.

Mr. Hyde remarked that crushed laurel leaves were not so rapidly fatal to grasshoppers as to wasps, bees, spiders, and beetles. He found that whilst the latter insects died in from two to three minutes, grasshoppers would remain alive for three days in the bottle. He also noticed that insects killed in this way died with the proboscis extended.

Mr. Brothers exhibited a Photograph of the Great Nebula in Orion, taken by Mr. Common, of Ealing, in 37 minutes, with a thirty feet telescope. Also a Photograph of a portion of the Sun's surface, taken at Meudon in October, 1877, by Professor Janssen.

January 14th, 1884.

MARK STIRRUP, Esq., Treasurer of the Section, in the Chair.

Alexander Hodgkinson, B.Sc., M.D., of Claremont, Bury New Road, Higher Broughton, and Charles Herbert Hurst, Assistant Lecturer in Zoology at Owens College, were elected Associates of the Section.

Mr. HYDE exhibited a specimen of the Lancelet Amphioxus or Branchiostoma Lanceolatum, from the Mediterranean. It belongs to the Fourth sub-class of fishes, *i.e.*, the Leptocardii, which is represented by a single family Cirrostomi and a single genus Branchiostoma.

Prof. DRESCHFELD gave a demonstration of some Micro-organisms found to be present in connection with certain diseases.

In the course of his remarks, Dr. Dreschfeld said that these organisms were vegetable, and belonged to the Class Schizomycetes. They were divisible into four Groups, Micrococci, Bacteria, Bacilli, and Spirilla. The Micrococci were little rounded organisms consisting of simple protoplasm, found singly or in pairs, or linked together to form chains, or in masses. When in a free state they showed distinct movement. They all stained readily with aniline dyes. They had been found in cases of Pneumonia and Erysipelas, and were believed to have been met with in Diphtheria. The Bacteria were small rod-shaped organisms, which in some states had been observed by Dallinger to have flagella at each end. They had not been found frequently in connection with disease, but had been observed by Pasteur in Chicken Cholera. The Bacilli were also rod-shaped, but longer than the Bacteria, and showed more signs of organization. Their life-history had been observed: First, the rod broke up into spores, kept together by protoplasm; the spores were very difficult to kill. When cultivated in a favourable medium, the spore elongated into a thread which divided into segments, each of which broke up again into spores which grew into fresh Bacilli. The Bacilli were very variable in their action under the different staining processes, and owing to this some of them could readily be detected by their taking a different stain to the containing medium. They had been found in cases of Splenic fever, Consumption, Typhoid fever, Glanders, Leprosy, and Cholera. The Spirilla were wavy thread-like organisms showing flagella in some states, and not staining readily. They had been found in the saliva, round the teeth, and in the ear.

With reference to the connection of these organisms with disease, Dr. Dreschfeld said that in order to be justified in concluding that the organism was the cause of the disease it must fulfil several conditions:—1st. It must always be present with the disease. 2nd. It must be present from the very first. 3rd. It must be capable of cultivation in a suitable medium. 4th. The cultivated organism must produce the original disease when inoculated into an animal of the same species as that from which it was derived. For obvious reasons it was exceedingly difficult to conduct experiments of this nature, but it had been done in the cases of Chicken Cholera and Splenic fever. Dr. Dreschfeld exhibited preparations showing the Micrococci of Erysipelas, the Bacteria of Chicken Cholera, the Bacilli of Splenic fever, Consumption, and Leprosy, and others of the micro-organisms which he had described.

February 11th, 1884.

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

Mr. Hyde described a method of preparing for educational purposes the various parts of trees, and exhibited preparations of the sycamore, beech, and oak mounted in this way.

Mr. Rogers exhibited specimens of Amblystegum Porphyrrhizum, Lin., collected on the sandhills at Southport in 1875. It is a continental species, this being the first occasion on which it has been found in England.

On the suggestion of Mr. Brothers it was resolved that the next meeting should be a working evening, and devoted to investigating some of the contents of the cabinets belonging to the Section.

March 10th, 1884.

J. Cosmo Melvill, M.A., F.L.S., President of the Section, in the Chair.

Messrs. J. Boyd and Theodore Sington were nominated by the President to audit the accounts of the Section.

Mr. Brothers exhibited two Photographs of Histological preparations, taken by him in the Physiological Laboratory of the Owens College, by the Electric Light, one with a Zeiss, the other with a Smith and Beck objective.

On the motion of Mr. ROGERS, seconded by Mr. BARRATT, it was resolved—

That Mr. Brothers be requested to ascertain whether and when Dr. Gamgee would permit the members of the Section to visit and inspect the Physiological Laboratory.

Annual Meeting, April 7th, 1884.

J. COSMO MELVILL, M.A., F.L.S., President of the Section, in the Chair.

Secretary's Report for the Session 1883-4.

The Section has held 7 meetings, and the Council 3, during the Session. The average atendance has been 9.

During the past year one Member, Mr. Wilfred Becker, and two Associates, Messrs. Lionel Adams and Dr. Hartog, have resigned. Dr. Hartog's resignation, which has deprived the Section of an able and active member, was consequent upon his appointment to a Professorship at one of the Queen's Colleges in Ireland. During the same period 3 new Members, Mr. H. H. Howorth, Dr. Hodgkinson, B.Sc., and Mr. C. H. Hurst, and one Associate, Mr. H. Hyde, have been elected, making our present number 33 Members and 9 Associates.

The Session has been one of unusual quietude both in the attendance at the meetings and the number and importance of the communications. Of the 14 communications (as against 19 last Session) which have been made, Professor Dreshfeld's demonstration of "Some Micro-organisms found to be present in connection with certain diseases," and Mr. Boyd's "On some parasitic mites," are the most important.

A supplementary meeting of the Section has been arranged for the 25th inst., to enable certain further communications to be made.

ROBT. E. CUNLIFFE, Hon. Sec.

Manchester, 7th April, 1884.

The HON. SECY. reported that Dr. Gamgee was willing that the members of the Section should visit and inspect the Physiological Laboratory of the Owens College, and that he was in correspondence with him as to a date. It was resolved that the Hon. Sec. should fix a date and notify it to the members in the usual way.

On the motion of the PRESIDENT, seconded by Dr. TATHAM, it was resolved: That the meetings of the Section be held in future on Tuesday instead of Monday as heretofore, the dates to be fixed so as not to clash with the meetings of the Parent Society, and the Physical and Mathematical Section.

The monographs on the Fauna and Flora of the Bay of Naples, published to date, presented by Mr. Darbishire, having been laid on the table, it was resolved: That the thanks of the Section be given to Mr. Darbishire therefor.

The following were elected officers for the ensuing session, 1884-5:—

President.

THOS. ALCOCK, M.D.

Vice-Presidents.

J. COSMO MELVILL, M.A., F.L.S.
A. MILNES MARSHALL, M.A., D.Sc., F.L.S.
A. BROTHERS, F.R.A.S.

Treasurer.

MARK STIRRUP, F.G.S.

Secretary.

J. F. W. TATHAM, M.D.

Council.

CHAS. BAILEY, F.L.S.
JOHN BOYD.
ROBT. E. CUNLIFFE.
R. D. DARBISHIRE, F.G.S.
W. BOYD DAWKINS, F.R.S., F.G.S.
THOS. ROGERS.
THEODORE SINGTON.
W. C. WILLIAMSON, F.R.S.

Mr. J. Boyd gave a demonstration of some parasitic mites. Confining his remarks to those belonging to the family of the Acarea, which are found on man and domesticated animals, and cause the diseases known as Itch, Mange, and Scab. Mr. Boyd explained that these mites belonged to the genera Sarcoptes, Dermatodectes or Psoroptes, Symbiotes, and Demodex.

On man a species of Sarcoptes and of Demodex are found, the former causing the itch, the latter inhabiting the sebaceous and hair follicles, causing the unsightly marks in the skin of the face, popularly called "black-heads."

On the horse and the sheep a species of Sarcoptes is found, and on the horse, ox, and sheep Dermatodectes affecting the body, and Symbiotes principally confined to the legs, producing the diseases known as Mange and Scab.

The dog is subject to two forms of Mange, one caused by a Sarcoptes, the other by the Demodex, which appears to be transferable from man to the dog.

The cat, goat, and pig are subject to the attacks of a species of Sarcoptes.

Mr. Boyd gave descriptions of the two sexes and larvæ of these various mites, and of their ravages on the different animals upon which they are respectively parasitic, drawing special attention to the serious loss to sheep-owners caused by the "Scab" disease induced by the Dermatodectes, and illustrated his remarks with large diagrams of several of the species, and a number of mounted specimens, which he exhibited under the microscope.

The Microscopical and Natural History Section of the Manchester Literary and Philosophical Society, in account with Mark Stirrup, Treasurer.

Dr.

		£	s.	d.
1883.				
July 30.	To J. E. Cornish (Micro. Jour., April)	0	8	4
Oct. 22.	,, Chas. Simms & Co. (Cards and Circulars)	0	13	6
,, 22.	,, Thos. J. Day (Challenger Report, vol. 7)	1	10	0
Nov. 9.	,, H. T. Stainton (Zool. Record, 1883)	1	0	0
,, 14.	,, J. E. Cornish (Micro. Jour., July)	0	8	4
1884.				
Feb. 13.	,, J. E. Cornish (Micro. Jour., Oct. and Jan., '84)	0	16	8
,, 13.	,, Chas. Simms & Co. (Circulars)	0	16	6
,, 13.	,, Jno. Van Voorst (Ibis, 1884)	1	1	0
Mch. 7.	,, Parent Society	2	2	0
Apl. 1.	,, Wm. Roscoe (Postage, &c., 17s. 7d.; Tea, Coffee, &c., £3 1s. 4d.	3	18	11
,, 3.	,, Thos. J. Day (Challenger Report, vol. 8)	2	0	0
,, 3.	,, Chas. Simms & Co. (Circulars)	0	16	6
	,, Balance in Manchester and Salford Bank, St. Ann's Street Branch	127	7	4
		£142	19	1

Cr.

		£	s.	d.
1883.				
Mch. 30.	By Balance in Manchester and Salford Bank, St. Ann's Street Branch	119	19	9
1883–4.	,, Subscriptions	20	10	0
	,, Excess of Subscriptions due *re* Hartog's cheque	0	0	3
1883.				
Dec. 20.	,, Interest allowed by Bank	2	9	1
		£142	19	1

By Balance in Bank £127 7 4

Examined and found correct,

Signed { JOHN BOYD,
THEODORE SINGTON.

April 3rd, 1884.

List of Members and Associates, April 7th, 1884.

Members.

Alcock, Thomas, M.D.
Bailey, Charles, F.L.S.
Barratt, Walter Edward.
Barrow, John.
Baxendell, Joseph, F.R.A.S.
Bickham, Spencer H., Jun.
Birley, Thomas Hornby.
Boyd, John.
Brogden, Henry.
Brothers, Alfred, F.R.A.S.
Cottam, Samuel.
Coward, Edward.
Coward, Thomas.
Cunliffe, Robert Ellis.
Dale, John, F.C.S.
Dancer, Jno. Benjamin, F.R.A.S.
Dent, Hastings Charles.
Darbishire, R. D., B.A., F.G.S.
Dawkins, W. Boyd, F.R.S., F.G.S.
Deane, W. K.
Higgin, James, F.C.S.
Hodgkinson, Alex., B.Sc., M.D.
Hurst, Charles Herbert.
Howorth, Henry Hoyle.
Marshall, A. Milnes, M.A., D.Sc., F.L.S., Prof. of Zoology, Owens College.
Melvill, J. Cosmo, M.A., F.L.S.
Moore, Samuel.
Morgan, J. E., M.D.
Nicholson, Francis, F.Z.S
Sidebotham, Joseph, F.R.A.S., F.L.S.
Smith, Robert Angus, Ph.D., LL.D., F.R.S., F.C.S.
Williamson, Wm. Crawford, F.R.S., Prof. Nat. Hist., Owens College.
Wright, William Cort.

Associates.

Cunliffe, Peter.
Hyde, Henry.
Percival, James.
Quinn, Edward Paul.
Rogers, Thomas.
Stirrup, Mark, F.G.S.
Sington, Theodore.
Tatham, John F. W., M.D.
Ward, Edward.
Young, Sydney.

PHYSICAL AND MATHEMATICAL SECTION.

January 29th, 1884.

ALFRED BROTHERS, F.R.A.S., in the Chair.

A letter from Mr. Baxendell was read, giving an account of spectroscopic observations made during the recent remarkable sunsets, and also stating that grains of magnetic iron were to be found in the sands at Southport very near the level of low water.

Annual Meeting, March 11th, 1884.

ALFRED BROTHERS, F.R.A.S., in the Chair.

The Treasurer's Accounts for the past year were presented and passed, and the following gentlemen were elected officers of the Section for the ensuing year:—

President.

J. P. JOULE, D.C.L., LL.D., F.R.S., F.C.S., &c.

Vice-Presidents.

JOSEPH BAXENDELL, F.R.A.S.
ALFRED BROTHERS, F.R.A.S.

Secretary.

J. A. BENNION, M.A., F.R.A.S.

Treasurer.

JAMES BOTTOMLEY, D.Sc., B.A., F.C.S.

General Meeting, April 15th, 1884.

Charles Bailey, F.L.S., in the Chair.

Mr. Samuel Okell, of Grange Road, Bowdon, and Professor Daniel John Leech, M.D., were elected Ordinary Members of the Society.

Ordinary Meeting, April 15th, 1884.

Charles Bailey, F.L.S., in the Chair.

"A Reminiscence of Dr. Dalton," by Chas. Clay, M.D.

I think, but am not quite certain, that it was in the year 1816 or 1817, I was an apprentice to Kinder Wood, Surgeon, 51, King Street, Manchester. About that time the Marsden School of Medicine began its operations, of which my master had the Midwifery Class jointly with Mr. Partington. Jordan and Bluntstone on Anatomy, Dalton on Chemistry, Fawdington on Surgery, Davies on Botany, and some others. I mention this as it has often been stated that the Pine Street School of Medicine was the first in Manchester, *which is not correct.*

Among other Lectures I was advised by my master to attend the Lectures on Chemistry, by Dalton, which I did. The course consisted of ten Lectures, which were to be extended afterwards. I thus became a pupil to Dalton. At that time he was busy experimenting on gases, and he asked my master if he could suggest any plan by which he could obtain some of the gases of the coal pits, more especially what was usually called fire damp. Mr. Wood replied, he had a friend in Oldham whose pits were unusually troubled with fire damp and had had many serious explosions; and if Dr. Dalton was very anxious he would try, *but how?* The Dr. then suggested some bottles filled with water, then taken into the mine and emptied, and when emptied well corked. Mr. Wood said he thought he would send his apprentice to his friend with bottles and instructions, and he felt sure it would be attended to correctly. *I was then asked and willingly volunteered to go.*

Four wine bottles which the Dr. thought sufficient were got and a wine basket that just held them, with a piece of sealing-wax in my pocket and four tightly fitting corks greased at the ends, to be inserted. I started for Oldham with the note. Mr. Wood drove me as far as Hollinwood; from thence I walked to Oldham and with some difficulty found the gentleman, who was just starting on a journey. After reading the note he smiled, and asked me to get into his gig. He drove right to the pits, explained the matter fully to his manager and left me in his care. The underlooker was then signalled from the pit, and soon after made his appearance, black enough from head to foot. Careful instructions were given to him on taking the basket. I interfered and said I had come to see the matter myself, and therefore wished to go into the pit. The manager smiled and asked me if I had ever been in a coal pit, I said no, but I was ready to go. So in the end we prepared to start; I was placed in the tub with the underlooker, who went with me one leg in the tub and the other outside, to guard the descent as there were no conducting rods. On progressing downwards I felt a curious sensation as though I should be sick, and I sensibly felt I was descending rapidly on looking at the sides of the pit, but when the light failed the motion appeared reversed, as though I was going upwards. In a few seconds more I felt the elasticity of the rope, which felt as though it elongated and contracted alternately, and which produced something like sea sickness; on the tub reaching the floor of the mine I got out and was surrounded by about half a dozen black faced mortals, full of curiosity as to what I could want there. What had the bottles in them? Was it gin? My conductor replied, "*nobbut water*"; loud laughter followed. "Neaw, lads," says the conductor, "look handy; two of you go with me and this lad as far as we can with candles and then stop for orders."

The conductor took the basket preceded by one of the men. I followed, and a man followed me; in this order we marched along the mine. I felt the iron rails beneath my feet. After proceeding for a considerable distance I heard a noise like thunder, and enquired what it was. The conductor said only the wagons. Now, said he, stand close to the wall. I had no sooner done so when four wagons of coal were pushed past by lads. We then proceeded as before; at last we got to a point that the conductor called out, *Halt*, and put out all candles but one that was put into a lump of clay and fasten'd on the wall of the passage.

"Now go on carefully." Soon after we came to a turn and enter'd another drift, where we had to creep in a bent position. My breathing at this time became difficult, I felt great oppression about my chest, and the perspiration was profuse all over my body. The conductor called out to me, "Heaw dost feel, lad?" I said, "Not very well!" "Con theaw manage a bit further?" I replied, "I think I can." We then proceeded, but in a short time we stopped. The conductor declared it was not safe to go further. "Neaw, lad," said he, "get done what theaw has to do." He gave me the basket, I felt for the bottles, took one and gave a cork to one of the party, and having emptied the water out gave the bottle to be corked well, instructing him to force it in well, and so on with the other three bottles, which when finished, I said I was ready to return, the bottles being put mouths downwards into the basket.

We then began to retrace our steps, and every few seconds I felt a sensible relief in my breathing. Turning from the narrow drift into the main track, we progressed more rapidly, until I could see a glimmer of light at a distance. It was the candle we had left, and by the time we arrived at it, I felt no difficulty at all in my breathing. I now asked the men to stay a few minutes. One held the candle and I took the piece of sealing wax out of my pocket, melted it at the candle—having first cut the cork off level—smeared it over with the wax. We then proceeded and soon arrived at the bottom of the shaft. Five or six miners, now full of curiosity, crowded round. One said "That's a queer go, bringing water and taking nowt back." "Aye," said another, "and corking *nowt* down, as if it would jump out." These remarks were cut short by my conductor telling me to get into the tub, basket and all. The signal given, we mounted and left our curiosity mongers no wiser.

The same sensations accompanied me up as on the way down, and when we emerged from the pit's mouth the sun was shining brilliantly, and the more so it appeared from being in the dark regions for some hour and a half; the daylight was to me a pleasurable surprise and delight. I experienced a similar sight in after years on emerging from the Peak Cavern in Derbyshire, after a long visit in its interior, on rounding the angle of a rock and coming suddenly to where the light came streaming in. But to my narrative: the underlooker gave an account to the banksman, who remarked that I should make a collier in time, then sent a lad with me to carry the basket and show me the way to Manchester Street in Oldham. Having arrived there, I looked about me to see if there was any way of riding to Manchester; seeing none, I trudged along homewards. After I had gone a mile or so, I saw a stand coach with the horse's head towards Manchester standing at a public house door. I went in and asked the driver if he would give me a lift to Manchester. He asked me in return "If I saw any green in his eye!" After he had perpetrated his joke, he told me he would take me for five shillings. I said I had no five shillings to spend, but if he would take me and the basket to 51, King St., Manchester, I would give him half a crown. After some demur he said, "Well, get in"; and off we set, and a weary ride I got. He stopped at almost every public house either to drink or let his horse drink. In two hours I landed safely in King Street. Mr. Wood was delighted and laughed heartily at my account, paid the man his two shillings and sixpence, and sent me to wash and refresh myself. When that was done, I was sent to George Street with my bottles. The Doctor received me very kindly, and the quiet twinkle of his eye showed his satisfaction, which was greatly increased when he learned the particulars of my travels. He eyed the bottles with great satisfaction, he looked at the corks closely sealed and seemed puzzled. I asked him what he was going to do with them. "Well," he said, "I am thinking how I am to get the corks out without mixing it, more or less, with the atmosphere. I want to put the air into that receiver on the shelf of that pneumatic trough." I said, "I think I could do it." He looked at me and said, "How?" I said, "File the bottle neck round, and then a smart tap under the water I think will do it." He said, "Capital, thou shalt try." He gave me some coppers to fetch a file, and I soon filed a bottle neck round, then held it under the shelf of the pneumatic trough, a gentle tap with the handle of a knife and the air bubbles very speedily rose into the receiver. The other bottles were beheaded, and very soon I took leave of the Doctor, who was apparently well pleased, and on parting said, if there was anything in his lectures which I did not understand, he wished me not to hesitate but ask him and he would always willingly assist me, and he was as good as his word; in fact, he showed me many little kindnesses afterwards, and so ends my small reminiscence of Dr. Dalton.

"Pasteur and the Germ Theory," by FREDERICK J. FARADAY, F.L.S.

1.—I have been encouraged by Dr. Angus Smith to present to you a *résumé* of some of the most remarkable results of the experimental development of what is known as the germ theory. In carrying into effect this idea it will not be expected that I should restrict my attention to Pasteur's work. There have been many able workers besides Pasteur in this field of biological investigation. But the work done by Pasteur is so original and important that he may well be regarded as the great leader of the school; and such other work as it may be desirable to refer to, can be most conveniently dealt with as bearing upon his researches. I have no new microbe to show you, nor have I succeeded in demonstrating the mutual convertibility of any known species. I have, however, given considerable attention to the literature of the subject, and it has appeared to my kind sponsor, as a member of this Society, that a special presentation of such of the facts as have grouped themselves together in my mind, and of some of the thoughts which have been spontaneously evolved from those groupings, might not be without utility. It may provoke what may be considered at the present juncture as a timely discussion, which may bring into clear outline the frontier points of one of the most profound and practical series of inquiries which have ever fascinated scientific men or exercised the human intellect. It is very probable that the paper may take a more philosophical turn than will be in keeping with the exact scientific character of the papers which the Society is in the habit of receiving. In extenuation I must plead that the Society is known as the Literary and Philosophical Society, and that according to the interesting centenary volume lately published by it, it has from time to time received even purely speculative communications. To follow the example of men like Percival and White may appear not entirely reprehensible.

2.—It is now a couple of centuries since Leeuwenhoek communicated to the Royal Society an account of what was apparently the first discovery of bacteria. In a letter to *Nature* Professor Cohn, a few months ago, called the attention of the scientific world to the fact that towards the close of 1683, Leeuwenhoek announced the discovery of active microscopic organisms, including bacilli, bacteriums, and vibrions. The Dutch microscopist discovered them in the white substance adhering to his teeth, and bearing in mind the important part which thermal conditions have played, or have been supposed to play in recent experiments on the sterilisation of "culture" infusions and the "attenuation" of microbes, it is worth while to note that, failing on a subsequent occasion to perceive the movements of bacteria in the same substance, he assumed that they had been killed by the hot coffee which he had taken at breakfast. The discovery not only gave a new vitality to the discussions on spontaneous generation, both sides finding therein arguments in favour of their special opinions, but also suggested ideas as to the propagation of contagious diseases and the nature of infection. In the papers communicated to the Royal Society during the last quarter of the 17th and the 1st quarter of the 18th centuries we find most of the ideas which are still the leading ideas of micro-biologists. With reference to generation in general it is argued that the animalcule is the germ furnished only by the male, and that the female merely supplies the nidus requisite for its development. Springing from this hypothesis we have the suggestion that the nidus affects or modifies the germ, which I take to imply that, given the germ, the nidus in which it is implanted determines the species evolved therefrom. Experiments were made with rain water, mineral water, infusions of pepper-corns, bay-berries, oats, barley, and wheat, and the scum collected from these infusions was discovered to be masses of organisms. Round and elongated pulsating bodies with transparent ends and opaque centres were observed. The possibility of disease being carried from person to person by sheets, towels, handkerchiefs, gloves, &c., in consequence of minute organisms having obtained a lodgment thereon, is referred to as an inference from the fact that the minute organism of itch can live outside the body for two or three days. The existence of globular and elliptical micro-organisms in water, wine, brandy, vinegar, beer, spittle, and urine is mentioned, with the occasional, though rare appearance of spots therein and central constriction; and the tendency of certain species to seek the top of the liquor apparently "for the sake of the air" is also mentioned. Small-pox is compared to fermentation, and it is suggested that it may be propagated through the air, "a bad disposition of the air" being favourable to its reappearance. It is suggested that the "variolous pus" when inoculated finds in the body "the native congenial variolous seeds," and ferments with them. This appears to be an inversion of the common modern doctrine which regards the inoculated matter as containing the germ and the animal body as producing the special fluid or *milieu* for its development; but it is perhaps in accordance with the ideas of Béchamp, the "native congenial variolous seeds" being possibly the micro-zymes of that inquirer.

3.—These earliest speculative results of Leeuwenhoek's important discoveries cover the whole range of the latest investigations into the nature, life-history, and action of microbes. The problems then started still occupy the minds of scientific men, and it may even be said that no absolute answer has yet been given to any of them. Though Dr. Tyndall has said that the doctrine of spontaneous generation is dead, the advocates of that doctrine are prepared to maintain that the question has only been moved a stage further back. It is quite certain that the extreme members of the evolutionary school would not admit that it has been finally demonstrated that inorganic matter does not contain "the promise and potency of all terrestial life"; indeed this is the doctrine enunciated by Tyndall himself at Belfast; and it is equally certain that even many of those who do deny that organisms capable of reproducing their species are ever evolved from absolutely unorganised matter, nevertheless do not consider the presence of any specific atmospheric or other germ as necessary for the reproduction of any given species. There is a domain which still invites the experimentalist, who may succeed in harmonising apparently antagonistic ideas. A very large and important amount of work has been done in showing the analogies between fermentation and disease, and in discovering apparently specific pathogenic microbes or ferments. Indeed, in recent years the multiplication of specific microbes has become almost embarrassing. But though strong evidence has unquestionably been adduced that, at least in certain cases, the characteristic microbe is the originator of the disease, or is capable of conveying it, the very multiplication of microbes is reviving the question as to whether these organisms are the causes or merely the accompaniments (in the sense in which the vulture is the accompaniment of carrion), or even the products of disease. The recognition of these facts does not imply any depreciation of the practical value or the significance of the work which has been done during the last thirty years, but helps us to a clearer view of its bearing and scope.

4.—In considering the development of the germ theory we may pass almost directly from Leeuwenhoek and his contemporaries to Pasteur. As a matter of history we must not of course overlook the observations of Cagniard La Tour and Schwann, based upon an observation of Leeuwenhoek, and really establishing the vegetable nature of yeast. But it is to Pasteur that we are indebted for definite progress in establishing or refuting the ideas which sprang immediately from Leeuwenhoek's discovery. The work of the Germans, and even of the French, apart from Pasteur, has been mainly in the filling up of details. Extremely important have been many of those details. The discovery of the micro-organism of anthrax by Rayer and Davaine; the subsequent discovery by Koch of the spores into which the anthrax filaments break up; Koch's discovery of the bacillus of tuberculosis; and, lastly, the same ardent investigator's latest discoveries bearing upon the nature and etiology of cholera, are all alike, not only important confirmations of previously-existing ideas, but in themselves elucidatory and suggestive. The Germans, too, have been most important critics, a natural consequence of their close attention to details; and Koch's criticisms of Pasteur's work may be perused with the greatest advantage by all who are interested in the subject, or are practically engaged in medical or surgical work. Some regret may be felt at a certain want of respect for the great Frenchman which seems to pervade the illustrious German's remarks. The true lover of science is little impressed, however, by the temporary acrimony of rival investigators, but is thankful for their mutual watchfulness. Pasteur remains the central figure in connection with the modern development of the germ theory; the discoveries and criticisms of the greatest of his contemporaries in the same sphere of investigation are, after all, of the nature of side-lights upon his work.

5.—This is not the place in which to offer any opinion on theistic questions. But it is strictly within the scope of a scientific paper to recognise facts having a direct bearing upon the subject under consideration. It is a fact that Pasteur must be added to the list of "spiritualist" *grands initiateurs* enumerated by Naville. We may take cognisance of Pasteur's religious beliefs as resulting in an attitude of mind and a selective influence which have undoubtedly been the primary conditions of his peculiar success. Perhaps the most general expression of the scientific consequence of his beliefs will be to say that they have made of him in even an unusually strict sense an inductive rather than a deductive inquirer. He has approached natural phenomena, in the most absolute sense of the words, with the simplicity and teachableness of a pupil. When the French Ministry of Agriculture commissioned him in 1865 to study the diseases of the silk-worm, Pasteur, as he declares in the preface to his "Études sur la Maladie des Vers à Soie," had never even seen a silk-worm. He mentioned this fact as a reason for declining the commission. "It is all the better" said Dumas, "that you know nothing about the subject; you will have no ideas upon it except those which result from your own observations." The determining mental conditions in Pasteur's work have been, firstly, a profound sense of the gulf between organic and inorganic matter, and, secondly, what may be most accurately described as a Christian sense of duty to his neighbours. The first was expressed in his discovery of what he calls molecular dissymmetry, resulting in his formulation of the law that while all inorganic compounds can be superposed, all organic compounds are characterised by what he has graphically symbolised as right and left-handedness. Starting from this basis, the same fundamental principle guided him into a strong opposition of the doctrine of spontaneous generation, and into the famous researches on fermentation which have afforded the sure foundation of the modern developments of the germ theory, of the study of the etiology and rational treatment of zymotic diseases, of antiseptic surgery, and of sanitary science in general. Nor is the second principle less deserving of recognition as a cause of Pasteur's science. Dumas's description of the misery resulting to the rural population of France from the silk-worm disease induced him to undertake those researches on *pébrine* and *flacherie* which resulted in further important confirmations and elucidations of the germ theory; his researches on the "maladies" of beer were undertaken with the avowed hope that the impoverishment of France, consequent on the war of 1870, might be alleviated by the establishment of a great national brewing industry, rivalling that of Germany; in the interests of the ruined stock farmers of France, and with the same patriotic motive, he turned his attention to fowl cholera and anthrax; and not less have his later researches on every zymotic disease on which he has been able to lay his hands, and on hydrophobia, been inspired by a philanthropic desire to minister to the happiness of mankind.

6.—In studying the work of one of the greatest and most successful investigators of this century, it is of scientific importance to recognise all the conditions which have contributed to the attainment of such remarkable results; and the facts noted in the last paragraph really force themselves upon the attention of the student of Pasteur's writings. It is the more desirable that attention should be given to these facts because erroneous impressions concerning Pasteur may retard the progress of science by weakening the influence of his utterances, and the confidence which they merit. There is a danger that the animated scenes in the French Académie des Sciences which have occasionally been reported, the tone of some of Koch's criticisms, the charges of dogmatism which have been levelled against Pasteur, and still more the misleading statements of those whose judgments are weakened by a more or less morbid and ignorant sentimentality respecting the lower animals, may give rise to misconceptions of the character of Pasteur. It is worth while, therefore, to say that no reader of Pasteur's own works can rise from their perusal without a strong consciousness that Pasteur is, in an exceptional degree, a single-minded and earnest man.

7.—The foregoing brief *résumé* of the course of Pasteur's investigations indicates the inquiries into which the accumulated mass of work done in connection with the development of the germ theory now resolves itself. Starting with Leeuwenhoek's discovery of micro-organisms, Cagniard La Tour and Schwann's discovery that the globules of yeast are living plants capable of indefinite multiplication in suitable media, and Pasteur's demonstration that fermentation in general is necessarily associated with the presence of living organisms, we have opened up a series of most profound inquiries into the relations between chemical force and affinities in general and that undefined something which may be provisionally called vital force. From speculations as to the influence of vital force on the chemistry of nature in general, concerning which vastly wider views are now presented than were dreamt of in the pre-Pasteurian period, we naturally pass to inquiries as to the influence of chemical conditions upon the special forms and the special attributes of particular forms of organized life. From such inquiries we proceed to inquiries as to the origin and nature of microbes themselves, and the phenomena of their pathological relations.

8.—With the overthrow of Liebig's motion or contact theory of fermentation, and the substitution of Pasteur's demonstrations that fermentation is a vital process, our view of the influence of the unknown force, vitality, in the chemistry of nature, has become so vastly extended that it may almost be said that chemical changes are dependent upon life. Death itself is life. The tendency is to the conclusion that no other foims of force could exert a sustained influence in rearranging the elements of matter. The changes possible in consequence of mere thermal or electrical conditions are so strictly limited that it may be said that without vitality certain forms and combinations of matter must have been eternal. Chemical affinity alone must have resulted in absolute stability. We may conceive the possibility of heat from an external source breaking up any matter, even living matter; but it is the tendency of Pasteur's work to show that without such external action and without life a few given forms must have remained for ever unchanged. We have long been familiar with the notion that life alone can build up organic combinations. The vegetable takes up the inorganic element and elaborates it into food for the more complex tissues of the animal; Pasteur's teaching brings us to the conclusion that for the reverse process life is still necessary. Without the action of micro-organisms, dead organic matter would accumulate and be at least as permanent as the rocks. Pasteur's researches tend to banish from the universe such a process as purely chemical decay. It is the function of anaerobies to split up organic tissues into simpler combinations, and we are indebted to the aerobies for the resolution of these simpler combinations into inorganic forms. It seems almost as though chemical affinity acted under the direction and control of life, and the fact that man in the laboratory is able to produce artificial compounds can scarcely be regarded as an exception to this rule. The opinions based on Pasteur's suggestion in 1862, that the production of nitrates in the soil is the work of a living organism, have been much strengthened and extended by such papers as that by Mr. R. Warington, on the value of microbes to the agriculturist, read at the meeting of the Brit. Assn., at Southport, last year. Not less remarkable is Dr. Angus Smith's discovery of the giving off of hydrogen from water as a consequence of the presence of microbes, and as constituting even a test of their activity. A brief *résumé* of Dr. Smith's observations on this point appeared in the *Manchester Guardian*, of January 28. Dr. Smith's own account, which will form part of his forthcoming report as Inspector under the Rivers Pollution Commission, will be looked forward to with the greatest interest, and all will anticipate with keen expectation Dr. Smith's further researches based on a discovery which seems so full of suggestiveness. Dr. Smith finds that from very pure spring water up to the most foul sewage hydrogen is given off, and that in each case its quantity is strictly proportionate to the activity of the microbe life present. Nitrates are found in rain water, but have been attributed by Obin and Muntz to electrical action, and to the presence of minute crystals in the atmosphere.* Considered from Pasteur's standpoint it will be seen that such phenomena may vastly extend our idea of the part played by life throughout the universe. The philosophical result of Pasteur's teaching may be perhaps best expressed by his answer to the famous question of Liebig, repeated by M. Bouillaud in the Academy of Sciences, as to what are the ferments of ferments? "If," says Liebig, "the fungus or mushroom be the *cause* of the destruction of the oak—if the animalcule be the *cause* of the putrefaction of a dead elephant; what then is the cause of putrefaction after death of the fungus? what is the cause of the putrefaction and decay of the dead animalcule? They also ferment, decay, and putrefy, and finally disappear entirely, just as do the mighty tree and the gigantic animal; and the final products are the same in all." "Dead aerobies," replies M. Pasteur, "become the prey of new aerobies of different species or of their own species. Though a mass of germs becomes in its turn a mass of organic matter susceptible to putrefaction and combustion, those germs, nevertheless, represent life in its eternal form; for life is the germ, and the germ is life."

9.—A consideration of the new views as to the influence of the microbe in the chemistry of the universe naturally leads to a consideration of the possible influence of chemical conditions upon the microbe. This is the old question of the influence of the environment upon the form of the organism, or, as we may say, in perhaps a deeper philosophical sense, upon its life. This branch of the enquiry has an important

* If any reliance can be placed on spectrum analysis, alcohol is present in the tails of comets.

bearing upon the pathological problems involved. One of the things which most strike the student of Pasteur's work and that of his followers is the remarkable variety of conditions under which microbe life is apparently carried on. Here again it seems as though life was the dominant force in the universe which moulded almost any conceivable conditions to its use. "You have discovered," said Dumas to Pasteur, "a third order of beings in animated nature—creatures who can live either with or without free oxygen." Following up the experiments of Pasteur demonstrating the existence of life outside the conditions which mankind had come to regard as essential to life, and resulting in his classification of germs as anaerobies and aerobies, we have had a most astonishing series of observations. Semper has called attention to the fact that far higher forms of life, than we assume the micro-organisms to be, actually do live under gaseous conditions which would be fatal to the higher vertebrata, and that the capability of breathing assumed poisonous gases varies greatly in different animals. The mere inference by Pasteur that each form of fermentation has its peculiar ferment implies the existence of life under a most extraordinary variety of chemical conditions. Dr. Miquel has cultivated a bacterium which has the singular power of transforming sulphur into sulphuretted hydrogen and which apparently lives and prospers in a *milieu* charged with sulphuretted hydrogen gas. The same experimentalist is sure of at least one bacillus which lives and multiplies in solutions heated to a temperature of from 70 to 72 deg. C., or 15 degrees above the temperature assigned by Cohn as the limit beyond which, though spores may retain latent the power of germinating, no actual growth or multiplication by scissiparity or spore production can take place. Van Tieghem professes to have carried the limit within which vegetation is possible up to 74 deg. C. We have further the experiments of the lamented Frank Hatton on the cultivation of bacteria in the presence of various gases supposed to be inimical to life, showing that bacteria can live and thrive in the presence of carbonic oxide, cyanogen, sulphurous anhydride, nitrogen, nitrous oxide, carbonic anhydride, and coal gas. Bacteria were also cultivated by the same inquirer in solutions containing large quantities of salicylic acid, strychnine, morphine, narcotine, and brucine. In all these cases the presence of the bacteria affected in a greater or less degree the chemical results; the decomposition of cyanogen, for instance, was "assisted" by the bacteria.

10.—In all these cases it is far from unreasonable to assume that the particular media acted upon may have, in their turns, an influence upon the germs themselves. And although with that strong tendency to see things simply as they are and to avoid generalising, which is, in a peculiar degree, the quality of Pasteur, the author of the modern theory of fermentation has refused to recognise the hypothesis of Von Nägeli, Buchner, and of Dr. William Roberts, as to the convertibility of the different species of micro-organisms, he does not expressly deny its possibility, and has, indeed, together with his immediate disciples, demonstrated by many suggestive and remarkable experiments the existence of a certain amount of variability, or adaptability, in microbes. But provisionally, at least, Pasteur rests upon the recognition of a special ferment for each particular kind of fermentation, and what is, in his view, another way of saying the same thing, a special microbe for each zymotic disease; and the variability which he admits is simply a variability of vigour. With him, moreover, vigour and youth appear to be convertible terms, and it is important in following the course of his researches to retain this idea. "Do I deny absolutely the polymorphism of *Mycoderma aceti?*" says Pasteur in his "Études sur la Bière;" "on the contrary, I have endeavoured many times to establish it. I have sought chiefly for physiological polymorphism, that is, whether *Mycoderma* *aceti* was not, for instance, the aerobic mucor of a ferment differing from it physiologically, say of the lactic ferment, whose analogies of form with the *Mycoderma aceti* are sometimes striking. I have not found anything hitherto. What I deny, with reference to this Mycoderma, are the polymorphisms admitted by M. Béchamp and other authors, which, in my judgment, rest upon erroneous and incomplete observations." Dr. Miquel, whose remarkable book on "Les Organismes Vivants de l'Atmosphère," containing the record of his experiments at the Montsouris Observatory, is full of interest, gives his testimony on the same side. "The theory of the evolution of species," he says, "can derive little profit from this class of experiments if they are conducted with the necessary rigour." After an enormous number of experiments he has found that the different species of microbes maintain their habits and their individuality unchanged for months and years. "Of 80,000 experiments," adds Dr. Miquel elsewhere, "not one has contradicted the affirmations of M. Pasteur, while many are in complete opposition to the statements published by some of his too zealous or inexperienced followers." Klein, as well as Koch, has also been forced to the conclusion that no satisfactory proof of the truth of Von Nägeli's fascinating hypothesis of the "sporting" of saprophytes, or in other words, of the conversion of pathogenic bacteria into harmless saprophytes, and the reduction of the latter into the former, has yet been adduced, and he has published a series of experiments tending to show that Buchner was mistaken in supposing that he had established the convertibility of *Bacillus subtilis* and *Bacillus anthracis*, and offering an explanation of the phenomena on which Buchner's conclusion was based.

11.—Nevertheless it must be admitted that the successive outbreaks and disappearances of epidemics, and the observations of Pasteur and others on the adaptability of microbes to different environments, and on the attenuation and cultivation of their vigour as ferments, cause Von Nägeli's hypothesis to have an inherent probability. Not that the idea that there is a struggle for existence between rival microbes, enunciated by Pasteur in his "Études sur la Bière," assumed by Klein to be the explanation of Buchner's supposed evolution of the anthrax bacillus from the hay bacillus (both forms being supposed to have inadvertently obtained admission to Buchner's culture solutions), and referred to by Miquel as the explanation of the varying proportions of germs in his cultures, may not also explain the occurrence of epidemics. If we assume the absolute inconvertibility of all species of microbes, epidemics might still be explained as the consequence of the occurrence of temporary conditions more favourable to the development of noxious than of harmless species. But this would really force us logically to the conclusion that all zymotic diseases have specifically existed as long as life itself. On the other hand we must be careful to distinguish between variability of species and what Pasteur means by variability of vigour. Pasteur's idea is perhaps most clearly conveyed by the use of the terms young and old germs, or we may perhaps better grasp the idea by using the terms tame and savage germs. Thus, let us take the remarkable observation of Pasteur concerning the difference in the proportion of fermentation accomplished in brewing, to weight of organism, in the presence or absence of free oxygen. In shallow vessels in which the ferment easily obtains free oxygen, 1 kilogramme of ferment will correspond to 5 or 6 kilogrammes only of decomposed sugar; while in deep vats, in which the free oxygen is speedily exhausted, and the access of fresh supplies is prevented by the layer of carbonic acid formed above the vats, a kilogramme of ferment corresponds to 70, 80, 100, and even 150 kilogrammes of sugar decomposed. It is as though the ferment in the presence of free oxygen lived the quiet and easy life of civilization, brought up a large family, and destroyed or consumed no more than was necessary for the support of the community; while the ferment thrust into the recesses of the vat and forced to tear oxygen from the material around him, figuratively speaking, cuts down a tree in order to cook a dinner, and destroys a forest in order to obtain a little breathing space. As the savage may acquire strength and ferocity by his mode of life, so it may be inferred that the germ actually acquires virulence by exercise in its anaerobic mode of life. The question is, does this virulence become fixed by heredity, in any case, in such a way as to amount to the establishment of a new species, with peculiar attributes which will enable it, not only to tear oxygen as a saprophyte from dead organic matter, but as a parasite from living tissues. For it must be borne in mind that, so far as reliable experiment has yet gone, the process absolutely stops at this point. The transformation of the harmless saprophyte into the deadly animal disease has not yet been conclusively shown.

12.—Modern scientific ideas and discoveries do not so much displace old ideas as spring from them. There is usually a certain basis of experience for the old ideas, and experience is really a basis of fact, which must be true. Hence it is natural that inquirers into the variability of germs and their pathogenic relations should turn to oxygen as being likely to play an important part in this connection. The influence of oxygen as a purifier of water attracted the attention of Dr. Angus Smith long before Pasteur's attenuation experiments. As he himself has explained, this was a natural consequence of the ideas of the older chemists as to the influence of oxygen as the active agent of decay. Again, the value of ventilation and fresh air in cases of consumption was insisted upon by medical men long before Koch's discovery of the *Bacillus tuberculosis*. From the beginning of his inquiries Pasteur has been strongly disposed to regard oxygen as an attenuating agent, or, in other words, as an agent for reducing the parasitic virulence of germs. For it may be suggested that the ability or habit of a ferment to tear highly complex organic compounds to pieces, so to speak, in order to procure the oxygen which, under other circumstances, it would obtain in the free state, is a kind of parasitic quality. Philosophically the anaerobie which feeds upon dead organic matter may be considered as an intermediate between the innocent aerobic saprophyte and the deadly anaerobic parasite which feeds upon the living tissues or fluids. Therefore the question presents itself whether the presence of free oxygen, and the proportion in which it is present with other gases, may be regarded as having really an educational influence upon the innocent saprophyte. In an early report on graveyards Mr. David Chadwick mentions a case of a man having been struck dead by a single puff of air from a long-closed vault in which the dead had been interred, whereas no such accidents happen in country churchyards. Again, Dr. Angus Smith has called our attention to the fact that the emanations from moving waters like the Clyde, open to the free air, though they may cause sickness, do not cause fevers; whereas the emanations from covered sewers, where the atmosphere will have a very different character to that over the Clyde, and from closed tombs and vaults, do cause fevers, and, as in the case mentioned above, even sudden death. But surely we cannot assume that the specific germs of typhoid, say, deliberately remain in the sewer and shun the river; or that specific agents of decay enter the vault beneath the city church and shun the country churchyard. We can scarcely draw a line beyond which no disease germ will venture to go. After all, therefore, the difference between the typhoid germ in the sewer and the germs in the river, the ferments in the country churchyard and those in the unventilated vault, is one of virulence; in other words, the river germ is an attenuated germ, and the reason why it produces nausea, let us say, only, and not fever, is because it is not strong enough to overcome the vital force of the person attacked. Undoubtedly there are various degrees of virulence. Apart even from Pasteur's wonderful "vaccine" experiments we know that there are mild and severe fevers, various degrees of diarrhœa, of which Asiatic cholera (according to Jules Guerin and Sir William Hunter) may be the most virulent form, and various degrees of small-pox. In the Board of Health reports on the cholera epidemic of 1848-9 it is stated that distinct warning of its approach was given in every European city by the prevalence of intermittent fever, dysentery, and especially diarrhœa; and reports on subsequent epidemics have so fully confirmed this observation that it may be taken as an axiom that cholera is always preceded by epidemic diarrhœa. To a certain extent we may therefore provisionally regard the nature of the gases in which microbes find themselves, in comparison with what I will call the standard of pure air, as determining the degree of parasitic virulence. In a paper read at the meeting of the British Association at Southampton, I ventured to suggest that the development of the tubercle bacillus as a deadly parasite might be due, so to speak, to its imprisonment in lungs inefficiently aerated, either in consequence of hereditary structure inducing weak breathing habits, the habitual breathing of air containing less than the healthy proportion of oxygen, or the choking of the air passages through catarrh or the inhaling of dust. Miquel points out that the proportion of "young" microbes is exceptionally large in sewers, where old or exhausted microbes are rare.

13.—But if we assume degrees of virulence from harmless to deadly in one and the same species, we imply a gradation from saprophyte to parasite, and from aerobie to anaerobie. For even if attenuation by means of free oxygen be regarded as the slow killing of the parasite, we can scarcely assume that free oxygen has been always fatal to the parent forms; for in that case how could we realise the possibility of zymotic diseases having ever begun, unless we trace them back to some time when poisonous vapours enfolded the earth? And, granted various stages of virulence from harmless to deadly in one and the same species, how are we to define the difference of species? We may define species pathologically by the different symptoms of the diseases with which they are associated, and to some extent possibly by the forms of the microbes. We may also classify microbes by the marked differences of their own constitutions. For the susceptibility of these organisms seems to differ in the most extraordinary fashion. What is meat for one appears to be poison for another. Thus, in his latest report on the cholera bacillus, Koch tells us that the smallest proportion of acid is fatal to the life of that organism, yet we know that other bacilli live and thrive in strongly acid solutions. Ideas bearing upon these later discoveries have long been current, witness Dr. Angus Smith's remark in 1848, that a man might be capable of one disease on one day and another disease on the following day. Perhaps the peculiar susceptibilities of the microbes may be developed and fixed as the peculiar virulence is developed and fixed. The desirableness of further experiments on the cultivation of organisms in various gases, and particularly on the cultivation of the spores, is strongly suggested by these considerations. It would also be worth while to test further the specific consequences of the presence or absence of light.

14.—The presence or absence of oxygen is associated with the question of spore formation. In this connection the varying susceptibility or vigour of microbes, not only in different animals, but in different *milieux* in the same animal, must not be overlooked. Thus the virus of the Maladie de Chabert, or *Charbon symptomatique*, formerly supposed to be the same disease as anthrax, acts as a vaccine if injected directly into the blood, while in solid tissues the same culture produces fatal results, according to the experiments of MM. Arloing, Cornevin, and Thomas. The law which M. Paul Bert has deduced from such observations is, that any condition which arrests the development of a virus converts it into a vaccine, and this implies the principle that specific microbes thrive better, or attain their maximum virulence, in certain tissues or juices, and are attenuated in others. Most remarkable series of observations have been made with respect to the varying effects from harmlessness to fatality of special microbes in different animals. These have led Pasteur and his assistants, MM. Chamberland and Roux, to the idea that differences of temperature affect the vigour of the microbes, and thermal conditions have been employed as a means of attenuation in the production of protective cultures. Thus the usual immunity of birds against anthrax inoculations is attributed by Pasteur to the high temperature of their blood, and he claims to have developed anthrax in the fowl by keeping its body in cold water. We must not, however, overlook, nor does Pasteur overlook, the possibility of the variation in the susceptibility, or vigour, being not on the side of the microbe, but on the side of the animal. Thus Koch claims to have developed anthrax in birds in spite of their high temperature, and he suggests that the fowl in Pasteur's experiment fell a victim, not because of any change in the microbe, but because the fowl's own vitality was lowered, weak animals succumbing to ailments which in health they would successfully throw off. These views distinctly admit the idea of a definite struggle for existence between the microbe and the cells of the living animal. Pasteur's views as to the influence of a few degrees more or less of heat on the specific vitality of the microbe are, however, supported by the experiments of Willems, and later of Arloing, Cornevin, and Thomas on the development of inoculations in different parts of the body. Thus inoculations in the tails of cattle proved ineffective, but when the temperature was artificially increased the specific disease developed. These ideas have a bearing upon the greater or less success of vaccinations according to the time of year when they are practised and the surrounding conditions of temperature; and also upon the appearance of epidemics at particular seasons and in particular years. Finally, with respect to the special relations between the specific microbe and different tissues, it may be mentioned that the special nidus of the virus of rabies appears to be the nerve-centres.

15.—In regard to all these phenomena, the question of spore formation cannot fail to attract attention, and the relation between spore formation and the presence of oxygen might prove a fruitful subject of inquiry. Klein's most ingenious experiments on the cultivation of *Bacillus anthracis* in gelatine pork tend to show that spores are not formed except in the presence of free oxygen, and in opposition to Pasteur he maintains that anthrax spores are never formed in the bodies of animals. On the other hand Miquel's observations on bacilli in general appear to agree to some extent with Pasteur's opinions. He says: "We may experimentally induce the formation of bacillus spores by depriving the bacilli of oxygen, or in determining the slow death of the adult forms by antiseptics, but evidently not by killing them rapidly, as then all vital phenomena cease and spores cannot be formed. The best way in which to obtain bacillus spores rapidly appears to me to be by enclosing nutritive infusions charged with filamentous bacilli in sealed tubes containing very little air." There is much obscurity and contradiction on this point, which may be due to all the conditions not having been duly considered, and it seems to offer a most promising field for investigation. Meanwhile the question arises whether the so-called spores are really the terrible things we are inclined to suppose them. There are some noteworthy phenomena connected with spore formation. Pasteur maintains that anthrax has been spread amongst cattle and sheep by the bringing up of spores from buried carcases by earthworms, which is opposed to the opinions of Koch and Klein that no spores are ever formed in the bodies of animals. Again, Klein has found that cultures of *Bacillus anthracis* which are fatal to rabbits and guinea-pigs, whether forming spores or not, are only fatal to mice when they are spore-forming cultures. In considering all these various results we must bear in mind that there are several modes in which the life of the higher organism may be destroyed. The phenomenon may be simply a struggle for existence between the microbes and the vital cells of the animal body, in which the strongest survives, death resulting from the destruction of the function of the parts invaded, the loss of nutriment, or their absolute change into another form of life, morbid growths or microbe life resulting from a dissolution of the tie which holds the cells together as a community; or the products of the fermentive action of the microbes may be poisonous, or may be poisonous in the particular channels in which they are produced; or finally, as Dr. Cameron has suggested, the fatal result may be due merely to the mechanical obstruction offered by millions of microbes blocking up the capillary circulation. Vastly extended threads of mycelium growth would, of course, have such a mechanical effect. Now, from the vitality of spores, the fact that they resist destruction up to 110° C. of heat, and that they seem to retain their specific life for indefinite periods, it is possible that we may be too much disposed to malign them. Of the two modes of reproduction, the multiplication by scissiparity and the multiplication by spores, may not the former be, at least in some cases, the true disease form ? Spores, if cultivated in suitable infusions, will apparently reproduce the *Bacillus anthracis* of the parent cultures, and inoculations with such cultures will kill with typical anthrax. But have we sure evidence that inoculation with pure spores would be fatal? Klein's mice experiments already referred to seem to show this. It is conceivable, however, that spores may require a suitable dead medium for their development, and that only the living organism, when developed, is able to contend as a parasite with the living cells of the animal body. It is at least a remarkable fact that experiment and observation are more and more tending to associate the communication of disease with liquids and moisture in which the bacilli are developed, rather than with atmospheric influences. Koch finds that desiccation is speedily fatal to the cholera germ, and we know that the communication of the disease is apparently associated peculiarly with the washing of infected linen. The statement of Miquel that he has entirely failed to develop disease in rabbits or guinea-pigs by means of germs collected from the atmosphere may have a bearing on this question. Of course, as Miquel observes, failure with rabbits and guinea-pigs would not necessarily imply failure with human beings, on whom experiments have not been tried. This does not affect the question of septic germs in hospitals. There may well be spores which, though unable to develop in living and healthy tissues or fluids, may find the suitable preliminary medium of culture in morbid secretions or dying tissues, as in wounds or in accumulations in the lungs or intestines when the bodily functions are disordered. Thus the spores of the cholera bacillus may pass safely with undissolved food through the acids of the stomach which would destroy the bacillus, and subsequently develop in the intestines. The general principle would be that a body in a bad state of health affords the preliminary conditions of nourishment necessary for the development of the vigorous parasite.

16.—The consideration of the question of spores, of nuclei, and of the granulations into which non-spore producing bacillus threads crumble leads to the inquiry, whence come all the varied forms of microbe life? There is scarcely any, if there is any fluid, in which these minute forms are not present. Dr. Angus Smith tells us that even in very pure spring water he finds them doing chemical work. They are present in the saliva, apparently elaborating a specific alkaloid; they are traceable in every organic fluid which has not been sterilised by heat. Under the microscope they "come like shadows, so depart." Leeuwenhoek wondered that his mouth should contain more living beings than there were people in the States of Holland, and modern microscopic investigation is certainly giving a kind of basis to the fancies of Rabelais and Swift. Are our failures to convert different species of microbes, to establish physiological polymorphism, due to the circumstance that we do not begin with the original forms? The essence of Darwinism is not that the cat has been developed from the lion, or the tiger from either, but that all have proceeded from some more primitive form. Possibly *Bacillus anthracis* is not a "sport" from *Bacillus subtilis*, but both are parallel developments from some more simple organism. There is a certain fascination in the ideas of Béchamp. According to Béchamp it is from the granulations, from certain apparently amorphous structures observable in organic liquids under the microscope, that all the forms of organised life are evolved, according to the conditions of culture. Béchamp believes in the continued existence of such microzymes in chalk and other geological formations of the life of past geological epochs. The rocks themselves include the germs of life. This seems to be a reproduction of the idea of Buffon respecting the existence of organic molecules, as Pasteur has pointed out; and Béchamp in fact admits that it is. As already remarked, Pasteur does not absolutely refuse to admit the possibility of such an hypothesis; all that he says is that the experiments which are said to have proved its truth are unsatisfactory, and that it is so far absolutely without proof, no such evolution as that implied having been artificially accomplished. The idea in Béchamp's mind is, however, essentially different from the idea of spontaneous generation; Béchamp's granulations are latent germs to begin with, which may, according to their special surroundings, be differentiated into all the forms of life. In the egg they are subservient to the special life-history of the animal and are differentiated with organs resembling those of the parent structure. But freed from that mysterious vital bond which holds the community of cells together, each micro-zyme falls away into an independent existence and may become a bacterium, or bacillus, or vibrion. Thus, the apparently dead body is not dead, it is simply the bond of union and co-operation which is broken, and the structure is resolved into its still living molecules. Nothing, says Béchamp, is the prey of death; all is the prey of life. Such an hypothesis would of course explain the appearance of microbes in organic fluids without the intervention of germs from the atmosphere being invoked. To the experiments of Pasteur showing the non-development of life in solutions previously heated, if atmospheric germs are rigorously excluded, Béchamp replies that the heat which has sterilised the fluids has destroyed the micro-zymes. Pasteur in reply has carefully introduced blood direct from the living animal into purified tubes from which all atmospheric germs were excluded, and still without developing fermentation or life in such fluids. This almost seems like a conclusive experiment, but Béchamp is not convinced, and may indeed reply that a negative result proves nothing in this case, as the conditions may not have been suitable for the development of the special micro-zymes present i· the blood. On the other hand there are analogies are worth noting, and which suggest that there may n both sides. Béchamp cites the fermentation of os , whose thick, ivory-like and unbroken shells exc contends, all atmospheric life. In these cases, how micro-zymes do not appear to have become microbes. To Pasteur's discovery of the corpuscles of *pebrine* in the eggs of the silk-worm, he replies that eggs contain many micro-zymes, and that the peculiar disease corpuscles are simply micro-zymes which have inherited the bad tendency developed in the micro-zymes of the parent moth and chrysalis. Without forming any decisive opinion on this mysterious and profound question (for what can appear more astonishing than the continued life of a parasite, not merely in the body of the parent worms, but actually in the eggs laid by the moths?) attention may be drawn to the analogy between the remarkable variety in the susceptibilities of microbes and the apparently specialised chemical work of different ferments, and the specialised chemical elaborations of the cells of different organs of the animal body. Are not many diseases of the human system, for instance, apparently due to the excessive activity of specialised secreting cells, or to the development of similar power of chemical elaboration by other cells; to an apparent change of function, as though secreting cells of a given order were working in the wrong places? And are not such phenomena analogous to the introduction into the blood or tissues of disease microbes endowed with special chemical activities of their own?

17.—In the course of this paper, mention has been made of the education of microbes. The idea has a bearing upon Pasteur's astonishing protective vaccination discoveries, and seems to have a relation to the mysterious phenomenon of heredity. The microbes of particular diseases, when passed from animal to animal, increase in virulence; thus, as Pasteur has shown, the microbe, which was originally powerless to kill a guinea-pig a week old, but which killed a guinea-pig a day old, has been nursed into a breed capable of killing a sheep. Yet there is apparently no specific change in the successive generations of bacilli; we must assume that the chemical constitution of their bodies remains unchanged, that they are essentially identical in structure; the only change is in the vigour of their life, developed hereditarily. What is vigour, what is life, what is heredity? When we turn now to the animals in whom the zymotic diseases do not recur, and to the phenomena of protective vaccination, may we not assume that some educational influence of the same kind is exerted upon the living cells of the animal body? The microbe which kills the unvaccinated animal is the same, in all respects, as the microbe which fails to kill the vaccinated animal; the difference is in the cells of the animal attacked. When it is suggested, as in the case of small-pox for instance, that the vaccination has used up some material, only rarely elaborated, in the body, and necessary for the development of the microbe, are we not guilty of as crude an attempt to represent the fact, as was the old notion of a material caloric? May we not with more philosophy regard the phenomenon as some mysterious educational influence, in the one case, as well as in the other. Regarding the contest between the microbe and the living cells of the body as a struggle for existence, may we not assume that resisting vigour is developed in the one, as attacking vigour is developed in the other? Miquel records a most remarkable instance which he says "seemed to show that bacteria are endowed with instinctive movements." A bacillus making a circular movement was arrested by a mass of germs. It vigorously attacked the mass and by rapid backward and forward pushes, attacking now right, and now left, cleared a *cul-de-sac,* which it finally developed into a complete canal; then it appeared to rest from its efforts. Miquel was utterly astonished by the "address" with which the bacillus thus disengaged itself from the vicious circle in which it found itself engaged. Is there anything more wonderful in this, than in the apparently instinctive movements observed by Darwin in the tips of the radicles of plants, the apparently muscular memory to which Romanes calls attention as the real import of the phrase that "practice makes perfect"? Smokers, for instance, know that they have overcome the nausea of the first mild cigar, and educated the cells of which they consist into the enjoyment even of strong Havanas. It would seem as though in nature no experience fails to leave its impress and its influence. When we consider how minute is the germ, even of the most intelligent vertebrate, which reproduces not only the specific form and structure of the parent, but its instincts and—excepting perhaps man—the influence of the experience of its ancestors, it cannot seem too wonderful to suppose that the protective influence of vaccines may be due to the operation of the same mysterious principle, and that the discoverer of the physical cause of protective vaccination will discover the nature of memory and heredity. Such a problem may well be insoluble, and the scientific man, like the Athenians of old, may have to content himself simply with the recognition of the existence of the unknown; but there is no more reason for discrediting the facts of protective vaccination because they are beyond explanation, than there would be for discrediting the facts of memory, heredity, or life itself. Reasoning from analogy, there is an inherent probability in protective vaccination. Reduced to its ultimate expression, animated nature would appear to consist of Buffon's organic molecules *plus* the principle of organic memory, as inorganic nature is inert matter *plus* the principle of motion.

Annual General Meeting, April 29th, 1884.

H. E. Roscoe, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

Mr. Alfred J. King, of Manchester, was elected an Ordinary Member of the Society.

Annual Report of the Council, April, 1884.

The Treasurer reports that the expenditure of the Society still gains slightly upon the receipts, and obliges your Council to exercise a rigid economy in all the expending departments. The increase in the number of new members added to the roll during the past session has been a step in the right direction, and the Council earnestly recommends a still further extension of the membership as the best means of placing the finances in a healthy condition. The publication of the centenary volume would have been a great drain upon the funds but for the generous gifts of a few friends whose names appear in the balance sheet, and for which the Society hereby expresses its hearty thanks. These donations were offered in the hope that they would lead to a more extended effort to enlarge the present building as a permanent memorial of the completion of a hundred years of the Society's labours.

The present seems an opportune time for your Council to earnestly commend this movement to the generous consideration of the members, and through them to the outside friends of the Society. Many of our fellow-citizens are scarcely aware how important, nay how essential, it is to the public welfare to have a centre of the most advanced culture in our midst,—an institution which takes the student after leaving school and the university, and encourages him to make use of the learning acquired in them in the formation of original ideas, and in the extension of the domains of knowledge.

A little more than a hundred years ago the Society was founded by men who worthily represented the public spirit of the town. Its 1st volume of memoirs was published in 1785, and was dedicated to the King; its twenty-ninth volume is now in the press, as is also the twenty-third volume of the "Proceedings" of the Society. These works are prized by cultivated men, both at home and abroad, as the repositories of some of the most important discoveries of the century which the Society has survived. A large library has in the meantime been formed, containing books, many of which are rare, and all necessary to the literature of science. The conversations, which form an important part of the proceedings of the Society, have resulted in permanent benefits, not only to the city and to the district, but to mankind in general. All this, including the acquisition of its house and the artistic treasures which it contains, has been accomplished by the members without adventitious aid, and at the cost of a comparatively small sum.

Societies like our own may be considered as educational establishments of the highest grade, in which students, having passed the condition of pupilage, afterwards advance by their own power. It may be confidently asserted that without the aid of societies which have sprung up in modern times with aims kindred to our own, science would have held a position at this day similar to that which it occupied three hundred years ago. A scientific society is always useful wherever located, but in a University city it must be doubly necessary, for there will be collected the largest number of men who have chosen intellectual pursuits as their chief business in life.

In order that the Manchester Literary and Philosophical Society may preserve its ancient traditions and enable it to continue and extend its sphere of usefulness as representing original research, both literary and scientific, your Council considers that it has become necessary to take the requisite steps for the proper arrangement of our unique library, now one of the most valuable collections of scientific reference in the kingdom; and also for enlarging its accommodation. For this purpose our present historic home is quite inadequate; we possess, however, freehold land at the rear of the premises upon which a suitable library and general meeting room can be erected, but the Society is without funds applicable for building purposes.

The principal result which the Society will be able to show in future years of the work which it has accomplished, will be established by its "Memoirs." The publication of such volumes is regarded by the Council as of the highest importance, and it is greatly to be regretted that more funds have not been at their disposal to issue more frequent volumes, and to produce them in a form more worthy of the Society, and of the city of whose intellectual life it forms a part.

No public appeal for pecuniary aid has ever been made by the Society during the century of its existence, but to carry out the objects here set forth the sum of at least £5,000 will be needed from the members and their friends. Your Council confidently appeals to all who realise the supreme importance of maintaining the Society in a condition of efficiency as a focus of scientific and literary activity, and who, being proud of its past history, feel the obligation strong to do what in them lies to make its present influence at least comparable with that which in past times it has exerted.

The President, Dr. Roscoe, is now engaged in a preliminary canvass of the members, which up to the present has resulted in the following promises, this list also including the donations already received :—

	£	s.	d.
The President	250	0	0
Dr. Wm. Charles Henry	200	0	0
Miss Henry	50	0	0
Mr. Oliver Heywood	100	0	0
Mr. Charles J. Heywood	100	0	0
Mr. W. H. Johnson	100	0	0
Dr. J. P. Joule	50	0	0
Mr. Andrew Knowles	100	0	0
Mr. James Parlane	10	0	0
Mr. Henry D. Pochin	100	0	0
Dr. Wm. Roberts	50	0	0
Dr. Edward Schunck	100	0	0
Dr. R. Angus Smith	50	0	0
Mr. Henry Wilde	100	0	0
Dr. James Young	50	0	0
The Treasurer	10	0	0
Mr. Baxendell	10	0	0
Dr. James Bottomley	5	5	0
Mr. Joseph Sidebotham	50	0	0
Mr. J. Ramsbottom	50	0	0
Mr. R. E. Cunliffe	10	0	0
Mr. Edward Lund	21	0	0
Mr. F. J. Faraday	5	5	0

The following papers and communications were read at the Ordinary and Sectional Meetings of the Society during the Session :—

October 2nd, 1883.—"On the Change produced in the Motion of an Oscillating Rod by a heavy Ring surrounding it, and attached to it by elastic cords," by James Bottomley, B.A., D.Sc., F.C.S.

October 16th, 1883.—"On the leaves of *Catha edulis*," by C. Schorlemmer, F.R.S.

"On the Duality of Physical Forces," by James Rhodes, M.R.C.S.

October 30*th*, 1883.—"On the Action of Water upon beds of Rock Salt," by Thomas Ward, Esq.

November 27*th*, 1883.—"On the Fungus of the Salmon Disease—*Saprolegnia ferax*," by H. Marshall Ward, M.A., Fellow of Christ College, Cambridge.

December 11*th*, 1883.—"On the Quantification of the Predicate, and on the Interpretation of Boole's Logical Symbols," by Joseph John Murphy. Communicated by the Rev. Robert Harley, M.A., F.R.S.

January 14*th*, 1884.—"On some Micro-organisms found to be present in connection with certain diseases," by Professor Dreschfeld.

January 15*th*, 1884.—"Note on Bouguer's Optical Essay on the gradation of Light," by James Bottomley, B.A., D.Sc., F.C.S.

"On the Effects of Solar Radiation in Atmospheric Vapour," by the Rev. Thomas Mackereth, F.R.A.S., F.R.Met.S.

"On the Recent Coloured Skies at Sunset and Sunrise," by the Rev. Thomas Mackereth, F.R.A.S., F.R.Met.S.

January 22*nd*, 1884.—"On a New Variety of Halloysite from Maidenpek, Servia," by H. E. Roscoe, LL.D., F.R.S., President.

"On a Method of Mounting Electrical Resistances," by Arthur Wm. Waters, F.G.S., &c.

"On the Introduction of Coffee into Arabia," by C. Schorlemmer, F.R.S.

February 19*th*, 1884.—"Notice of the Geology of the Haddon District, eight miles south-west of Ballaarat, Victoria," by F. M. Krausé, Professor of Geology in the School of Mines, Ballaarat. Communicated by the President.

March 4*th*, 1884.—"On the Production and Purification of Gaseous Fuel for Industrial Purposes, with the results of several large Applications of a system," by W. S. Sutherland, Esq., of Birmingham. Communicated by Francis Nicholson, F.L.S.

March 18*th*, 1884.—"On the Equations and on some Properties of Projected Solids," by James Bottomley, B.A., D.Sc., F.C.S.

"Notes on the Meteorology and Hydrology of the Suez Canal," by Dr. W. G. Black, F.R.Met.S. Communicated by Joseph Baxendell, F.R.A.S.

April 1st, 1884.—"Note on the Stannotype, with a Practical Demonstration," by Alfred Brothers, F.R.A.S.

April 7th, 1884.—"On some Parasitic Mites," by J. Boyd, Esq.

April 15th, 1884.—"On Pasteur and the Germ Theory," by Frederick James Faraday, F.L.S.

"A Reminiscence of Dr. Dalton," by Charles Clay, M.D.

Several of these papers will appear in volume 8 of the Society's Memoirs, which is now near completion. Volume 9, "A Centenary of Science in Manchester," by Dr. R. Angus Smith, F.R.S., has been printed, and members who have not received a copy can obtain one on application at the Society's Rooms.

The number of Ordinary Members on the roll of the Society on the 1st of April, 1883, was 138, and 11 new members have been elected; the losses have been:—resignation 1, deaths 3, and one Ordinary Member elected an Honorary Member. The number on the roll on the 1st instant was therefore 144. The deceased members are Mr. Henry Bowman, Mr. Edward Hunt, and Mr. Peter Spence.

Mr. Edward Hunt, F.C.S., was born at Hammersmith, in the year 1830, and was 53 years of age at the time of his death. He had been a member of the Literary and Philosophical Society from January 27, 1857. He received his early education at his father's school at Hammersmith, and completed it by a course of study at the University College, London, where he obtained a certificate of honour as the result of his chemical studies. It was about the year 1850 that Mr. Hunt came to Manchester as an assistant to the late Crace-Calvert. He afterwards accepted the position of chemist in the Chemical Works of H. D. Pochin and Company, Salford. It was there while working in the laboratory with Mr. Pochin that the invention of bleaching rosin by distillation was effected, and that was done by passing through heated rosin superheated steam, by which means a beautiful article of rosin of the finest straw-colour was produced, suitable for use in the manufacture of fine pale yellow soaps. That process was patented and afterwards worked on a large scale.

Mr. Hunt subsequently became a partner with Mr. Pochin and Mr. Barlow in the large Bleaching, Dyeing, and Finishing Works at Stakehill, where, as well as at the Chemical Works, Mr. Hunt's knowledge of manufacturing processes rendered his advice and help of great value.

He was of a most genial disposition, making no enemies, but attaching to himself very many friends, all of whom deeply deplore his early death.

Mr. Peter Spence, J.P., F.C.S., was born at Brechin, Forfarshire, in 1806, and died 7th July, 1883. His forefathers had for time immemorial occupied a farm on the Grampian Hills.

Early in life, while apprenticed to a grocer in Perth, he evinced great fondness for chemical experiments, and as he grew up his chemical propensity asserted itself more and more strongly. Like many young Scotchmen of that generation he was an active member of a debating society. He also wrote numerous poems. Some of these, having many years afterwards and unknown to him been handed to the Editor of the Athenæum, were reviewed in very commendatory terms. He for some time took a situation in the Dundee Gas Works, and in 1834 commenced business in London as a chemical manufacturer. His enterprise there, however, not proving successful, he removed to a chemical works at Burgh-by-Sands, near Carlisle, where, in 1845, after a patient and protracted course of experiments, he discovered his well-known process for the manufacture of alum from the refuse shale of collieries and the waste ammoniacal liquor of gas works. This process was destined to so completely revolutionise the alum manufacture originally introduced by Sir Thomas Chaloner, from the Papal States, in the reign of Queen Elizabeth, that it had the effect ultimately of closing the whole of the old Whitby and Guisborough works.

Shortly after patenting the process, Mr. Spence selected Manchester as a field for practical operations, his choice being determined by the consideration that the raw materials for the manufacture were there readily obtainable, whilst the district as a centre of the dyeing and paper making trades afforded a good market for the manufactured product.

Although for some years the process did not pay, and the prejudice of the consumers of potash alum had to be overcome, the Manchester Alum Works eventually became the largest of the kind extant, and the source of the purest alum, no other make being now used by the great Lancashire or Clyde turkey-red dyers. In 1855 Mr. Spence built another alum works at Goole, to supply the East Coast trade. As a commercial result of the new process, and of the operations of rival works which arose on the expiry of the patent, it may be mentioned that alum is now selling at less than half its former price.

For successive periods, extending over some 30 years, Mr. Spence contracted for the gas liquor produced by the Manchester Corporation, amounting to some 5,000,000 galls. per annum, and manufactured it into sulphate of ammonia. He also for some years back converted into this valuable fertilizer the gas liquor of the Birmingham Corporation, amounting annually to 7,000,000 gallons.

About eight years ago, in conjunction with one of his sons, Mr. Spence brought out, as an extremely cheap source of soluble alumina, a compound made from Bauxite, termed "aluminoferric." This article, produced in the form of large blocks or slabs, was designed as a sizing agent for paper, and precipitant of suspended and other foreign matters in impure waters. Its action in the latter case depends on the mordanting property of alumina and peroxide of iron, which seize upon and rapidly carry down the whole of the mechanical and dissolved colouring impurities. The water, though by this process rendered beautifully clear and colourless, contains not a trace of any substance which was not present in it before treatment. The process is already extensively used both for the treatment of water supplies for towns and manufactories, as well as for that of sewage and other waste waters.

Mr. Spence continued in harness to his latest years, experimenting almost daily in his laboratory, patenting all radically new improvements of his processes, and generally "bearing fruit in old age." The number of the various patents taken out by him nearly equalled that of the years of his life.

As a citizen, Mr. Spence applied his extensive technical knowledge to the solution of various sanitary problems connected with life in towns. His well-known pamphlet "Coal, Smoke, and Sewage" was the reprint of a paper read before the Manchester Literary and Philosophical Society over a quarter of a century ago, and had a very extensive circulation. In this pamphlet the suggestion was made that the sewers and house and factory chimneys of Manchester should be connected with a colossal shaft 600 feet high, at which elevation it was maintained that diffusion would operate so powerfully as to prevent all possibility of nuisance from the gases, to the population below.

Its leading principle—fuel chimney ventilation of sewers—has been increasingly applied of late years in a variety of forms. Mr. Spence himself permanently cured two dwelling houses, in which he resided in succession, of sewer gas exhalations, by simply connecting the drains below the house with the back of the kitchen chimney by a piece of cast-iron pipe. By adopting the principle of chimney ventilation, Mr. Waterhouse, who consulted Mr. Spence in preparing his plans, secured a continuous supply of fresh air for the various rooms of the Manchester Assize Courts.

Mr. Spence was the first practical chemist to draw attention to the fallacy that to completely burn coal-smoke was to purify the atmosphere of our manufacturing towns. He made a series of examinations of the air in and around Manchester, and demonstrated that it contained practically as much sulphurous acid on Sundays when the smoky factory chimneys were stopped, and the house chimneys only were going, as on ordinary days of the week.

About 14 years ago, on the occurrence of a railway accident which appeared to confirm the general belief that intense cold causes iron to fracture, Mr. Spence made a series of comparative trials of the strength of iron at ordinary temperatures and of the same when reduced to zero Fahr., and in a paper read before the Manchester Literary and Philosophical Society, he declared the result to be that cold increases instead of decreases the strength of iron. Dr. Joule showed at the same time that experiments which he had undertaken led him practically to the same conclusion.

At the Exeter meeting of the British Association in 1869, Mr. Spence having stated before the Chemical Section that steam at 212° Fahr. could be made to raise the temp. of saline solutions to their boiling point however high that point might be, and that acetate of potash, for example, could be readily raised by its means to a temp. of 336° Fahr., his statement was received with incredulity; but on his demonstrating its correctness by actual experiment the result appeared so anomalous that Professor Williamson declined to accept it until he had himself examined the thermometer. This being found in order, a little reflection soon made it obvious to the Professor that the *latent* heat evolved by the condensing steam had become *sensible* heat measurable by the thermometer! The phenomenon had been familiar to Mr. Spence for many years in connection with his process for dissolving alum on the large scale. The discovery, as has been pointed out by Mr. Stanford, President of the

Glasgow Section of the Society of Chemical Industry, in the March number of that Society's journal, is now receiving industrial application.

Mr. Spence, as an ardent reformer, took great practical interest in the recent movement for lessening the burdens upon industry and trade by a reform in railway charges based upon the principle of "equal rates for equal services." He was an enthusiastic supporter of and contributor of £1,000 to the Manchester Ship Canal scheme; and his evidence before the Railway Rates Committee of the House of Commons, in 1881-2, reprinted in pamphlet form under the title, "How the Railway Companies are Crippling British industry and Destroying the Canals," greatly aided the launching of that now popular proposal.

Mr. Spence's leading mental characteristic was his tendency to regard all questions, moral and material, from the standpoint of scientific principle; and it will not be difficult to understand how—sympathising as he earnestly did with the lapsed masses in our large towns—his keen acumen should have led him to the conviction that their material condition is in the vast majority of cases the direct result of their moral weakness; and that "total abstinence" for the individual, and "local control," even to the extent of "entire prohibition," for the community, is the true remedy for the evil. He was, from its establishment a liberal supporter of the U. K. Alliance for the total suppression of the liquor traffic; was at one time, "Grand Worthy Treasurer" of the Order of Good Templars; and recently, along with one of his sons, initiated two great "Gospel Temperance" Missions in Manchester, at which many thousands took the pledge.

His own practice as a teetotaler dated from the earliest inception of the temperance movement; and, commencing life, as he did, with a consumptive constitution, he attributed very much of the health he enjoyed throughout his 77 years to his practice in this respect, as well as to his optimist views of God's moral government of all things in favour of those who obey his moral and physical laws.

Religiously, Mr. Spence was a Congregationalist, and an ardent admirer of the preaching of Dr. MacLaren. For a generation back Mr. Spence was the intimate friend of our distinguished townsman Dr. Angus Smith.

To the last he retained the full vigour of his mental faculties—characteristically cracking a joke on the day of his death. He showed no evidence of organic disease, and there is little doubt that he would now have been alive and well but for the vital shock he received by the death of his second wife.

The Council consider it desirable to continue the system of electing Sectional Associates, and a resolution on the subject will, as usual, be submitted to the Annual Meeting for the approval of the members.

On the motion of the Rev. WILLIAM MARSHALL, seconded by Mr. JOHN BOYD, the Report was unanimously adopted, and ordered to be printed in the Society's Proceedings.

On the motion of Mr. ALFRED BROTHERS, seconded by Mr. SAMUEL OKELL, it was resolved unanimously:

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

On the motion of Mr. CHARLES BAILEY, seconded by Mr. SAMUEL C. TRAPP, it was resolved unanimously:

"That the members cordially approve of the movement initiated by the President for raising a fund for extending the accomodation of the Library and otherwise increasing the resources of the Society, and request Dr. Roscoe to continue the canvass in concert with the members of the Council with powers to add to their number as a canvassing Committee."

A letter from Professor O. Reynolds, tendering his resignation of the office of Honorary Secretary, having been read, it was moved by Mr. BAXENDELL, seconded by Dr. BOTTOMLEY, and resolved unanimously:

"That the Society accepts with regret Professor Reynolds' resignation of the Secretaryship, and thanks him for the services which he has rendered as a contributor to its publications and for his endeavours to maintain for the Society a position worthy of its past history."

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

President.

WILLIAM CRAWFORD WILLIAMSON, F.R.S.

Vice-Presidents.

HENRY ENFIELD ROSCOE, B.A., PH.D., F.R.S., F.C.S.

JAMES PRESCOTT JOULE, D.C.L., LL.D., F.R.S., F.C.S.

ROBERT ANGUS SMITH, PH.D., LL.D., F.R.S., F.C.S.

OSBORNE REYNOLDS, M.A., F.R.S., PROFESSOR OF ENGINEERING, OWENS COLLEGE.

Secretaries.

JOSEPH BAXENDELL, F.R.A.S.

JAMES BOTTOMLEY, B.A., D.SC., F.C.S.

Treasurer.

CHARLES BAILEY, F.L.S.

Librarian.

FRANCIS NICHOLSON, F.Z.S.

Other Members of the Council.

ROBERT DUKINFIELD DARBISHIRE, B.A., F.G.S.

BALFOUR STEWART, LL.D., F.R.S.

CARL SCHORLEMMER, F.R.S.

WILLIAM HENRY JOHNSON, B.SC.

HENRY WILDE.

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

Dr. E. Schunk communicated the following extract of a letter from Mr. R. H. Gibson, of Taranaki, New Zealand, dated 31st January, 1884:—

"I see it is asserted in the English newspapers and even, I believe, in the scientific journals, that the probable cause of the singular lurid light observable in the sky in both hemispheres, is the volcanic dust ejected by the recent volcanic disturbance in Java. If this be the case how do you account for the fact, well known by us here, that for *many weeks before that eruption* this lurid glow was most strikingly perceptible in New Zealand? At any rate the phenomenon was manifested most clearly in our southern sky over Mount Egmont, close to which I live, and formed a very beautiful appearance, especially as contrasted with the snow-capped mountains. We are, from some cause or other, having a most extraordinary season all over the colony—the wettest and coldest summer known by the oldest inhabitant—certainly for more than forty years, or almost longer than the existence of the colony. Even for England the season would be thought most inclement. Here in New Zealand instead of bright, nearly cloudless skies and a temperature of 75° to 80° in the shade at noon, our normal heat in January and February, we are having day after day tremendous rain, constant gales, and not infrequent thunder storms—the last being very rare in summer."

Note on a paper read before the Society on October 2nd, 1883, concerning the motion of an oscillating rod, by James Bottomley, D.Sc., F.C.S.

In the paper, read on the above date, I discussed this problem, to determine the motion of an oscillating rod having a heavy ring surrounding it, and attached to it by elastic cords.

The differential equation to be solved is one of the fourth order. Four constants are introduced by integration. The rod being supposed to start from a position of rest, with given velocity, two of the constants vanish, and for the determination of the other two we have only one equation; hence another equation is necessary. This second relationship between the two constants is quite arbitrary, and the form of the solution will depend upon what relationship we choose. The physical interpretation of this arbitrary connection of the two remaining constants is this, when we set the rod in motion by an impulse we may conceive any independent velocity to be simultaneously impressed upon the ring. Hence the solution given in the paper referred to is only one out of many possible solutions. If we suppose the rod to start with velocity V from a position of rest, and the ring to be initially at rest, the equation of motion of the rod becomes

$$x = \frac{V}{m(q^2 - p^2)} \cdot \left\{ \left(mq^2 - 2\left(\frac{\lambda'}{L} + \frac{\lambda}{l}\right)\right) \frac{\sin pt}{p} - \left(mp^2 - 2\left(\frac{\lambda'}{L} + \frac{\lambda}{l}\right)\right) \frac{\sin qt}{q} \right\}$$

the letters having the same meaning as in the paper referred to.

Dr.

Charles Bailey, Treasurer, in account with the Society,
Statement of the Accounts

1883-4.	£	s.	d.	1883-4. £	s.	d.	1882-3. £	s.	d.
To Cash in hand, 1st April, 1883				88	7	1	39	14	8
To Members' Contributions :—									
Arrears 1882-3, 8 Subscriptions at 42s.	16	16	0						
Old Members, 1883-4, 111 Subscriptions at 42s.	233	2	0						
New Members, ,, 7 ,, 42s.	14	14	0						
,, ,, ,, 5 Half ,, 21s.	5	5	0						
,, ,, ,, 9 Admission Fees at 42s.	18	18	0						
Old Members, 1884-5, 2 Subscriptions at 42s.	4	4	0						
New Member, ,, 1 ,, 42s.	2	2	0						
				295	1	0	313	19	0
To One Associate's Library Subscription				0	10	0	0	10	0
To Sectional Contributions for 1883-4 :—									
Physical and Mathematical Section	2	2	0						
Microscopical and Natural History Section	2	2	0						
				4	4	0	4	4	0
To Use of the Society's Rooms :— Manchester Geological Society to 31st March, 1884				30	0	0	60	0	0
To Sale of the Society's Publications				14	3	5	5	11	1
To Repayment of cost of Periodicals (Physical Section)							0	5	10
To Natural History Fund :— Dividends on £1,225, Great Western Ry. Co. Stock				59	17	7	59	13	9
To Bank Interest, less Bank postages				6	0	0	2	14	7
To Anonymous donation for 6 years' subscriptions to the Pali Text Society				5	5	0			
To Donations :—									
Dr. J. P. Joule	50	0	0						
Dr. H. E. Roscoe	50	0	0						
Dr. R. Angus Smith	50	0	0						
Mr. Henry Wilde	100	0	0						
Dr. James Young	50	0	0						
				300	0	0			
				£803	8	1	£486	12	11

1884.—April 1. To Cash in Manchester and Salford Bank, Limited £248 11 5

Note.—The detailed accounts of the session 1883-4 (of which the above account is an abstract) are in course of audit by Mr. J. Cosmo Melvill and Mr. J. A. Bennion.

PHILOSOPHICAL SOCIETY.

rom 1st April, 1883, to the 31st March, 1884, with a Comparative
or the Session 1882–1883.

Cr.

1884—March 31.	1883-4. £ s. d.	1883-4. £ s. d.	1882-3. £ s. d.	1882-3. £ s. d.
By Charges on Property:—				
Chief Rent	12 12 2		12 12 2	
Insurance against Fire	12 17 6		12 17 6	
Property Tax	3 10 10		4 12 1	
Repairs, &c.	3 14 2	32 14 8	1 3 3	31 5 0
By House Expenditure:—				
Coals, Gas, Candles, and Water	18 8 6		15 13 1	
Tea and Coffee at Meetings	16 14 1		15 9 6	
House Duty	6 7 6		6 7 6	
Cleaning, Brushes, &c.	4 0 5	45 10 6	5 10 1	43 0 2
By Administrative Charges:—				
Wages of Keeper of Rooms	57 4 0		57 4 0	
Postages and Carriage of Parcels	14 2 0		16 19 1	
Attendance on Sections and Societies	9 9 0		9 4 0	
Stationery, Printing Circulars, & Receipts	12 3 9		10 17 6	
Distributing Memoirs	2 1 6	95 0 3	... ...	94 4 7
By Publishing:—				
Printing Centenary Volume	213 12 0		... ...	
Printing Memoirs	... ...		75 19 3	
Printing Proceedings	28 17 0		43 13 0	
Wood Engraving and Lithographing	3 19 0		3 5 6	
Editor of Memoirs and Proceedings	50 0 0	296 8 0	50 0 0	172 17 9
By Library:—				
Binding Books	19 17 8		... ...	
Books and Periodicals	25 18 3		7 16 1	
Assistant in Library	11 0 0		9 0 0	
Geological Record for the Year 1878	... ...		0 10 6	
Palæontographical Society for the Years 1883 and 1884	2 2 0		... ...	
Ray Society ditto ditto	2 2 0		... ...	
Pali Text Society (6 years' subscriptions)	5 5 0	66 4 11	... ...	17 6 7
By Natural History:—				
Works on Natural History	18 18 4		9 16 9	
Lithographing and Printing Plates of Paper on Frog	... ...		29 15 0	
Grant to Microscopical and Natural History Section	... ...	18 18 4	... ...	39 11 9
By Balance		248 11 5		88 7 1
		£803 8 1		£486 12 11

		1883-4. £ s. d.	£ s. d.
Compounders' Fund:—			
Balance in favour of this Account, April 1st, 1884			125 0 0
Natural History Fund:—			
Balance in favour of this Account, April 1st, 1883		55 9 11	
Dividends received during Session 1883-4		59 17 7	
		115 7 6	
Expenditure during Session 1883-4		18 18 4	
Balance in favour of this Account, 31st March, 1884			96 9 2
General Fund:—			
Donations during the Session 1883-4	£300 0 0		
Ordinary Receipts during the Session 1883-4	355 3 5	655 3 5	
Balance against this Account, 1st April, 1883	92 2 10		
Expenditure during the Session 1883-4	535 18 4	628 1 2	
Balance in favour of General Fund, 31st March, 1884			27 2 3
Cash at Bankers, 31st March, 1884			£248 11 5

PROCEEDINGS

OF THE

MANCHESTER

LITERARY AND PHILOSOPHICAL SOCIETY.

VOL. XXIV.

SESSION 1884–5.

MANCHESTER

PRINTED BY T. SOWLER AND CO., 24, CANNON STREET

1885.

NOTE.

The object which the Society have in view in publishing their Proceedings is to give an immediate and succinct account of the scientific and other business transacted at their meetings to the members and the general public. The various communications are supplied by the authors themselves, who are alone responsible for the facts and reasonings contained therein.

INDEX.

CORRIGENDA.

Page 27, line 17, for Ferious Oxide read Ferrous Hydrate.
,, ,, 19, for Ferrous read Ferric.

PROCEEDINGS

OF THE

MANCHESTER

LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, October 7th, 1884.

Professor W. C. WILLIAMSON, F.R.S., President, in the Chair.

It was announced that Mr. Henry Wilde had made a donation of £400 to the Building Fund of the Society, in addition to his donation of £100 towards the expenses of the Centenary Volume.

On the motion of Mr. CHARLES BAILEY, seconded by Mr. ALFRED BROTHERS, the thanks of the Society were voted to Mr. Wilde for his very liberal donations.

"The Pink Sun-Glow," by ALFRED BROTHERS, F.R.A.S.

In the *Photographic News* for September 12th, Mr. C. RAY WOODS writing from the Riffel, in Switzerland, where he has been stationed for some months for the purpose of photographing the Corona, says, "But the most interesting sight to me . . . was the remarkable haze round the sun. A pink glow extended for some twenty degrees around the sun, and at the extremity of this glow was a vivid and well defined red ring . . . On every clear day we have had here this peculiar haze has been more or less apparent."

In the *English Mechanic*, a few weeks since, a letter on the same subject appeared, written, I think, from Canada, and gave very much the same description of this very curious phenomenon.

As this pink glow has attracted attention from places widely separated, it may be of some interest if I state that many times during the present year I have noticed the same effect. As early as January I saw at mid-day the pink tint extending to at least 15° or 20° from the sun. I saw the same thing again from the East coast of Anglesea about 5 o'clock in the afternoon of the 5th July, and at the same time some of the clouds near the pink part of the sky showed the most beautiful nacreous tints, this effect lasting for a few minutes only.

About the end of August, and lasting for at least an hour after sunset, this pink tint was visible as a broad band of light, bounded at right and left by a green tint exactly complementary to the pink. Taking the place of the sun as a centre this pink light had about the breadth of the zodiacal light and extending in the same direction as when that phenomenon is seen in the western sky. By this I do not wish it to be inferred that I think the zodiacal light has anything to do with the matter, and merely refer to it to indicate the appearance of the pink light on the evening named. On the following morning there was a fainter pink tint in the sky near the sun, and several times since the same appearance has been visible at different times of the day.

It is a singular fact that some persons fail at first to see the pink colour.

It may be stated that the pink colour of the sky is not always visible when the atmosphere seems favourable for its appearance, the neighbourhood of the sun having the usual grey tint. The times when the pink colour is best seen are when there are masses of white cloud near, the colour of the sky then becomes most apparent.

Since writing the above a paragraph has appeared in

"*Knowledge*" of September 26th, in which the writer calls attention to an unusual glow around the sun, and suggests that the effects may be cosmical and a real appendage of the sun. That the effect referred to is not connected with the sun seemed to me easy to prove as, if belonging to our atmosphere, a clear moonlight night might reveal the same effect, but in a fainter degree. This supposition has proved to be correct, as on the evening of Friday last, 3rd October, there was an exact repetition of what I had so often seen during the year at mid-day, and at other times of the day. The coloured sketch shows very roughly the effect when the sun is seen partly surrounded by cloud, and it may be taken to show sunlight or moonlight allowing only for the different intensities of the light.

The pink glow is not persistent on any day when it may be visible. The colour may be as bright as I have attempted to show it for half an hour or more, and then all colour may quickly disappear and only the usual grayness surrounding the sun may be visible; and again the pink colour may reappear as quickly as it vanished. The colour is often seen to increase in intensity in a few moments, and always appears of a darker tint if the sun is obscured during the observation.

Mr. R. F. Gwyther, M.A., described an Aurora seen on the night of September 13th, off Rimouski, on the St. Lawrence. When first seen the arch passed through the zenith, and stretched to the horizon on either side. The phenomenon remarked upon was that in the final stage in place of the usual streamers the light flashed across the sky, presenting the appearance of a border to hanging drapery (represented by dark sky). Of this border, the uppermost part was distinctly green in colour, whereas the lower fifth or sixth part (in breadth) was distinctly purple.

Mr. CHARLES BAILEY, F.L.S., read a paper entitled, "Notes on the Structure, the occurrence in Lancashire, and the Source of Origin, of *Naias graminea* Del., var. *Delilei* Magnus.

General Meeting, October 21st, 1884.

Professor W. C. WILLIAMSON, F.R.S., President in the Chair.

Mr. EDWARD DONNER, of Manchester, Merchant, was elected an Ordinary Member of the Society.

Ordinary Meeting, October 21st, 1884.

Professor W. C. WILLIAMSON, F.R.S., President, in the Chair.

"Note on the Visibility of the Moon during Total Lunar Eclipses," by JOSEPH BAXENDELL, F.R.S., F.R.A.S.

It has been generally supposed by astronomers since the time of Kepler that the visibility of the moon during total lunar eclipses is due to light refracted by the earth's atmosphere; but in considering the phenomena of the late eclipse, and endeavouring to estimate the amount of light which could be bent by the atmosphere of the earth into its shadow, I was led to doubt whether this light was sufficient to illuminate the eclipsed moon to the extent observed in many total eclipses; and this view appeared to me to be supported by the faintness of the illumination of the dark part of the moon by the reflected light from the whole, or nearly the whole, of the disk of the earth a little before or after new moon. This illumination is not much greater than that observed in some total eclipses, but it seems difficult to suppose that the light of the narrow ring or thread of sun-light round the earth's disk as seen from the moon, and greatly subdued as it must undoubtedly be by passing through the earth's atmosphere, could be comparable with the light from an almost fully illuminated hemisphere of the earth, and it therefore became necessary to inquire whether any other source existed which would contribute light sufficient to render the moon so distinctly visible as it sometimes appeared during total eclipses.

At the time of maximum phase during the late eclipse, or when the centre of the moon was nearest to the central line of the earth's shadow, the apparent diameter of the earth as seen from the moon would be 1°26′41″ greater than that of the sun, and therefore, besides the whole of the disk of the sun, the whole of the lower corona, or corona proper, would be covered by the earth, but according to the statements of observers of total solar eclipses the outer corona extends to a much greater distance on each side of the sun than the semidiameter of the earth as seen from the moon, and from the estimations of the brightness of this uncovered portion by some observers, it seems probable that to it may be due a not inconsiderable portion of the light which renders the moon visible when immersed in the earth's shadow; and this probability is increased when it is considered that the intensity of the light of the corona, as seen from the earth, is much reduced by the absoption of the atmosphere, an effect which would not be produced in the case of the moon.

"On the Diamond-bearing Rocks of South Africa," by Professor H. E. Roscoe, LL.D., F.R.S., &c.

The communication opens with an account of the general features of the diamond-bearing region based chiefly on the papers of Mr. Dunn and Mr. W. H. Huddleston, with special reference to the theory of the volcanic origin of the "pipes" in which the diamonds occur, first advanced by Professor E. Cohen, of Strasburg.

The strata at Kimberley mine (from which the specimens referred to in this paper were kindly sent by Mr. Loewenthal) are then described; two shafts which have been sunk there —one in the "pipe," the other in the shale near it—passed through the following strata. :—

(1) "Pipe."	
Red Sand...............	3 feet.
Tufaceous Limestone	15 ,,
Soft yellow earthy diamond rock	30 ,,
Soft blue diamond rock proved to	282 ,,
Total excavated...	330 feet.

(2) "Outside the Pipe."	
Red Sand	3 feet.
Tufaceous Limestone	5 ,,
Yellow Shale............	20 ,,
Black carbonaceous do.	10 ,,
Two thin bands of black dust in Shale	1 foot.
Black Shale	236 feet.
Dolerite	2 ,,
Total excavated...	277 feet.

The diamonds are found in the yellow and blue "Stuff" along with garnets, mica, bronzite, ilmenite, pyrite, &c., and are separated by washing the broken-up earth in sluices similar to those used in gold mining. The annual value of the diamonds from Kimberley is said to be £3,750,000, and the total amount raised since 1870, to reach the enormous sum of £40,000,000.

The specimens forwarded were as follows :—

I. A compact greenish-grey rock, labelled "The Hard Rock."

II. A compact rock of dull rusty-brown colour, labelled "Layer of Ironstone."

III. A friable earthy rock of greenish-blue colour in which the diamonds occur.

IV. A mixture of several minerals, in pieces about the size of a pea, labelled "Coarse heavy Deposit, Kimberley blue ground."

V. A similar mixture, in much finer grains, labelled "Fine heavy Deposit, Kimberley blue ground.

Sections of the first three specimens were cut and sent to Professor Bonney, F.R.S., an abstract of his report upon them is as follows:—

I. This rock is an actinolitic diabase, and could not be distinguished from specimens obtained from various British localities, where rocks of paleozoic or greater age occur.

II. This is a rather decomposed basalt belonging to the same group as I., but probably from a different mass and altered in a different way.

These two specimens were analysed with the following results:—

	I.	II.	
SiO_2	58·03	48·47	
Al_2O_3	15·53	16·33	
Fe_2O_3	——	9·85	
FeO	9·64	1·65	
MnO	4·54	0·48	
CaO	6·99	8·43	
MgO	4·55	7·38	
Loss on Ignition	——	7·44	5·55 % at 120°; 1·89 % at red heat.

It will be observed that these have a very similar composition, the second differing from the first in containing a considerable percentage of water, and in the fact that its iron is almost entirely in the peroxidized condition.

III. Of this specimen, the diamond-rock itself, Professor Bonney reports as follows:—

"No. III is evidently a breccia composed of a compact serpentinous rock, of dark colour; the fragments and the paste in which they are embedded apparently being similar in character; one or two scales of bronzite and a black mica are scattered in the matrix with some small grains of a black mineral of irregular fracture, and one of a brown mineral.

Microscopic examination does not enable me to come to a definite conclusion as to the nature of this earth. So far as I can make out, the ground-mass consists of a very minute aggregation of doubly refracting crystallites of no very definite but rather fibrous shape, and specks of ferrite. Here and there (and these patches have rather definite outlines and an approach to crystal form) the colouring mineral is opacite. Frequent cracks appear to traverse the slide, occupied by a clearer mineral similar to that disseminated through the slide. There is a small crystal resembling a hydrous bronzite. I cannot recall ever having seen a slide exactly of this character, but I have several that throw some light upon it, and I have a very strong suspicion that the fragments have been a basalt-glass or an olivine-glass, more probably the latter, converted by hydration into a kind of serpentine. As a rule the peridotites appear to be deep-seated rocks, but it is quite possible that there may be occasional exceptions. I do not see anything specially characteristic of a breccia of volcanic origin, but there is nothing incompatible with this."

An analysis of the earth gave the following numbers:—

$Si\,O_2$	46·16	
Al_2O_3	10·00	
$Fe\,O$	6·71	
$Mn\,O$	0·34	
$Ca\,O$	3·84	
$Mg\,O$	16·63	
Loss on ignition	15·43	9·75 at 120° 5·68 at red heat.

It was noticed that a peculiar smell, somewhat like that of camphor, was evolved on treating the soft blue diamond-earth with hot water, and an attempt was made to isolate the aromatic body. A quantity of the earth was powdered and digested with ether. On filtering and allowing the ether to evaporate, a small quantity of a crystalline, strongly aromatic body was obtained. This substance was very volatile, burned easily with a smoky flame and melted at about 50° C.

The presence of this carbonaceous substance in the diamond matrix is most interesting and tends to confirm Professor Cohen and Mr. Dunn's hypothesis that the carboniferous shales that are penetrated by the diamond bearing "pipes" have been the source of the carbon which is now found in the crystalline form as diamond. It is unfortunate that the quantity of the substance obtained was too small to admit of a full investigation of its composition and properties.

The results of the examination of the remaining specimens, which are samples of the deposit obtained by washing the "stuff" at Kimberley, are interesting, as showing the minerals which accompany the diamond in the matrix :—

100 grams. of the "Fine heavy Deposit" contained—

Garnet	10·76	grams.
Bronzite	3·64	"
Ilmenite	54·80	"
Pyrites	0·14	"
Mica	0·20	"
Limonite	16·12	"
Pieces of the rock which have escaped disintegration with some Limonite	10·84	
Coarse sand—a mixture of all the above	3·46	
	99·96	

The composition of the limonite and bronzite are given below :—

	Limonite.	Bronzite.
SiO_2 per cent.	6·93	55·17
Al_2O_3 "	6.85	2·95
Fe_2O_3 "	71·40	—

	Limonite.	Bronzite.
Fe O per cent......	——	5·76
Ca O „	0·71	3·64
Mg O „	0·86	32·83
H_2O „	12·53	——
	99·28	100·35

"Note on Envelopes and Singular Solutions," by Sir JAMES COCKLE, F.R.S., F.R.A.S., &c., Corresponding Member of the Society. (Continued from Vol. XXI., p. 100.)

16. Arts. 13 and 15 (misnumbered 14) require a correction. The tac-locus occurs twice (see Mr. J. W. L. Glaisher's Examples, &c., Messenger, N.S., No. 133, May, 1882). And in art. 13 (p. 100, line 1) the reference should be to No. (not vol.) 36, vol. III.

17. Conceive a system of primitive curves, all constructed according to one law and depending upon a single arbitrary parameter; and each, therefore, marked by the magnitude of its parameter.

18. When every primitive curve is an envelope, then each touches every other, and the places, or the limits of the places, of intersection of consecutives will be the envelopes. Such places, or limiting places, will be either points or curves. Take them to be primitive curves, finite in number. Then every primitive curve is not an envelope. Take their number as indefinitely large, still they will not (except upon the inadmissible supposition that consecutives entirely coincide, and so are, in fact, identical) comprise every particular primitive curve. Hence, when all the primitive curves are envelopes, the envelopement does not take place along curves.

19. If all the primitive curves are in mutual contact at a certain point draw their common tangent, and when it does not pass through the origin then on it, let fall a perpendicular from the origin. The point of envelopement will lie

at a finite distance from the origin and from the perpendicular, and we have a case of Symptotic Envelopement.

20. But we may conceive the law of construction as changing, and the point of contact as passing off to an infinite distance, and becoming the point at infinity in the tangent. We shall then have a case of Asymptotic Envelopement.

21. Again, we may conceive that the foot of the perpendicular also passes off to an infinite distance, and so that the tangent lies altogether at infinity. In this case, the line at infinity is an envelope.

22. In each of these three cases all the primitive curves, non-consecutive as well as consecutive, are, or are conceived as being, in mutual contact. And in whichever of the three senses above indicated the word envelope is used, in that same sense the word tac-locus might also be used. In all the three cases the envelope is also a tac-locus. Such an envelope may be called a General Primitive Envelope.

23. When the primitive curves are not all envelopes but a certain particular primitive curve is an envelope, we have a Special Particular Primitive Envelope. Such an envelope I shall call an Epicene Envelope.

24. When an envelope is not a primitive curve, it is a Singular Envelope.

25. There are three species of envelope, viz.:

I. General Primitive Envelopes.
II. Epicene Envelopes.
III. Singular Envelopes.

26. There are three varieties of the first species, and a general primitive envelope may give rise to—

(1) A Symptotic Envelopement.
(2) An Asymptotic Envelopement.
(3) An Envelopement on the line at infinity.

27. Suppose each particular primitive curve to be capable of being represented by its respective particular primitive equation, or, briefly, by its particular primitive. Then an equation wherein the parameter, now regarded as the arbitrary constant, is left undertermined in value, but by

means of which any particular primitive may, by an appropriate determination (accompanied or not by a decomposition into factors), be constructed is the complete primitive. General primitive and epicene envelopes are represented by particular integrals, singular envelopes by singular solutions.

28. Epicene and singular envelopes possess a common geometrical property. But an epicene envelope is, and a singular envelope is not, a primitive curve. So a particular integral is, and a singular solution is not, a case of the complete primitive. And whether we say that an envelope is at once epicene and singular, or that a solution is both a singular solution and a particular integral, the logical principle of contradiction is alike violated. In the geometry the contradiction is plain. In the analysis it is as real though less plain. It is less plain because, if we decompose a complete primitive into factors, each factor will represent a distinct part of a curve. The curve is therefore no longer represented as a geometrical whole, but as a synthesis of parts, each having its own analytical representation. The several factors will give rise to distinct differential equations, two or more of which may have a common solution. But such solution may be a particular integral of one differential equation, and a singular solution of another. Illustration of this may be drawn from my paper "On Particular Integrals" in the *Quarterly Journal of Mathematics* (Vol. XIII., No. 51, see pp. 240-1, art. 5). For if, instead of looking at its separate parts, we view the parabola as a whole, then the epicene primitive (therein called a singular integral) possesses the geometrical properties of a singular solution.

29. Nevertheless, if we confine our attention to the product, and suppress all reference to its factors, we may regard the common solution either as particular or singular. It is only in this sense that a solution can be both a singular solution and a particular integral.

12, St. Stephen's Road, Bayswater,
London, W., Oct. 9, 1884.

General Meeting, November 4th, 1884.

Professor W. C. Williamson, LL.D., F.R.S., President, in the Chair.

Mr. Bulkeley Allen, of West Lynn, Altrincham; and Mr. Joseph Corbett, of Manchester, Architect, were elected Ordinary Members of the Society.

Professor O. Reynolds, F.R.S., read a letter from the Council of the Manchester and Salford Sanitary Association, proposing that a Conference on Health and Education should be held in Manchester, at Easter, 1885, and requesting the Society to nominate one or more of its members to act as its representatives on a Committee to be appointed to organize such a Conference.

It was resolved that the letter be referred to the Council.

Ordinary Meeting, November 4th, 1884.

Professor W. C. Williamson, LL.D., F.R.S., President, in the Chair.

The President, in referring to Mr. Caldwell's recent discovery of the oviparous reproduction of the Duck-billed Platypus of Australia, called attention to the fact that when he undertook the curatorship of the museum of the Manchester Natural History Society, in Peter Street, in 1835, he found in that museum two very remarkable eggs which had been brought from Australia, and which were labelled "Eggs of the Duck-billed Platypus." Those eggs were in the collection when he resigned his curatorship in 1838, and no reference to their existence can be traced beyond that date. Their size and oblong form made them wholly unlike the eggs of any bird or oviparous reptile known at the above date. But the evidence that the Ornithorhynchus was oviparous was so inconclusive that these two eggs seem to have attracted less attention than they even then deserved, and their apparent disappearance from the collections of the Natural History Society, now in the Owens College, is the more to be regretted since Mr. Caldwell's discovery makes it certain that these missing specimens were what their label declared them to be, viz., the Eggs of the Mammalian Ornithorhynchus platypus. Whether these eggs have been abstracted from the collection at some period subsequent to 1838, or whether they have merely been mislaid during one of the many changes which the museum collections have since undergone, is uncertain.

A paper was read "On the Discharge of Electricity through Gases—illustrated by experiments," by ARTHUR SCHUSTER, Ph.D., F.R.S.

Ordinary Meeting, November 18th, 1884.

Professor W. C. WILLIAMSON, LL.D., F.R.S., President, in the Chair.

"On the Reversion of the Minima of the Double-period Variable Star *R Sagittæ*," by JOSEPH BAXENDELL, F.R.S., F.R.A.S.

On the 2nd of March, 1880, I communicated to the Physical and Mathematical Section a paper on this star, in which, after giving the results of my observations up to that time, I remarked that "the mean difference between the magnitudes at the two minima is slowly decreasing, and it will therefore be interesting to watch whether this decrease will go on until the difference entirely disappears and the star becomes a single period variable; or whether the difference is subject to periodical changes, alternately increasing and decreasing within certain limits." Since the reading of this paper additional observations and a re-examination and discussion of the former observations have brought to light a phenomenon which, so far as I am aware, has not been previously observed. Each list of minima in the paper referred to consists of two series, the first of minima observed from 1859 to 1868 at the Crumpsall Observatory, and the second those observed in 1878 and 1879 at the observatory in Birkdale, and in the re-examination I have recently made of all my reductions and results I found that I had been in error in assuming that the minimum of August 19, 1878, was a principal minimum, and that the interval from September 12, 1868, comprised 52 periods, whereas the minimum of July 16, 1878, was a principal minimum, and the interval from September 12, 1868, to that date comprised 51 complete periods, giving a mean period of 70·47 days. It appears, therefore, that six minima which I had entered in the table of principal minima ought to have been entered in the table of secondary minima, and four minima entered as secondary were really primary; and that in fact a reversion of the two minima had taken place in the interval from 1868 to 1878. Since I arrived at this conclusion I have examined the results of Professor Schönfeld's observations to 1874, published in Nos. 1907, 1992, and 2066 of the "Astronomische Nachrichten," and find that they fully bear out this view, and as he states that the period seems to have decreased up to 1870-71, and that in 1874 it had again increased, there can be no doubt that the number of periods between 1868, September 12, and 1878, July 16, was only 51, and that a reversion of the minima took place in or about 1874 after an increase in the length of the period had commenced. Schönfeld, indeed, in his last communication alluding to the near approach to equality of the two minima which had then taken place, remarks that if the star's variability had not been discovered till that time, it would almost certainly have been regarded as a single period variable.

The observations I have made since 1879 show that the reversion continued till the spring of 1883, but from that time to the autumn of the present year they seem to indicate that a return to the former relations of the two minima has already commenced.

The changes in the length of the period are shown as follows:—

1859, Oct. 27, to 1861, Oct. 8......	mean period	= 70·88	days.
1861, Oct. 8, to 1864, Aug. 30......	,,	= 70·46	,,
1864, Aug. 30, to 1866, Dec. 22...	,,	= 70·44	,,
1866, Dec. 22, to 1868, Sep. 12 ...	,,	= 69·96	,,
1868, Sep. 12, to 1878, July 16 ...	,,	= 70·47	,,
1878, July 16, to 1881, June 12...	,,	= 70·76	,,
1881, June 12, to 1884, Sep. 28...	,,	= 70·98	,,

The minima observed since September, 1868, are as follows:

FIRST OR PRINCIPAL MINIMA.

	Mag.		Mag.
1878, July 16—	9·5.	1881, June 12—	8·9.
Sep. 21—	9·3.	Aug. 17—	8·9.
Dec. 5—	9·4.	Oct. 24—	9·0.
1879, Sep. 3—	9·4.	1882, May 26—	8·9.
Nov. 14—	9·3.	Aug. 7—	9·0.
1880, June 16—	8·9.	Oct. 15—	9·1.
Aug. 29—	8·9.	1884, July 16—	9·4.
Nov. 10—	8·9.	Sep. 28—	9·4.

The mean magnitude = 9·14.

Epoch = 1881, March, 29·086.

SECONDARY MINIMA.

	Mag.		Mag.
1878, Aug. 19—	9·1.	1880, Dec. 14—	9·7.
Oct. 30—	9·6.	1881, May 7—	9·1.
1879, Jan. 10—	10·1.	July 11—	9·3.
Aug. 5—	10·0.	Sep. 18—	9·1.
Oct. 15—	10·0.	Dec. 2—	9·9.
Dec. 24—	9·8.	1882, June 30—	9·9.
1880, May 16—	9·7.	Sep. 13—	9·3.
July 22—	10·1.	1884, June 5—	8·8.
Oct. 4—	9·9.		

The mean magnitude = 9·61.

Epoch = 1880, October, 3·365.

The interval between a principal and next following minimum derived from the two epochs is 35·709 days; the value derived from the results given in my former paper is 34·886 days. The mean is therefore 35·297 days, which is practically identical with the half of the mean period derived from all the observations made since the discovery of the star's variability—the difference being only 0·015 of a day.

The mean magnitude of the star in the principal minima in the years 1859 to 1868 was 9·75, and in the years 1878 to 1884, 9·14, or 0·61 higher; while on the other hand the mean magnitude in the secondary minima in the former years was 9·03, and in the latter 9·61, or 0·58 lower.

No theory has yet been advanced that will account satisfactorily for the ordinary phenomena of variable stars, and it seems very probable that this occurrence of a reversion of the minima of a double-period variable will increase the difficulty of framing such a theory.

MICROSCOPICAL AND NATURAL HISTORY SECTION.

November 10th, 1884.

THOMAS ALCOCK, M.D., President of the Section, in the Chair.

Mr. MARK STIRRUP, F.G.S., exhibited specimens of the nests of the Trap-door-nest Spider Nemesia cœmentaria (Latr.) from Cannes and explained some of the interesting habits of these creatures.

They form subterranean cylindrical burrows, generally penetrating from two to three inches from the surface of the soil; the openings into these burrows or nests are closed with a beautifully close fitting door, which opens on a hinge, and when these doors are closed, it is extremely difficult to detect their whereabouts, as the doors are made of the material of the surrounding soil and simulate exactly its appearance. They usually select for their homes earthen banks, such as we may find bordering roads or deep worn lanes, but it is not impossible that they may make their nests on the level ground, but they have not yet been found in such a position.

The difficulty of finding these nests is shown by an interesting anecdote related of Mr. Moggridge who, when visiting Marseilles with one of his sons, called at the museum there, to see the entomological Curator, and asked him whether trap-door spiders were found in the neighbourhood.

To this question the Curator said he could confidently answer *no*, as he took a great interest in these creatures and had repeatedly searched for them.

Mr. Moggridge on leaving the museum said to his son, "Now let us go and try what we can do," and the result of their search was so successful that they were able to present the astonished Curator next day, with several specimens got in the immediate vicinity.

It would appear that the best indications to guide a searcher are to look out for the little round doors that often strew the sides of the banks where these spiders are located.

The doors being but frail soon wear out and give way, but the spider seems to be able to quickly replace them, and if a door be removed to-day, a new door, hinge, and all will be found hung on the following day, thus effectually guarding again the privacy of its home.

The nests of the trap-door spiders are now common objects of sale in the towns of the Riviera, which is no doubt due to the interest created by that most interesting work published a few years ago by the late Mr. Moggridge, on "Harvesting Ants and Trap-door Spiders," the result of his investigations while residing on the shores of the Mediterranean for the benefit of his health.

Ordinary Meeting, December 2nd, 1884.

Professor W. C. Williamson, LL.D., F.R.S., President, in the Chair.

The President made some observations on the double foliar fibro-vascular bundle supposed by M. Renault of Paris to exist in Sigillaria, but to be absent from the leaf-scars and Lepidodendron. He called attention to specimens of *Lepidodendron Harcourtii*, recently obtained by him, which exhibit most clearly the *apparent* presence of such a double bundle, but he demonstrated that this appearance was merely due to the separation of two parts of a single leaf-bundle originally united by a mass of delicate phloem cells which had disappeared. In the living plant these delicate cells had separated the vascular string from a similar string of sclerous cells resembling hard bast. These latter cells have been so preserved as to give the *appearance* of a *second zylem* bundle whereas they are merely one of the *phloem* tissues belonging to the single bundle of which the vascular string represents the true Zylem element. As seen on the leaf-scar of an ordinary structureless *Sigillaria* the real nature of these two structures would be unrecognisable.

The President also exhibited a photograph of a fine specimen from the coal-measures of Dudley, in the rich collection of Mr. Johnston of Dudley, in which a stem is surrounded by a cluster of leaves, indentical with the Lepidophyllum lanceolatum of Lindley and Hutton. This specimen was correctly recognised by Mr. Johnston as demonstrating the Lepidodendroid character of this well known leaf.

MICROSCOPICAL AND NATURAL HISTORY SECTION.

December 8th, 1884.

THOMAS ALCOCK, M.D., President of the Section, in the Chair.

Professor A. MILNES MARSHALL, M.D., D.Sc., of Owens College, read a paper on the morphology of the sexual organs of *Hydra.* He also exhibited some specimens showing the regeneration of the visceral mass in *Comatula,* and likewise some specimens of *Pennatula.* Professor Marshall promised to make some further communications to the Section on the subject at an early date.

Mr. HYDE exhibited to the Section (1) a piece of chalk from Brighton, perforated by *Pholades*; (2) some stalactites from Victoria Cave, Settle; and (3) a piece of Fluor Spar, from the Blue John Mine, Derbyshire.

Mr. R. D. DARBISHIRE, exhibited some fine specimens of *Magilus Antiquus,* and some remarkable series of various forms of *Leptoconchus* from the Mauritius.

Mr. A. BROTHERS, F.R.A.S., exhibited (under the microscope) the electric spark, as produced by a Carbonate of Potash Battery, at the extremities of two lead pencil points. An induction coil being used in the process.

"On the Caernarvonshire Station of *Rosa Wilsoni,* Borrer," by CHARLES BAILEY, F.L.S.

I exhibit, to-night, fruiting specimens of *Rosa Wilsoni,* Borrer, collected on the first of October last from plants growing in the original station on the Caernarvonshire side of the Menai Straits. In former years I had frequently sought for this rose on both sides of the Straits, at different seasons, and it was by the kindness of a local botanist, Mr. John E. Griffith, F.L.S., of Vronheulog, Upper Bangor, and in his company, that I had, at last, the pleasure of seeing the plant in its native state.

At the date of our visit, while other roses were in full leaf, all the leaves of *Rosa Wilsoni* had fallen from the fructiferous branches, and the bare bushes with their bright scarlet fruits and erect sepals, and their claret-coloured branches with their divaricate twigs, gave the plant a very marked facies, so that it would not be likely to be overlooked by any one who had once seen it in the living state. There were a few barren shoots growing from the old stocks, crowded with prickles, and each surmounted with a tuft of leaves. In some cases the leaves were of an ashy-green colour, but most of the shoots had the serrations of their leaves edged, on their upper surface, with a rosy-claret colour, which passed into a large central crimson-purple blotch along both sides of the midrib. These purple patches were of a redder tinge than the dark purple leaves of the contiguous *Rosa spinosissima*, L.

The most noticeable feature of the station for this plant was the extremely limited area upon which it grew; there were very few bushes, and the whole patch could readily be accommodated in one half the area of the Society's present meeting-room. The sea is gradually encroaching upon the bank occupied by the plants, and as these begin to occur just above high-water mark at a part of the shore where it is exposed to rough wave-action, it is an easy matter to foresee the approaching extinction of the Rose. Last winter, as I learned from Mr. J. E. Griffith, a portion of the area on which *Rosa Wilsoni* grows was utilised by the owners of the oyster-beds in the Straits for piling-up some of their stores, so that the rose's present lease of life is doubly imperilled.

It is a singular circumstance in the geographical distribution of *Rosa Wilsoni* that excepting on the Umbra rocks in county Derry, it should not have been found in any other portion of the British islands. On one or other side of the Menai Straits there must be other limestone banks well adapted for the plant, but as far as is known it is confined to a few square-yards of one bank on the Caernarvonshire side of the Straits. Much of the land, however, on both shores is not accessible to the public, and the plant may exist in the neighbourhood in some unknown station. In the almost near certainty of the early disappearance of the plant, I hope Mr. Griffith will carry out the intention he expressed to me of taking his man to transplant a few of the stocks a little further from danger. One hardly likes to see one of our native plants "assisted" after this fashion, but when the alternative is a possible extinction of the species from its Welsh habitat, the fostering care of botanists is quite justifiable; Lancashire botanists in particular would be glad to see Wilson's name perpetuated after this fashion, rather than in herbarium specimens only.

Along with the examples of my own gathering I exhibit specimens from a plant grown at Kew, derived from the Menai station, and it will be seen that the plant has not improved in luxuriance by growth in a southern latitude. I also show a specimen collected by Mr. John Ralfs in 1840, and another by our old and valued member Mr. Joseph Sidebotham, F.L.S., collected as long ago as 1844. It would, I am sure, be interesting to the Section if Mr. Sidebotham would put upon record his recollection of what the Welsh station was like forty years ago.

The late Mr. John Hardy—formerly an associate of the section and whose comparatively early death so many Lancashire naturalists regret—has frequently referred to Wilson's Rose at our meetings, but a specimen in his herbarium labelled *Rosa Wilsoni* is not the true plant. It may interest the members to know that Mr. Hardy's phanerogams and cryptogams will be incorporated with my herbarium of British plants; they include almost a unique set of Sole's Mints, and a good series of Irish Saxifrages collected by the late Dr. Andrews.

Ordinary Meeting, December 16th, 1884.

Charles Bailey, F.L.S., in the Chair.

Mr. E. P. Quinn exhibited several forms of frictional electrical machines.

"Note on Envelopes and Singular Solutions," by Sir James Cockle, F.R.S., F.R.A.S., &c., Corresponding Member of the Society.

(*Continued from p. 12.*)

30. A differential expression with its complete integral implies a corresponding equation with its complete primitive. Solutions and integrating factors remain the same on either assumption. A solution is a substitution which makes the expression vanish or which satisfies the differential equation.

31. Any given solution can always be deduced from the complete primitive. But we may have to replace the arbitrary constant, sometimes by a definite constant, sometimes by a variable function, and sometimes by one or the other at pleasure.

32. If the solution cannot be deduced without giving the arbitrary constant a definite constant value the solution is a Particular Primitive.

33. If it can be deduced in either of two ways indifferently, viz., either in giving to the arbitrary constant a definite constant value or in replacing it by a variable function the solution is an Epicene Primitive.

34. If it cannot be deduced without replacing the arbitrary constant by a variable function the solution is a Singular Solution.

35. Thus we have three kinds of solution, viz.:—

(I). Particular Primitives.

(II). Epicene Primitives.

(III). Singular Solutions.

36. Suppose that the complete primitive can be decomposed into factors one-valued, say linear, with respect to the arbitrary constant. Then an epicene solution is a primitive, and particular, when considered in relation to one or more of such factors. But in relation to the rest it may not be a solution at all, or it may be not particular but singular, and consequently not a primitive.

37. Regarding each such linear factor as a complete primitive, there will be only two other kinds of solution at most, viz., Particular Primitives and Singular Solutions.

38. The derived equation of course contains the differential coefficient, and it may also contain all, any, either, or none of the three quantities following, viz., the arbitrary constant and the two variables. The cases in which it contains none, and in which it contains the constant alone, are cases in which it cannot be brought under what I call an adfected form, viz., a form containing the arbitrary constant, together with one at least of the variables. In all other cases the derived equation is either adfected as it stands or else may be rendered so; for the constant, if absent from, may be introduced into it by eliminating a variable between it and the complete primitive or, otherwise, by substituting for the variable in a part only of the expression for the differential coefficient. In seeking a general primitive envelope I deal with the differential equation under its adfected form. This form cannot be attained without a knowledge of the complete primitive.

39. When the complete primitive and its adfected derivative can both be satisfied, for all values of the arbitrary constant, by a system of particular values of the variables we have a general primitive envelope.

40. An epicene envelope is represented by an epicene primitive. But an epicene primitive does not represent an epicene envelope, unless it gives a double value to the arbitrary constant in the complete primitive. An epicene primitive which does not give such double value is epicene in form only, and is in substance a particular primitive.

41. A singular solution represents a singular envelope, and a singular envelope is represented by a singular solution. A singular solution gives a double value to the arbitrary constant in the complete primitive; but a value or relation which gives a double value to the arbitrary constant in the complete primitive does not always represent a solution, singular or other than singular.

12, St. Stephen's Road,
Bayswater, London, W.,
December 9th, 1884.

"Some novel phenomena of Chemical Action attending the efflux from a capillary tube," by R. S. Dale, B.A.

The results obtained in the experiments I propose to describe were the outcome of a desire to know what, if any mechanical action took place where two solutions capable of forming a precipitate, were slowly mixed. Next to find the nature of such mechanical action, and latterly, if possible, to measure it. I have made no attempt in the latter direction, but propose describing a series of experiments which have yielded some very novel effects.

1. Solutions of Lead Acetate and Potassium Dichromate were allowed to travel in opposite directions along a thread placed in the field of a microscope. At the moment of mixing very considerable disturbance took place, accompanied with a whirling motion. This method not offering results which could be easily registered, it occurred to me to cause one solution to flow into the other through a capillary tube or syphon. The apparatus used was of the

simplest possible description, consisting of a pair of cylinders connected by a capillary syphon, the effluent end of which was bent upwards. One cylinder was raised slightly above the other to insure a flow. I have a photograph of the general arrangement adopted.

2. Solutions of Lead Acetate and Potassium Dichromate were allowed to mix in this manner. The latter salt was passed into the former. The capillary syphon was charged with water, and after this had passed through the heavier fluid a series of vortex rings began to be formed at the point of the tube. Later one attached itself to the tube, and others to this, until a tube was built up *through which* the Potassium Dichromate was passed without any chemical action taking place to the top of the Lead Acetate. This action continued until the system reached an equilibrium. Fearing that I could not show the experiments before the Society I photographed some of them, and they show exceedingly well the curious growths of Lead Chromate which were thus produced. With these two substances to obtain a single tube was most difficult, and only a series could be obtained with anything like certainty.

An experiment was made reversing the fluids. The same results were obtained, though the growth was less stable, as the Potassium Dichromate being of much smaller specific gravity no support was given to the Lead Chromate formed, and thus the growth continually fell off the point of the syphon.

3. A cold saturated solution of Sodium Sulphate was passed into a saturated solution of Barium Chloride. A perfectly straight tube was obtained, which formed with great rapidity, and was very stable. This result was most unlooked for taking into consideration the great density of Barium Sulphate.

4. A solution of Ammonium Oxalate was passed into a solution of Calcium Chloride. These particular solutions

were chosen because the Amorphous Calcium Oxalate first produced on mixing these solutions rapidly becomes crystalline, and the effect could not be surmised on mixing with a capillary tube. The usual phenomena took place until the tube reached the height of about one inch, when the Amorphous Calcium Oxalate suddenly changed to the crystalline variety, and apparently stopped the action, as no further upward growth took place. On careful examination, however, of the point of the growth, a fluid was noticed to emerge which had no action on the surrounding Calcium Chloride, showing that chemical action was still going on. Now, the upward growth having ceased, it was inevitable that the tube should become wider, and this is what really took place. On another experiment I obtained a nearly spherical body, about half an inch in diameter.

5. Action of Ammonia on Ferrous Sulphate. A very thick tube of Ferious Oxide was formed, which I am able to show you, as it is by no means fragile. It has of course been since, out of the fluid, partially converted into Ferrous Oxide.

6. Sodium Carbonate on Copper Sulphate. In this case a crystalline Copper Carbonate was obtained of two shades, one a bright blue, resembling Azurite (if it be not actually that substance), and another a bright green, resembling Malachite. I am able to show this tube.

7. Ammonium Sulphide on Copper Sulphate. An action closely resembling in many particulars the action of Ammonia on Ferrous Sulphate.

8. Sodium Carbonate on Calcium Chloride. The commencement of the action was marked by the formation of a perfectly transparent and highly refractive sheath of Calcium Carbonate, which did not show any signs of crystallization until about half an inch in length. On examination after the lapse of about twelve hours, a crystalline tube of Calcium Carbonate had made its way to the top of the

containing cylinder. This tube was composed of minute but well defined crystals. I found it impossible to retain it in its perfect shape for inspection here.

9. Sodium Carbonate on Barium Chloride. A very similar action to that mentioned in experiment 7, but at no time was a transparent substance noted, the growth being quite opaque and not palpably crystalline.

10. Hydrochloric Acid on Sodium Silicate. Here a well marked action took place, and a tube of silica was produced, a portion of which I am able to show.

11. Knowing the Silica produced by the action of Ammonium Chloride on Sodium Silicate was much denser than that obtained in the previous experiment, I caused these substances to act on each other, and succeeded in obtaining a very long tube of Silica of considerable thickness. I am able to show this also.

12. Ferricyanide of Potassium on Ferrous Sulphate. Notwithstanding the extreme lightness of the blue precipate produced by these solutions a perfect tube was obtained, which reached the surface of the Ferrous Sulphate.

Many experiments on the above lines will readily suggest themselves, but I think I have described sufficient to call attention to this, to me, novel method of experiment, and I must leave it to some future occasion to describe such others as may show any peculiarities worth noting. I purposely refrain from making any theoretical deductions, with the one exception, that it is pretty certain that these phenomena are inseperably connected with vortex action, the tubes being undoubtedly built up of a series of vortex rings.

Ordinary Meeting, December 30th, 1884.

Dr. JAMES BOTTOMLEY, Hon. Secretary, in the Chair.

"Notes on the early history of the Manchester Literary and Philosophical Society," by JAMES BOTTOMLEY, D.Sc., F.C.S.

The recent work by Dr. Angus Smith has been the means of accumulating much intelligence respecting the early history of the Society, nevertheless there remains information of interest to be gathered by those who are inclined to glean in the same field. The references to the two first presidents in Dr. Smith's work are brief and unsatisfactory, and I know that he was anxious to have more information relative to them. It is, however, something to have called attention to the existence of these gentlemen, whose connection with the Society seems well nigh to have been forgotten. It is a matter of regret that of these two members, so closely associated with the origin of the Society, we have no memorial either in the shape of portrait or memoir. They were both useful citizens in the town in which they resided in several capacities, both were representatives of old Cheshire families, both lived to an advanced age, indeed Dr. Mainwaring must have been considerably past eighty when he assisted in the formation of this Society; it adds much to their local interest, that both were intimate friends of Dr. John Byrom, who makes frequent references to them in his journal. The high esteem in which Dr. Mainwaring was held by the members is testified by the following resolution, which I find in the minute book of the Society:—

1782, May 1st, Adjourned Annual Meeting.

"It was resolved unanimously that the Members of the Literary and Philosophical Society regard Dr. Mainwaring as the Father of their Institution, and wish for the continuance of his sanction and support."

Some account of the two first presidents would be a valuable addition to the history of the Society.

Members of the Society may feel some curiosity about its former habitation, before the erection of the present building; in the old minute books I find an entry which establishes this :—

1781, October 3rd.

> "The question was put whether the room at the Assembly Coffee House, at which the Society has lately met, be convenient for the future meetings of the Society, and the ballot being taken it was determined in the negative. Ordered that the next meeting of the Society be held in the room adjoining to the Dissenter's Chapel, and that the Rev. Mr. Barnes be requested to inquire into the terms on which the Society can be accommodated with the same room weekly."

At a subsequent meeting the following resolution was passed :—

1781, October 10th.

> "It was ordered unanimously that the room in which the Society are at present met will be convenient for their future meetings, ordered that two guineas be allowed quarterly to the Rev. Mr. Barnes for the use of the room, fire, candles, and other conveniences."

Ordinary Meeting, January 13th, 1885.

Professor W. C. Williamson, LL.D., F.R.S., President, in the Chair.

"On the Composition of Projections in Geometry of Two Dimensions," by James Bottomley, D.Sc., B.A., &c.

(*Abstract.*)

In previous papers (Proceedings, Vol. XXI., p. 188, *et seq.*; Memoirs, Vol. VIII., third series, p. 218, *et seq.*), the author considered the application of a new kind of projection to the geometry of solids. The kind of projection there contemplated has its analogue in geometry of two dimensions. The projections to be compounded in the first case are those of a line on a line, and of a plane on a plane; in this case the projections to be compounded are those of two lines on two lines. As in three dimensions we may derive from a solid three solids of variable volume, but subject to the condition that their sum is constant, so in two dimensions, from any area bounded by straight or curved lines, may be derived two areas such that their sum is constant, though each is a variable magnitude, if we suppose the primitive area to revolve round any axis perpendicular to its plane. In the present paper the author considers the question, given the equation to the primitive curve, to find that of the projected curve. If the primitive curve be a circle, the curve derived from it will be an ellipse, the magnitude and inclination of whose axes to the axis of x will depend upon the inclination of the primitive axis to the same fixed axis. The envelop of this ellipse is given, and also the locus of the extremities of its axes. By means of the relation between the coordinates, inverse questions may be solved, viz., given the projected curve to find the primitive. In three dimensions, if an arbitrary curve be traced on the primitive solid and curves drawn on the projected solids passing through the corresponding points, a simple relation may be found among the infinitesimal arcs of these curves. A similar proposition holds in two dimensions, the relation in this case being between the infinitesimal arcs of the perimeters of the primitive and its two derivatives. Finally, it is remarked that each projected area may again be regarded as a primitive subject to projection, and if we suppose the operation to be repeated n times, we shall obtain 2^n areas, variable if we suppose the primitive to have any motion of rotation, yet subject to the condition that their sum is constant and equal to the primitive area.

Ordinary Meeting, January 27th, 1885.

Professor W. C. Williamson, LL.D., F.R.S., President, in the Chair.

"The Morphology of the Sexual Organs of Hydra," by Prof. A. Milnes Marshall, M.D., D.Sc.

Hydra stands alone, or almost so, among Hydrozoa, inasmuch as its reproductive organs, whether ovaries or testes, develop and ripen in the body-wall of the animal instead of in special buds or gonophores. Concerning the relationship in this respect between Hydra and other Hydrozoa two diametrically opposite views have been held, one being that Hydra exhibits the simplest and most primitive condition of the reproductive organs prior to the evolution of special sexual buds; the other that the condition in Hydra is one of extreme degeneration, the sexual buds that were previously present having completely aborted.

Quite recently Prof. Weismann of Freiburg has published some extremely interesting and valuable researches on the development of the sexual products in Hydrozoa, and it is the object of the present paper to enquire into the bearing of these results on the problem stated above concerning Hydra.

In one of the typical hydroid colonies such as Podocoryne or Bougainvillea the sexual products, whether ova or spermaldzoa, are contained in medusoid buds, and do not ripen until these medusæ have attained full development, and detached themselves from the colony so as to lead a free-swimming existence. In many cases, however, the sexual products ripen before the medusoid bud has completed its development, in which case the bud remains attached to the colony in a more or less immature condition. In some instances the gonophore is a fully-formed medusa, which, however, never detaches itself from the colony, such a gonophore being called an attached medusa; in other cases development stops at an earlier stage, giving rise to a disguised medusa, in which all the essential parts of the medusa are present, but in an unexpanded condition; and, finally, development may go no further than the production of a hollow diverticulum of the body-wall of the parent known as a sporosac or sporophore.

It is worthy of notice that the free medusa in the course of its development passes through in succession the stages of sporosac, disguised medusa, and attached medusa; so that these latter may be regarded as due to arrested development of the medusa at an earlier or later stage. That this view is correct rather than one which would regard the sporosac, disguised medusa, and attached medusa as representing stages in the gradual progressive evolution of the free medusa, is evident from the consideration that the disguised medusa and attached medusa, which have all the parts of the free medusa fitting it for independent existence but never have an opportunity of employing them, could never have arisen by a process of natural selection from the sporosac, for the possession of a swimming bell that is never opened could clearly be of no advantage.

Hence the forms with free-swimming medusæ must be regarded as the most primitive, and those with attached or disguised medusæ, or with sporosacs, must be viewed as derived from these by abortion, more or less complete, of the various parts of the free medusa, such abortion being intimately associated with the early or premature ripening of the sexual products.

Weismann, in the work alluded to above, has shown that the genital cells may arise in parts other than those in which they are ultimately lodged, and indeed before the appearance of these latter, into which they migrate later on. In some cases this may be carried so far that the genital cells arise in the body-wall of the primary zooid not only before the commencement of the development of the gonophore, or sexual bud, but even before the first trace of the appearance of the branch on which the gonophore will be borne. A good example of this is afforded by the fresh-water genus Cordylophora, in which the ova arise in what Weismann calls the germinal zone of the primary zooid, then migrate into the lateral branch of the zooid when this is formed, and later on shift again into the gonophore which arises as an offset from this lateral branch.

The explanation of this curious migration is probably to be found, as Weismann suggests, in the advantage derived from commencing the development of the sexual products as early as possible. The development of the ovum, especially, is a long and complicated process, which in most animals is commenced at a very early date; in the highest mammals, for instance, the ovary contains either at or very shortly after the time of birth all the ova that will ever be developed in it. The development of spermatozoa is a more rapid and less elaborate process than that of ova, and we find accordingly that the date of their appearance is not thrown back so far as that of the ova. For instance, in Eudendrium the ova arise in the primary zooid before the appearance of the lateral branches; the male cells, however, are not formed till later, and appear first in the lateral branches, from which, like the ova, they migrate into the gonophores.

The suggestion I would make with regard to Hydra is that it represents one step further in the process of migration beyond the stage reached by Cordylophora or Eudendrium; *i.e.*, that in Hydra the genital products not only make their first appearance in the wall of the primary zooid, but remain and undergo their whole development in the same position, no lateral bud or gonophore being formed.

Weismann himself takes the direct opposite view that Hydra represents a primitive, and not, as I believe it to be, an extremely modified condition. He considers that in Hydra there has been no shifting of the place of origin of the sexual cells, but that Hydra represents in this respect the primitive and original condition.

In support of the contention that Hydra is a modified and not a primitive form, I would cite the following arguments :—

1. Hydra is hermaphrodite, being in this respect almost unique among Hydrozoa. There is not the slightest evidence for regarding a hermaphrodite condition as being primitive among Hydrozoa, and there is very strong reason for viewing it as secondary and acquired wherever it occurs in other groups of animals.

2. Hydra is fresh-water, differing in this respect from almost all other Hydrozoa. Fresh-water forms are in most cases derived from marine forms, and are very liable to undergo modifications in consequence of their change of habitat.

3. The structure of the ovary of Hydra shows it to be in a highly modified and not a primitive condition. Out of a large number of primitive ova only a single one ripens, the remainder serving merely to supply it with food. This is an entirely exceptional and much modified condition.

4. The other fresh-water genus, Cordylophora, is one in which the shifting has already taken place to a very great extent. It is a form which is believed to have only recently become fresh-water, and it would not require a very great amount of further modification to reduce it to the condition of Hydra.

5. The difference between the ovary of Hydra, which involves ectoderm only, and the gonophore of an ordinary Hydroid, which consists of both ectoderm and endoderm—a difference which is fatal to a comparison of the ovary of Hydra with a sporosac—becomes readily intelligible on the above theory.

Ordinary Meeting, February 10th, 1885.

Professor W. C. Williamson, LL.D., F.R.S., President, in the Chair.

Mr. J. A. Bennion, M.A., and Mr. A. Brothers were appointed Auditors of the Treasurer's Accounts.

"On some undescribed tracks of Invertebrate animals from the Carboniferous rocks, and on some inorganic phenomena, simulating plant remains, produced on tidal shores," by Professor W. C. Williamson, LL.D., F.R.S., President.

Professor Williamson's Memoir first contained descriptions and figures of a new form of Chrossocorda, which he named C. tuberculata, from the Yoredale rocks of Stonyhurst, in Lancashire, which genus has hitherto been found only in Palceozoic rocks of much older age than the Yoredale beds. Reciting the views of Schimper and others, who believe that the genus Chrossocorda represents some Fucoidal form of Palæozoic life, the author regards the various modifications of it as consisting of tracks of Marine animals, probably Crustaceans. He assigns the name of Chrossochorda tuberculata to that now described.

A second form of track, of a different type, was found by Mr. J. W. Davis, F.G.S., of Chevinedge, near Halifax. It consists of a line of curved footprints in groups of eight—four on each side—the successive groups varying from five-eighths of an inch to two inches apart from each other. The specimen described was found in a Quarry of Yoredale beds, near Hawes. The author assigns to it the name of Protichnites Davisi, after its discoverer.

Casts of two series of markings, produced by water, were exhibited and described. One of these series represented branching forms easily mistaken for Fucoidal remains. They were in reality casts, made in plaster of Paris, of remarkable drainage lines left by the retiring tide, on the sandbanks at Llanfairfechan, in N. Wales.

The second series consisted of allied objects, but in this case drainage lines had combined with ripple marks to produce an effect easily mistaken for the geometrically arranged scale-leaves of some Cycadean stem. These casts were obtained from sandbanks to the north of Barmouth.

The author called attention to the controversy bearing on these subjects still in progress, especially between Professor Nathorst and the Marquis of Saporta, and renewed an objection, recorded in more than one of his previous publications, to such anomalous objects as those in dispute being made use of, when attempting to frame, from Palceontological evidences, a pedigree of the vegetable world.

It was moved by the President, seconded by Dr. Bottomley, and resolved unanimously, That the thanks of the Society be given to Mr. Brothers for having presented to the Society photographic illustrations of the specimens discussed in the President's Memoir.

Ordinary Meeting, February 24th, 1885.

Professor W. C. Williamson, LL.D., F.R.S., President, in the Chair.

"On Unipolar Convolutes," by the Rev. H. London, M.A,

Let a string of fixed length be wrapped round a curve, and let the free end be fastened to a given point. If then the string be kept stretched by a pencil point dividing it into two segments, and if the string be unwrapped from the curve, the pencil point will describe another curve, which I call the Unipolar Convolute of the given curve.

In fig. 1 let VV′ be the given curve, O the fixed point, and PP′ the convolute. Then it follows that if

$$OP = r,\ \ PV = l,\ \text{and}\ VV' = d\sigma,\ \ dl + dr = d\sigma \quad \ldots\ldots\ldots\ldots\ 1$$

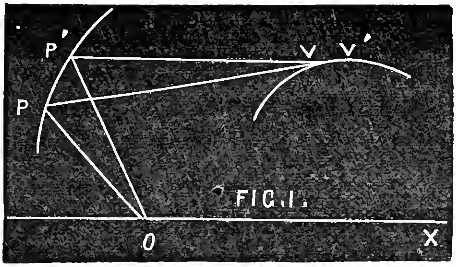


FIG. I.

Hence we get a geometrical method of describing the curve which, with a given radiant point shall produce a given caustic by reflexion.

All theorems respecting caustics are thus capable of a geometrical solution.

It has been noticed and is easily proved that if r, p be the coordinates of the curve (P), and ρ, π those of (V)

$$\sqrt{r^2 - \pi^2} + \sqrt{\rho^2 - \pi^2} = \frac{pr\dfrac{dr}{dp}}{2r - p\dfrac{dr}{dp}}$$

$$\text{and}\quad \pi = \frac{2p}{r}\sqrt{r^2 - p^2}$$

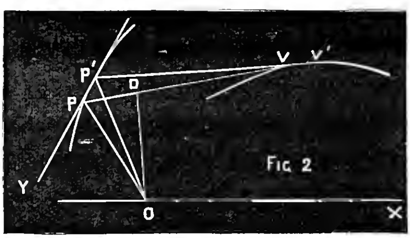


Fig 2

from which equations the convolute may sometimes be found. But, in order to remark the properties of the curve (P) with regard to (V), I have used pedal coordinates. Let the coordinates of P be (r, θ) as before and those of D be (π, ω).

It may be observed that the relation above remarked follows from regarding the curve (P) as the envelope of a family of ellipses, whose fixed focus is O, and whose instantaneous focus lies on the curve (V).

We get therefore the equation

$$r d\theta = l d\omega \qquad \ldots\ldots 2$$

Now
$$l = \frac{d\pi}{d\omega} + \sqrt{r^2 - \pi^2} \qquad \ldots\ldots 3$$

therefore
$$\frac{dl}{d\omega} = \frac{d^2\pi}{d\omega^2} + \frac{1}{\sqrt{r^2-\pi^2}}\left\{r\frac{dr}{d\omega} - \pi\frac{d\pi}{d\omega}\right\}$$

but from equation 1

$$\frac{dl}{d\omega} = \frac{\delta\sigma}{d\omega} - \frac{dr}{d\omega} = \pi + \frac{d^2\pi}{d\omega^2} - \frac{dr}{d\omega} \qquad \ldots\ldots 4$$

hence from 3 and 4

$$\left(\pi - \frac{dr}{d\omega}\right)\sqrt{r^2-\pi^2} = r\frac{dr}{d\omega} - \pi\frac{d\pi}{d\omega}$$

$$\therefore \frac{dr}{d\omega}\left\{r + \sqrt{r^2-\pi^2}\right\} = \pi\left\{\frac{d\pi}{d\omega} + \sqrt{r^2-\pi^2}\right\} \qquad \ldots\ldots 5$$

also
$$\theta - \omega = \cos^{-1}\frac{\pi}{r} \qquad \ldots\ldots 6$$

Hence if the equation to the curve (V) be $\pi = f(\omega)$, we can from equations 5 and 6 completely determine the equation to the convolute. It is evident that equation 5 can be put in the form

$$r + \sqrt{r^2-\pi^2} = \int \pi \delta\omega \qquad \ldots\ldots 7$$

The equation of the Unipolar Convolute also admits of a simple solution whenever that of the Involute is known.

For in fig. 3 if Q, Q′ be the images of O with regard to the tangents to the Convolute at P, P′ and if OZ the perpendicular on QQ′ be equal to p, then the locus of Q is an involute of the curve V.

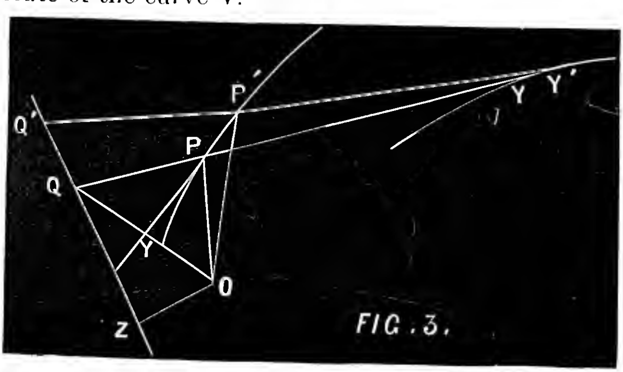


FIG. 3.

Also $\pi = \frac{dp}{d\omega}$ and $p = r + \sqrt{r^2 - \pi^2}$ $\therefore$ $2pr = \pi^2 + p^2$......8

Again if OZ make an angle χ with the prime vector, equation 6 becomes

$$r\sin(\theta - \chi) = \frac{dp}{d\chi} \quad \text{.................................. 9}$$

Hence to determine the Convolute we have

$$\left.\begin{aligned} 2pr &= p^2 + \left(\frac{dp}{d\chi}\right)^2 \\ r\sin(\theta - \chi) &= \frac{dp}{d\chi} \end{aligned}\right\} \quad \text{............................ 10}$$

From the above it is evident that the convolute is similar to and half the dimensions of the inverse pedal of the involute of any curve. It has also been noticed by Rev. J. T. Ward, Fellow and Tutor of St. John's College, Cambridge, that the radius of curvature at any point of a convolute, whether unipolar or not, is independent of the curvatures of the curve or curves from which it is derived.

From equation 10 it is easily proved that if any curve have an involute of the form

$$r^m = a^m \sec m\theta$$

then its unipolar convolute is a curve of the same class and of degree n where

$$n = \frac{m}{2m + 1}.$$

Also that if the involute of any curve be of the form

$$f(p, r) = 0$$

where f is a homogeneous function, then the unipolar convolute is a similar curve of half the linear dimensions.

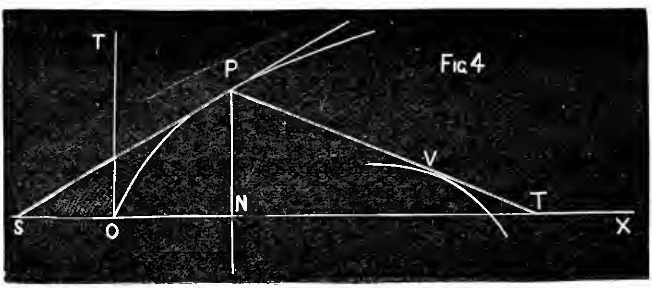
The theory of convolutes leads not only to a geometrical representation of the curves which will produce a given caustic by reflexion, but applies equally to the case of refracted rays. But the details which are based upon the construction of Cartesian Ovals, would become too cumbersome for practical application save for a few most simple values of the refractive index.

From what has been said, however, it may be suggested that the theory enables us by a simple construction to pass from any one system of radiant energy to any other system. For if the wave fronts of these respective systems be taken and if the derived surfaces of these systems be used as generators of a convolute surface, then the transition from one wave system to the other can be effected by means of the surface so described.

It follows that the radiant energy which is dissipated in the first system will be conserved in the second, and conversely, so that the two systems are finitely interdependent.

The case in which one of the generating curves is at an infinite distance is peculiar, and again leads to a construction for the convolute.

Let PN (fig. 4) be the direction of the parallel rays, and Ox, Oy axes.



Let V be (xy), P $(\xi\eta)$ and $\angle PTx = \psi$, $\angle PSx = \phi$

then $$y - \eta = (x - \xi)\tan\psi \qquad \ldots 11$$

$$\frac{d\eta}{d\xi} = \tan\phi = \frac{1 + \tan\frac{\psi}{2}}{1 - \tan\frac{\psi}{2}} \qquad \ldots 12$$

Eliminating y and η from equations 11 and 12

$$\frac{d\xi}{d\psi} - \xi\sec\psi = -x\sec\psi \qquad \ldots 13$$

$$\therefore \xi = e^{\int\sec\psi d\psi}\left(-\int e^{-\int\sec\psi d\psi} x\sec\psi d\psi + c\right)$$

If the constant be zero we have

$$\xi - x = -(\sec\psi + \tan\psi)\int(\sec\psi - \tan\psi)dx \ldots\ldots 14$$

from which, with equation 11 if x is known as a function of ψ the equation to the convolute can always be found.

Again, from equation 14

$$x - \xi = \frac{s - y}{s' - y'},$$

where the dashes are differentials with regard to x, and where s is measured along the curve (V). And if $PV = \lambda$ we obtain from this last equation

$$\lambda + \eta = s \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 15$$

Hence supposing N the free end of the string to be fastened to a ring which can slide along Ox, we obtain a geometrical construction for the convolute in this case also.

MICROSCOPICAL AND NATURAL HISTORY SECTION.

January 19, 1885.

Dr. ALCOCK, President of the Section, in the chair.

Mr. HYDE showed specimens of the wings of the following insects, mounted dry between glass-plates, for the purpose of exhibition in the magic lantern.

1. Dragon Fly.
2. Grasshopper.
3. Ditiscus Marginalis.

He also showed some interesting drawings of insects on ground glass for the magic lantern.

The PRESIDENT exhibited some specimens of Everlasting flowers, and made some remarks upon them.

Mr. ROGERS made some remarks in continuance of a previous communication made by him to the Society. 'On some observations made by his son during the years 1882 and 1883 on the absence of the earthworm on the prairies which lay along the track of the Canadian Pacific Railway between Winnepeg and East of the summit of the Rocky Mountains.' His son having resided during the year 1884 West of the Rockies (Vancouver's Island) had continued his enquiries and observations amongst the farms and older inhabitants in the neighbourhood of Corvichan, an agricultural district, and in some part an Indian reservation, about 40 miles from Victoria, which resulted in the general belief that no earthworms existed there up to that time. But during his occupation of road making near his own farm, he himself had found two specimens, which he exhibited at the time, much to the surprise of his more immediate neighbours.

Ordinary Meeting, March 10th, 1885.

Professor W. C. WILLIAMSON, LL.D., F.R.S., President, in the Chair.

"On making Sea Water Potable," by THOMAS KAY, President of the Stockport Natural History Society. Communicated by F. J. FARADAY, F.L.S.

The author called attention to the absence of research in this direction, and how man, endowed to overcome every physical disability which encompassed him on land, was powerless to live on the wide ocean, although it is teeming with life.

The water for experiment was taken from the English Channel about 50 miles south-west of the Eddystone Lighthouse, and it was found to correspond closely with the analysis of the Atlantic, published by Roscoe, viz. :—total solids 35·976 of which the total chlorides are 32·730, representing 19·868 of chlorine.

The waters of the Irish Sea and the English Channel nearer to the German Ocean, from their neighbourhood to great rivers are weaker than the above.

Schweitzer's analysis of the waters of the English Channel, near Brighton, was taken as representing the composition of the sea, and is here given :—

Sodium Chloride	27·059
Potassium ,,	0·766
Magnesium ,,	3·666
,, Bromide	0·029
,, Sulphate	2·296
Calcium ,,	1·406
,, Carbonate	0·033
Iodine and Ammoniacal Salts—traces	... ...
Water	964·795
	1000·000

The Chlorides in the Irish Sea are about 30 per mille.
„ English Channel „ 31 „ „
„ beyond the Eddystone are 32 „ „

As the requirement for a potable sea water does not arise except in mid-ocean, the proportion of 32· per mille. must be taken as the basis of calculation.

This represents as near 20· per mille. of Chlorine as possible.

From the analysis shown it will be perceived that the Chlorides of Sodium and Magnesium are in great preponderance.

It is to the former of these that the baneful effects of sea-water when drunk, are to be ascribed, for Chloride of Sodium or common salt produces thirst, probably by its styptic action on the salivary glands, and scurvy by its deleterious action of the blood when taken in excess.

Sodium Chloride being the principal noxious element in sea-water, and Soda in combination with a vegetable or organic acid, such as Citric Acid, Tartario Acid, or Malic Acid, being innocuous; the conclusion is that the element of evil to be voided, is *Chlorine.*

After describing various experiments and calling attention to the power of earthy matters in abstracting salts from solutions by which he hoped the process would be perfected; an Imperial pint of water from beyond the Eddystone was shown mixed with 960 grains of Citrate of Silver and 4 grains of free Citric Acid.

Each part of the Chlorides requires three parts by weight of the Silver Citrate to throw down the Chlorine, thus—

$$3\,NaCl + Ag_3C_6H_5O_7 = Na3.\ C_6H_5O_7 + 3Ag.Cl.$$

The Silver Chloride formed a dense insoluble precipitate, and the supernatant fluid was decanted and filtered through a rubber tube and handed round as a beverage.

It contained in each fluid ounce by calculation about

18	grains of	Citrate of	Soda
$1\frac{1}{2}$	„	„	Magnesia
$\frac{1}{2}$	„	„	Potash
1	„	Sulphate of	Magnesia
$\frac{1}{2}$	„	„	Lime
$\frac{1}{5}$	„	Citric Acid	

with less than half a grain of undecomposed Chlorides.

To analyse this liquid therapeutically, it may be broadly stated that Salts of Potash are *diuretic*, Salts of Magnesia *aperient*, and Salts of Soda *neutral*, except in excessive doses or in combination with acids of varying medicinal action, thus, Soda in Nitric Acid, Nitrate of Soda is a *diuretic*, following the law of Nitrates as Nitrate of Potash, a most powerful diuretic, Nitrous Æther, &c. &c.; whilst Soda in combination with Sulphuric Acid as Sulphate of Soda is *aperient*, following the law of Sulphates which increase aperient action, as in Sulphate of Magnesia, &c.

Thus it would seem that Soda holds the scales evenly between Potash and Magnesia in this medical sense and that it is weighted, so to speak, on either side by the kind of mineral acid with which it may be combined.

With non-poisonous vegetable acids, and these slightly in excess, there is not such an effect produced.

Sodium is an important constituent of the human body, and Citric Acid, from its carbon almost a food. Although no one would advocate saline drinks in excess, yet, under especial circumstances, the solution of it in the form of Citrate can hardly be hurtful when used to moisten the throat and tongue, for it will never be used under circumstances where it can be taken in large quantities.

In the converted sea-water the bulk of the solids is composed of inert Citrate of Soda. There is a little Citrate of Potash which is a feeble diuretic; a little Citrate and Sulphate of Magnesia, a slight aperient, corrected however by the constipatory half grain of Sulphate of Lime; so that the whole practically is inoperative.

The combination of these salts in nature's proportions would seem to indicate that they must be the best for administration in those ailments to which their use would be beneficial.

Citrate of Silver is an almost insoluble salt, and requires to be kept from the light, air, and organic matter, it being very easily decomposed.

A stoppered bottle covered with india-rubber was exhibited as indicating a suitable preserver of the salt as it affords protection against light, air, and breakage.

As one ounce of Silver Citrate will convert half a pint of sea-water into a drinkable fluid, and a man can keep alive upon it a day, then seven ounces of it will keep him a week, and so on, it may not unreasonably be hoped, in proportion.

It is proposed to pack the Silver Citrate in hermetically sealed rubber covered bottles or tubes, to be inserted under the canisters or thwarts of the life-boats in ocean going vessels, and this can be done at a simple interest on the first outlay, without any loss by depreciation, as it will always be worth its cost, and be invaluable in case of need.

MICROSCOPICAL AND NATURAL HISTORY SECTION.

February 16th, 1885.

THOMAS ALCOCK, M.D., President of the Section, in the Chair.

The following gentlemen were elected Associates of the Section:—

JOHN B. PETTIGREW, Esq., of Didsbury.

FRANK A. HUET, Esq., L.D.S., R.C.S., Eng., of Bloomsbury, Oxford Road.

JOHN SMITH, Esq., M.R.C.S., Eng., of 28, Chorlton Road.

WILLIAM BLACKBURN, Esq., F.R.M.S., of Woodlands, Chorlton-cum-Hardy.

H. G. BROOKE, Esq., B.A., M.B., Lond., of 189, High Street, C.-on-M.

Referring to the paper on *Pulex Penetrans* formerly read by him, Mr. BOYD also drew attention to two papers on the Chigoe, or Jigger: *Pulex Penetrans* in the same magazine, one by Waterton, the other a translation from Pohl and Kollar's work, "Brasiliens vorzüglich lästige Insecten," which give good descriptions of the ravages of these little pests, but do not enter fully into anatomical details.

Mr. Boyd showed under the microscope specimens of this insect, and dissections of its oral appendages.

Mr. J. COSMO MELVILL, M.A., F.L.S., read a paper entitled, "A proposed revision of the species and varieties of the subgenus Cylinder (Montfort) of Conus (L.)."

After briefly enumerating the chief characteristics of the large assemblage of Mollusca included in the genus Conus, containing from 450 to 500 species, he pointed out that the subgenus under discussion corresponded with the 17th and last Section "Texti," of Weinkauff's classification of the genus—adopted in the latest issued monograph, by Mr. G. W. Tryon, Junr., of Philadelphia, in his "Manual of Conchology," 1884.

He illustrated his paper with specimens from his collection, which exhibited 35 of the 39 described forms. He proposed that these should be divided into five groups, as follows:—CONUS (L.) § subg: CYLINDER (Montfort).

I. Textilia.

Vera.

C. textile (L.).

Variety 1. tigrinus (Sowb.).
,, 2. vicarius (Lam.).
,, 3. verriculum (Reeve).
,, 4. concatenatus (Sowb.).
,, 5. canonicus (Hwass).
,, 6. scriptus (Sowb.).
,, 7. condensus (Sowb.).
,, 8. telatus (Reeve).
,, 9. Dalli (Stearns).
,, 10. Corbula (Reeve).
,, 11. euetrios (Sowb. and Melvill).

b) *Abbates.*

C. abbas (Hwass).
C. panniculus (Lam.).
Var. 1. textilinus (Kiener).
C. Victoriæ (Reeve).
Var. 1. complanatus (Sowb.).

(c) *Pyramidalia.*

C. pyramidalis (Lam.).
Var. 1. convolutus (Sowb.).
C. gloria maris (Chem.).
C. Paulucciæ (Sowb.).
C. Prevostianus (Sowb.).

II. Retiferi.

C. retifer (Lam.) only species = solidus (Sowb.).

III. Lucidi.

C. lucidus (Mawe) only species [= reticulatus (Auct)].

IV. Aulici.

(*a*) *Crocati.*

C. crocatus (Lam.).
C. racemosus (Sowb.).
C. colubrinus (Lam.).

(*b*) *Episcopi.*

C. Elizæ (Kiener).
C. prælatus (Hwass).
C. magnificus (Reeve).
C. episcopus (Hwass).
Var. 1. Rubiginosus (Hwass).
,, 2. Pennaceus (Born).
C. Omaria (Hwass).
C. Aulicus (L.).
Var. 1. auratus (Lam.).

V. Aurei.

C. aureus (Brug).
C. clavus (L.).

He next gave details of the geographical distribution, and differentiated the various species and forms.

Among the specimens exhibited, was one of that most highly esteemed of known shells, *Conus gloria maris* (Chemnitz), which he provisionally classed under Textilia Pyramidalia, but at the same time there can be no doubt but that it stands by itself, as the result of the highest effort of evolution in its own particular sphere. He gave a history of what is known of its discovery; first being heard of about 1750, it was not till 1788 that it was described by Chemnitz. There are at present 11 specimens certainly known to exist, besides one which is reported from Amsterdam, and requires confirmation. Five are in this country, three of which are in the National collection at South Kensington. France, Italy, Belgium, and Portugal each possess one, and two others are located in New York and Melbourne museums respectively. Of these, not more than one-half are in good condition. Jacna, Island of Bohol, Philippine Islands, is the locality whence the late Mr. Hugh Cuming, in 1838, procured two specimens, one immature, but no example has been procured since, excepting one poor dead shell by Mr. Carl

Bock, in 1879, and it is surmised by those who have studied the subject most thoroughly that the race is now exhausted, and doomed to extinction in all probability.

The PRESIDENT made some remarks on the growth of Everlasting Flowers in the neighbourhood of Manchester, illustrated by five common Australian species, namely, *Ammobium alatum, Helichrysum braceatum* and *Helipterum Manglesii, roseum* and *corymbiflorum.*

He said the summer of 1884 was unusally favourable to the growth and perfection of these flowers. The flower-heads were continually visited by crowds of winged insects of various kinds, which evidently found some strong attraction in the bracts of the involucre rather than in the florets; the insects were hive-bees, several specimens of wasp, drone flies, hoverers, ichneumon flies, house-flies, and others, and late in the season large numbers of gay butterflies, and these were constantly present. The hygrometric properties of the bracts were noticed in all the species, the flower-head immediately closing on the commencement of rain, and it was especially remarkable in *Helipterum roseum* from the fact that the part affected by damp was at the line of junction of the petal-like lamina with the claw at the base. It was shown that the dry bracts of the expanded flower-head of this species when damped, merely by being breathed upon, immediately turn up as if on a hinge, and the united action of all the bracts is to form a perfect conical tent over the central florets. It was concluded that the use of the involucre is evidently to protect the florets from damp, and it might be a subject for reflection why such a special contrivance should be required by plants inhabiting a country whose summer climate is so dry as that of Australia; and it would not seem unreasonable to suppose that these plants could not possibly be cultivated in the open air in this country where, on the contrary, the weather is so constantly unsettled.

The plants, however, grew here with remarkable vigour, and considerably exceeded the size attained in their native country. This was especially the case with *Helichrysum bracteatum*, and from a large proportion of these plants having flower-heads of the original wild form or only slightly altered, it was inferred that they were the produce of a recent importation of seed.

Mr. SINGTON made the following remarks with respect to a specimen he exhibited of Mineral deposit, occurring at Windy Knoll, near Castleton.

This deposit is exposed on the top of a small isolated hill, in the face of a quarry, near Castleton. It is specially noticeable on account of the peculiarity of its position and its chemical constitution, which has not, as yet, been definitely ascertained. There are specimens in the mineralogical museums of several Continental Universities. The entire deposit occupies a space of about one cubic yard, in a slight hollow on the hill top, filled up with fragments of limestone and quartz, the spaces between which are occupied with the mineral. When freed by means of benzine from the impurities with which it is mixed, it is found to consist of a bright yellow jelly-like body. The limestone in contact with it has been saturated with the mineral, and has been changed to a black colour; they can be separated by boiling in a suitable solvent. Quartz is not affected by the mineral. It is insoluble in water.

MICROSCOPICAL AND NATURAL HISTORY SECTION.

March 16th, 1885.

THOMAS ALCOCK, M.D., President of the Section, in the Chair.

"On the breeding of the Reed Warbler, *acrocephalus arundinaceus*, in Cheshire," by FRANCIS NICHOLSON, F.Z.S.

In the February number of the "Naturalist," there appeared a letter from Mr. Chas. Oldham, of Sale, Cheshire, in which he announced that on the 29th of May last, when searching in company with Mr. T. A. Coward, of Bowdon, for the eggs of the Sedge Warbler (*acrocephalus phragmitis*), among the reedy margins of Pickmere, near Northwich, he was agreeably surprised to find a nest of the Reed Warbler, suspended on the reeds, and containing four eggs, &c. An editorial note follows, saying that this is the most north-westerly locality in which this species has been known to breed in Britain, although it breeds regularly in Eastern England, annually, as far north as mid Yorkshire.

Mr. Nicholson showed that although it has not been recorded to have nested, it has been known to him and most of our local Ornithologists that it does so regularly on most of the Cheshire meres that are suited to its habits. The nest, as elsewhere, is fixed usually to three or four reed stems, of the common English reed, *Phragmitis communis*, and is one of the most beautiful of those of our British birds. It is composed of slender blades of grass, interwoven with reed tops, and is a deep and solid structure. The eggs cannot easily roll out, and though the nest may be blown to the surface of the water, the old and young ride as securely in their cradle as a sailor does in his hammock.

Mr. Nicholson also drew the attention of the members to the nearest ally of the Reed Warbler, viz., the marsh warbler, *Acrocephalus palustris*, which Mr. Seebohm says, in his history of British birds, must now be admitted to be a regular, though local summer visitor to the south of England. The two species differ considerably in their song, habits, eggs, and distribution; the prepared skins are almost impossible to distinguish, unless just after the moult, when the rump of the Reed Warbler is russet-brown, and the same part in the Marsh Warbler is olive-brown. Mr. Nicholson was at some trouble a few years ago to snare a number, with the result that he is pretty certain that it does not occur in Cheshire, though it would be well for those who have the opportunity to be on the look-out for the species.

"On Lagena crenata," by Dr. ALCOCK, President.

The publication of the important Report on Foraminifera obtained from dredgings off Dublin, by Mr. Joseph Wright, and the fact that my specimen of *Lagena crenata* has been honoured by having a place assigned to it among the beautiful illustrations to the Report, has induced me to exhibit my specimen of this comparatively rare variety to the meeting.

The reason for its admission was that the Dublin dredgings yielded only one specimen, which was unfortunately less perfectly developed than the Dog's Bay example, and this, being also from the Irish coast, was admitted in order to show the perfect form of the variety.

Lagena crenata occurs as a fossil in the Middle Tertiaries of Bordeaux and Malaga, and was first recorded and described as recent by Messrs. Parker and Jones in the Philosophical Transactions of 1865. They describe it as "decanter-shaped, neck long and coiled; body gradually widening and smooth at the base, which for half its radius is widely and deeply crenate with broad radiating furrows; the centre of the base being smooth and gently convex." Length about $\frac{1}{50}$-inch.

This variety is described by Messrs. Parker and Jones, from shore-sand obtained at Swan River, Western Australia. I found my specimen in the same year, 1865, and recognised it at once from their figure and description, then just published. At that time I believe my specimen and theirs were the only recent examples which had been met with, and it is curious to notice that they occurred at opposite sides of the globe, giving promise of the very wide distribution which this remarkable and beautiful form of Lagena has since been found to have.

In the Challenger Report, Mr. Brady says, "*Lagena crenata* is a somewhat rare form, and though it has been found in a considerable number of localities, it is nowhere abundant. The distribution list includes several points in the British seas, at depths of less than 60 fathoms; the North Atlantic, west of Ireland, 183 fathoms; the Cape of Good Hope, 15 to 20 fathoms; Australia shore-sands; Bass Strait, 38 fathoms; and three stations in deep water in the South Pacific, from 2,325 to 2,425 fathoms." To these localities, Mr. Wright adds off Corfu 36 fathoms, a lovely specimen obtained.

With regard to the scarcity of this variety, I may say that during the twenty years which have passed since my specimen was found, extremely few have been met with in British seas, although dredging has been carried on so persistently all round our coasts; I believe in fact that the whole number could still almost be counted on the fingers of one hand. The exact record, according to Mr. Wright, is as follows:

"It was obtained by Mr. Brady either off Shetland or Hebrides, but I cannot, he says, at the moment lay my hands on the note I had from him in reference to the find. It was also got by the late Edward Waller, off Valentia, Ireland, in dredgings taken in the late Dr. Jeffrey's yacht. Waller did not live to publish the result of these gatherings, although some three years were spent at the work. Three plates were drawn by Wild, in one of these he figured three forms of *Crenata*, each differing somewhat in shape, but all referable to the one species."

Your find, he says, off Dog's Bay, and mine off Dublin, complete the list of British examples.

The apparently world-wide distribution of this form of Lagena, considered in conjunction with the fewness of the specimens obtained from each known locality, is a singular fact which must admit of some explanation, though what that explanation may be, I am not sure that I can offer even a probable conjecture. Some forms of Lagena, where they are present at all, are to be found in abundance, such as *Lagena striata, costata* and *clavata*. Others are less common, but still are usually found in tolerable plenty; while *Lagena crenata* is said to be everywhere scarce, though its form is so remarkable that it could not be overlooked by anyone searching a sample of marine deposit, and therefore I conclude its variety must be admitted.

Can it be supposed that the sarcode which forms a test of this particular shape is distributed in only small quantity, and yet so widely over the sea-bed; or might it not seem easier to believe that all the sarcode which assumes a flask-shape, that is all the varieties of Lagena, may take the form of any of the varieties and all of them in succession, though some shapes are more frequently assumed than others?

According to this view the forms are interchangeable in successive generations, the forms taken depending possibly on varying external and internal conditions.

"The Post-Glacial Shell Beds, at Uddevalla, Sweden," by MARK STIRRUP, F.G.S.

During a tour that I made last summer through parts of Sweden and Norway, I took the opportunity of visiting the little town of Uddevalla, some 65 miles (by railway) north of Gothenburg in Southern Sweden.

The steps of wandering naturalists and geologists have been long drawn to this spot, since Linnæus, some century and a-half ago, drew attention to it in an account he published of a journey in this part of Sweden.

Its attractions are the immense accumulations of fossil marine shells and barnacles which are found massed against its hills all over the district, at heights from 50 to 200 feet or more above the level of the sea, and of which we find mention made in almost every treatise on the science of Geology.

The great interest which attaches to these deposits is not only the evidence they afford of the character and geographical distribution of a recent marine fauna, but they have supplied undeniable proofs of the oscillation of land areas, changes of relative level of land and sea, at a period, geologically of yesterday.

From the inquiries and researches of Swedish geologists and the late Sir Charles Lyell, we learn that this terrestrial movement is still going on in various parts of Scandinavia.

Although our society has had the benefit of a previous and valuable communication on these shell deposits from Mr. R. D. Darbishire in 1876, I thought it would not be inadmissible to give the result of my collection and observation, as great inroads and destruction of the principal deposits at Kapellbackar have, in recent years, been taking place.

The town of Uddevalla, situated at the head of a small and narrow fjord, lies in a basin-shaped depression almost surrounded by hills: it is in the valleys and ravines among these hills, that the shell deposits are found.

As my time in the neighbourhood was limited, I visited only two of them. The first and most considerable one is at Kappelbackar, about one mile south of the town; after you have left the town and begin to ascend the winding road up the hill, you see signs of the shells on both sides of the road filling up the ravine. The roads are, in fact, repaired with the shells, and a promenade has lately been laid out and planted with trees, which has caused the destruction of some of these shell heaps. The ravine is entirely filled up with shells to a depth varying from about 20 to 30 feet. At the bottom of the ravine runs a small stream; upon its bank, behind some cottages, I saw a small pit had been scooped out in a bed of dark blue clay or silt, this underlies the mass of shells, and I believe is continued under the town of Uddevalla, and probably occupies the bottom of many of the valleys near the coast, as the same kind of clay is said to be now forming in the fjords in proximity to the land. I did not get any clear section of the whole depth, as, when standing by the stream at the bottom of the ravine, the bank was obscured by talus and alterations of the road.

Dr. Jeffreys, in his paper on these deposits read before the British Association in 1863, speaks of, lying upon this clay, "a bed of sandy gravel with rolled stones or pebbles, containing *Mytilus Edulis* and a small form of *Saxicava arctica*. This bed was about six inches deep, and resembled a raised beach." This bed I was not able to detect.

My specimens were collected, for the most part, from the uppermost layer of those closely compacted heaps which line the road as it crosses the top of the hill.

The most prominent and abundant shells are those of *Mya truncata* var. *Uddevalensis* and *Saxicava rugosa* *(arctica)* with these are mixed enormous numbers of the detached valves of the giant barnacle, *Balanus Hameri.*

The extensive accumulations of shells at Kapellbackar differ in constitution from that of ordinary "raised beaches" where the shells are dispersed through beds of sand and gravel; here they seem to have been heaped and collected together in a bay among the rocks, by the action of marine currents, without being buried in sand or shingle.

The shells are often filled with a fine earthy clay, in which fragments of broken shells, etc., are largely mixed, but the clay seems as much like a wash from the land as a marine deposit.

That these mollusks and barnacles lived and flourished close to where they are now found, is shown by the frequent finding of the two valves, of some of the conchifera, closed and in juxtaposition; this statement is more clearly proved in the case of the barnacles, as their basal plates have been found attached to the rocks against which these deposits are heaped. This circumstance is mentioned by Alexander Brogniart in the early part of the present century; he reports, having found near the top of the hill, and a little above the heaps of shells, several balani still adherent to the rock.

Balanus Hameri is said to be an inhabitant of deep water, therefore the proof is furnished that the sea once covered the tops of these hills, and that they remained submerged at a depth, and for a period sufficiently long, to permit of countless generations of these balani to live and contribute their calcareous shields to the heaps we have described.

The time required for these operations must be counted by centuries of years if we attempt to estimate the time it would take to amass these extensive deposits, which have been despoiled from time immemorial for reducing into lime, road mending, and other purposes.

The species are the same, for the most part, as those now inhabiting the adjacent ocean, with the exception of *Pecten Islandicus*, which is said not now to exist on the Swedish coast or further south than Trondjhem in Norway. They are arctic in their general facies, and though from their position above the glacial beds, they must undoubtedly be classed as post-glacial, and marking the close of the extreme glacial conditions on the land, yet the temperature of the sea could have been but slightly diminished from that of the previously more arctic conditions.

The other locality that I visited, Lilla Herrstahagen, lies about one mile *east* of Uddevalla. Though so short a distance separates these two deposits, the molluscan fauna differs in several particulars, but whether that difference has been due to the character of the shore, or whether the deposit is of a later age, is somewhat difficult to decide.

This deposit is but of small dimensions when compared with that of Kapellbackar. It nestles among the rocks at some short distance from the road across some tilled land, and it has been disclosed, apparently by the working of a bed of sand and gravel which underlies the shell deposit.

The shell bearing stratum is the uppermost, and of about 7 or 8 feet in thickness; the underlying beds, which are unfossiliferous, are composed of about 3 feet of rough pebbly sand with rounded stones, and a thick sand-bed, showing current bedding, the full depth of which has not been laid bare; the whole depth of the section being about 25 feet.

The shell bearing deposit consists mainly of the broken and rotten shells of *Mytilus edulis*, but these have not that thickened or distorted form which is seen at Kapellbackar; shells which occur frequently at the latter place are conspicously absent here, such are *Astarte borealis, Tellina* *calcarea, Pecten Islandicus*; on the other hand, I collected species here of which I did not find any representatives at Kapellbackar, viz.: *Ostrea edulis, Lucina borealis, Cardium edule,* and *Nassa reticulata,* with these were *Trophon clathratus,* which Dr. Gwyn Jeffreys describes as a high northern species, and found living only within the arctic circle.

Dr. Jeffreys records from this deposit some species which I did not meet with there, viz.: *Tapes pullastra, Corbula gibba,* and *Aporrhais pes-pelecani,* which he says, with the *Ostrea edulis,* "are shells of rather a southern type." Now one of these species, *Aporrhais pes-pelecani,* which Dr. Jeffreys considered absent from Kapellbackar, I was successful in finding there.

This mixing up of species of a southern type with those of an undoubted arctic or boreal type, is somewhat difficult of explanation. Some of these apparent anomalies may be ascribed to our ignorance of the extent of the range of some of these mollusks in our present seas, or this influx of southern types may be due to changes in the sea bed, currents of warmer water finding their way northwards, bringing with them denizens of a more southern latitude.

Whatever may be the interpretation of these difficulties, we may be certain that these immense heaps of fossil shells are the result of slow growth and accumulation, during which many changes of elevation and depression of the coast line have taken place.

That these shells indicate colder climatal conditions than those now prevailing on the coasts of Southern Sweden, is proved by the absence of the large *Pecten Islandicus* from the neighbouring sea, and most of them are at present inhabitants of the Arctic Ocean, and have been dredged from the Greenland and Spitzbergen waters.

Many of them are also common shells in our glacial clays of the Clyde and other localities in Scotland, where they are often of larger size than in the post-glacial deposits of Sweden.

That a similar marine fauna lived in the Polar Sea, when that sea was more extensive than now, and covered lands that now form the northern coast of Siberia, is demonstrated by the explorations of Nordenskiöld in the "Voyage of the Vega."

In the upper earthy layer of the *tundra*, on the banks of the Yenisej, he discovered numerous species of shells, some of which are common species in the Uddevalla beds, as *Mya truncata* var. *Uddevalensis*, *Tellina lata*, *Trichotropis borealis*, and *Natica helicoides*.

Before concluding, it may not be uninteresting to record the plants seen and gathered on the rocky knoll near the last deposit, on 21st March, 1884. They are all common British plants, except the *Hepatica triloba*, which is not an inhabitant of the British Isles.

The Sloe, *Prunus spinoza*, was in flower; the rock was gay with the numerous white blooms of *Saxifraga granulata*—the following were also in flower: *Anemone nemorosa*, *A. hepatica*, L. *(Hepatica triloba)*, *Orobus tuberosus*, *Sedum acre*, *Leontodon taraxacum*, a large lilac flowered *Viola (canina?)*, *Viola tricolor*, *Convallaria majalis* (not yet in flower); and in the meadows below grew the *Caltha palustris* with large corolla.

In the following list of Uddevalla fossils, which have been kindly identified for me by R. D. Darbishire, Esq. (the result of one day's visit), I have, for the sake of convenience, made use of the nomenclature and the synonymic list of the late Dr. J. Gwyn Jeffreys, published in the Report of the British Association for the Advancement of Science, for 1863.

	Localities.		Remarks.
	Kapell-backar.	Lilla Herrs-tehagen.	
Ostrea edulis..........		×	One valve.
Pecten Islandicus......	×		Pleutiful. Colour well preserved in some specimens.
Mytilus edulis	×	×	Colour well preserved in some. A distorted form occurs largely at Kapellbacker, the lower margin being much thickened and turned inwards, owing probably to its living in crevices of the rocks.
Modiola modiolus.. ...		×	Fragment.
Leda arctica	×		One valve and fragment.
Lucina borealis		×	Plentiful.
Cardium edule		×	Rather rare.
Cyprina Islandica ...	×		Fragment.
Astarte sulcata .. .. (var. elliptica)	×	×	Plentiful.
—— compressa	×		Plentiful.
—— borealis	×		Abundant.
Tellina calcarea..... ...	×		
—— Balthica	×	×	
Mya truncata .... (var. Uddevalensis)	×	×	Very abundant at Kapellbackar.
Saxicava arctica	×	×	Ditto.
Pholas crispata	×		Fragment.
Lepeta cæca	×		One specimen.
Littorina litorea	×	×	
Natica affinis...........	×	×	
—— Islandica .... (N. helicoides, *Johnston.*)	×		Rare. One specimen.
Aporrhais pes-pelecani	×		Two specimens.
Buccinum undatum ...	×	×	Plentiful.
Trophon clathratus ...	×	×	Plentiful.
—— Truncatus......... (M. bamffius)	×		Rather rare.
Fusus antiquus	×		Fragment.
—— latericeus, *Möll.*.	×		Rather rare.
Nassa reticulata		×	
Cirripedia.			
Balanus Hameri	×	×	Very abundant at Kapellbackar
—— porcatus...........	×		
Echinoderm.			
Fragments of Spines			

CORRIGENDA.

Page 27, line 17: For Ferious Oxide read Ferrous Hydrate.

" " " 19: For Ferrous read Ferric.

Ordinary Meeting, March 24th, 1885.

Professor W. C. Williamson LL.D., F.R.S., President, in the Chair.

"On Peculiar Ice Forms," by Arthur Wm. Waters, F.G.S.

In "Nature," November the 6th of last year, some "Peculiar ice forms" were described by Mr. W. Woodd Smith who found "a bare slope almost covered with a coating of ice nearly four inches in depth, and of very curious structure, being formed in four layers ..... Each layer was composed of an aggregation of filaments or elongated crystals, one-sixteenth of an inch and downwards in diameter, and all of a length equal to the thickness of the layer ranged side by side like organ-pipes or basaltic columns and with pyramidal ends."

Mr. Smith says that "the mass had evidently been pushed up from below," and my observations here certainly leave no doubt in my mind that this is correct.

In the correspondence* which followed one observer thought that "they were mainly due to the prolonged condensation of aqueous vapour from the air;" another authority considered that "the separate layers of ice may possibly be the small remains of four separate and distinct snow storms piled one above the other," and he thinks that this snow has been converted into ice and assumed the basaltic form.

* Since this paper was read an interesting letter from Professor Mc.Gee has appeared in "Nature," March 26th, giving references to a series of letters to which I found no necessity to allude, and in the communication the subject is dealt with from a different standpoint to the one I had in view.

All the writers seem to consider that these ice structures are not common, and do not seem to appreciate how quickly they are formed, and it therefore seems advisable to put upon record the circumstances which are most favourable for their production.

I have often seen them in Davos, and also in North Italy, and in the fine winter of 1881-1882 I many days purposely went early in the morning to the same slopes above Davos Platz to observe these peculiar forms. I cannot now lay my hands on the notes made, but find on November the 13th, 1881, that the surface of what I call the talus, from the turf was covered with vertical acicular crystals of ice in bundles, 1½ to 2 inches long, looking like asbestos. The diameter of each needle was about 0·5 millimetres. This asbestos-like appearance has struck another observer. I have frequently seen a layer several feet in extent about 3 to 4 inches in depth, and these I used to break up to find them fresh formed the next day.

The places where they can most regularly be observed are at the sides of the mountain paths, on the slopes facing to the south or east. The grass does not in most cases come down to the path as the action of the weather breaks it away at the edge, and thus from the grass there is a steep slope of light loamy earth, and when there is snow melting on the turf above, the water percolates and keeps this earth moist for a long time, and the sun shining full on this dark ground makes it very warm in the day, but each night all is frozen hard.

The conditions for the formation of these crystals did not exist in the middle of winter, but as soon as the winter snow was partly melted away I knew that I should find them in large quantities, and took the opportunity of examining the same place on three consecutive suitable days, namely, from the 26th to the 28th of February.

The 25th had been warm with the air temperature

+10·6° C. (51·1° F.) at 1 p.m., and the solar radiation was 51·7° C. (125·1° F.). On the 26th, at 7 a.m. (which may be taken as about the minimum of the night), the temperature was −7·2° C. (19·0° F) but rose at 1 p.m. to 9·9° C. (49·9° F.). On the 27th, at 7 a.m., we had −6·2° C. (20·9° F.), and at 1 p.m., 10·2° C. (50·4° F.), with solar radiation 48·9° C. (120·0° F.). On the 28th, at 7 a.m., −5·5° C. (22·1° F.), at 1 p.m., 5·2° C. (41·4° F.), with solar radiation 46·6° C. (115·9° F.). The nights were clear, and a terrestial radiation thermometer would have shown about zero Fahrenheit each night.

It will be seen that the days were warm, with a very powerful sun, while the nights were clear and cold. On the slopes in question, the earth was softened very soon after the sun appeared above the mountains, and about two hours after this, all the peculiar ice forms examined had been melted away, therefore, to study them, these slopes must always be visited early, though they may be found under less favourable circumstances, and with different aspects at other times.

On the first day these forms averaged about an inch. On the second some were as much as two, but most were a little more than one inch. The third day when the earth was becoming drier, was the most instructive, as then at the upper part of the earth slope, which was the driest, the crystals were only a quarter of an inch long, while below, where the earth was still soaked they were two inches long.

I have not this year found any case of their occurring in several layers, though I have previously seen it, and the cause is no doubt an interruption in the meteorological conditions. Besides the straight rods, there are often some bent into a half circle, or into reversed ∩ shape, and frequently in the lower part of a layer the filaments are more numerous than in the upper part. As far as my observations go no trace of these peculiar forms is to be found upon the turf.

The amount of earth carried on the top of these columns is often considerable, but varies on different days, and probably depends upon the rapidity with which the crystallisation commences. The morning on which there seemed to be least dirt was after several warm days, during which there had been rain and snow, and, consequently, the ground was pretty equally saturated.

Although probably on more than thirty days in every winter it would be possible to gather some cart loads of these filaments by the side of the favourite mountain walk above Davos, I feel convinced that many pass by without ever seeing them in consequence of the covering of dirt, and, as we have said, it is only those who walk early who could, as a rule, see them in great abundance.

Many other ice and snow structures occurring here would well repay careful study, but competent workers do not take the matter up. On the 11th of this month I was surprised to see the stalks of some herbaceous plants supporting thin sheets of ice the shape of a razor blade and about half an inch broad. These blades were directed against the prevailing wind, and on the umbels of some dead umbelliferae had a very curious appearance. As there had been rain, snow, and mist the day before, the way in which they grew is somewhat doubtful.

I have in a previous paper* called attention to the fact that the snow entirely recrystallizes during the winter, but towards the end of the winter when the snow is being melted each day it becomes in the night coarsely granulated without any trace of crystalline form. On the 15th of March, in the morning, the granules had much the form of very coarsely granulated zinc, with irregular granules about a quarter of an inch in diameter.

* "Observations made in St. Moritz." Proc. Manch. Lit. & Phil. Soc., vol. xxii., p. 83.

Ordinary Meeting, April 7th, 1885.

J. P. Joule, D.C.L., LL.D., F.R.S., &c., Vice-President, in the Chair.

"Note from Davos Dörfli," by Arthur Wm. Waters, F.G.S.

If I was a strong man I should not be in Davos, and meteorological observations ought to be undertaken by those in health, and this will be sufficient explanation why I am only able to make a small contribution to our knowledge of the Davos climate; and a severe illness last summer prevented my putting up either of the electric thermometers* which I devised especially for an extreme winter climate. Instead, I used the variations in the electrical resistance of wire, a plan which was described by Sir William Siemens,† and has been employed in deep sea and other measurements.

Besides wishing to know the temperature without leaving my room, I was anxious to become practically acquainted with the advantages and difficulties of the system.

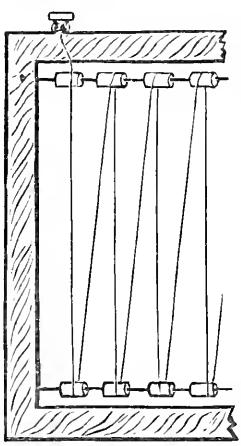
The coils described by Sir W. Siemens are platinum wire, wound on pipe-clay, and for furnace or deep sea measurements this would not seem to have any disadvantage, but for meteorological purposes the aim should rather be towards an arrangement that will very rapidly take the temperature of the air. As an experiment I therefore took some fine copper wire (0·1 millim.) and wound this in such a way that it should be as much as possible exposed to the air currents. Beginning near the centre I wound a number

* New Method of reading a Thermometer and Hygrometer at a distance, by means of Electricity.—Quart. Journ. of the Meteorol. Soc., vol. ix., p. 205. See also Proc. Manch. Lit. and Phil. Soc., vol. xxii., p. 106.

† Electrical Resistance Thermometer and Pyrometer Trans. Soc. Telegr. Engineers 1875. See also "Nature," July, 1875.

of turns, making circles 12 centim. in diameter, then about 0·5 centim., further out another series, going on until the last circle was 25 centim. These skeins, if they may be so called, were suspended by silk threads within a light wooden frame, and looked much like a spider's web; and in this way the wire was uninfluenced by the neighbourhood of any wood or metal. The wire, however, had to be silk covered and soaked in paraffine wax, and as both are bad conductors of heat, it is evident that although the wire will pretty quickly take the temperature of the air, yet greater sensitiveness might be obtained.

It would be difficult to have a satisfactory resistance of uncovered wire with any other metal than platinum, and this should be very fine, so as not to require too great a length. I have, therefore, made another coil with 10 yards uncovered platinum wire, about 0·04 millim. in diameter.



First I put together a frame, something like a slate frame, and near and parallel with the top and bottom fastened two strings (35 centimetres apart) which were threaded through small pieces of tobacco pipe, fastened on with shellac. The object of having a broken up surface is to avoid connexion by dew, or hoar frost. The platinum wire, which is uncovered, is now led from a piece of tobacco pipe on the upper string round one on the lower, and up again to the second piece on the upper string, and thus from one to another until the whole is fixed. In this way each wire is about 15 millim. from the one before, and with this very fine wire we may, I think, say that it will almost instantaneously take the temperature of the air. The resistance is about 600 ohms, and being wound so open does not, so far as the measurements made with my present instruments indicate, show any rise of temperature when a suitable measuring current is sent through, though the same wire wound compactly upon a piece of clay pipe rises considerably with this current.

The Wheatstone bridge and resistances which were used are those I described before this Society,* and the arrangement has proved very satisfactory when rapidity of measurement is a consideration. The galvanometer is a very good astatic which was bought for other purposes, but being a short coil I was not working under advantageous circumstances, and am, therefore, making a more suitable one. For the sake of any who may make similar measurements I would advise a galvanometer shunt, so that too much time may not be lost through swinging of the needle during the balancing. Correction has to be made for the temperature of the room, and as an open window may not act as quickly upon the measuring coils as upon a thermometer, this may from time to time be the source of a small error. For very exact measurements the temperature of the resistance bridge might be taken by means of a small coil placed in melting ice.

For laboratory, or observatory observations, there is no doubt that this plan of taking the temperature may be readily developed, so that an amount of exactness may be attained which would be impossible by any other method. Living in rooms in an hotel, it is rather awkward to have delicate instruments left permanently in suitable positions, and in this respect my previous instrument, with its simple reader and ordinary compass galvanometer, which might be moved about and hung up out of the way, was much less troublesome to use. In that case, as I pointed out, the weak point was the sluggishness of the thermometer, whereas

* On a Method of Mounting Electrical Resistances: Proc. Manch. Lit. and Phil. Soc., vol. xxiii., p. 43.

with the present plan, the thermometer part may be made most sensitive. It should not be forgotten that in these severe climates the errors through bad position of the instruments is often considerable, whereas with an electric system they can be placed far from the houses. Therefore, if with a metal thermometer, such as was used before, the error should even rise as high as a half a degree Centigrade, and a quicksilver thermometer placed near a house should give, in consequence of the position, an error of two degrees C., then we obtain the most reliable figures from the least sensitive instrument.

The following table shows the temperature as measured in Davos Dörfli in my screen, fifty metres from the hotel. The nine a.m. figures were always taken with a mercury thermometer; at one p.m. usually with the electrical resistance, but on a number of days I used the mercury thermometer. Except on a few days in February, when a friend took the observations, the seven a.m. and nine p.m. were taken regularly with the electrical resistance. The coil used was the one described as a spider's web, in which the resistance was 450 ohms at —7· Fahr., and 550 ohms at 83 Fahr.

As the whole thing was really in an experimental stage, to see what could be done with the apparatus I possessed, the results must not be looked upon as reliable within half a degree Fahrenheit, but I think that they may be taken as so far correct.

	7 A.M.	9 A.M.	1 P.M.	9 P.M.
1884. Nov.*	− 8·1 C.(17·4 F.)	− 3·5 C.(25·7 F.)	+2.6 C.(36·8 F.)	− 7.3 C.(18·9 F.)
,, Dec.	− 7·9 C.(17·8 F.)	− 6·5 C.(20·2 F.)	−1·1 C.(30·0 F.)	− 7·8 C.(17·9 F.)
1885. Jan.	−13·2 C.(8·2 F.)	−11·3 C.(11·7 F.)	−1·9 C.(28·6 F.)	−11·7 C.(11·0 F.)
,, Feb.	− 5·6 C.(21·9 F.)	− 2·8 C.(27·0 F.)	+3·8 C.(38·9 F.)	− 3·7 C.(25·4 F.)

The results obtained are just about two degrees Cent. colder than those published from Davos Platz, and possibly Platz is a trifle colder, but the main difference must be

* November, 1884, at 3 p.m. the mean was—0·9 C. (30·4 F.)

taken as arising from my instruments being free, while those in Platz are in a position where they must receive a good deal of heat from surrounding houses.

I must point out that we are now getting together a considerable number of figures of these high climates at other hours than the official ones, so that gradually we shall see the course through the day. The nine a.m. observations have been made by me in Davos both during the winter 1870-71 and this winter. During 1882-83 winter, I took it in St. Moritz, and Dr. Wise registered it in Wiesen 1882-3, and in Maloja 1883-4. Many patients who could not undertake to keep a record at seven a.m. could do so at nine a.m., and therefore it is important to know its relation to other hours. In St. Moritz I also made observations at three p.m., and Dr. Wise has done so in Wiesen and Maloja, but it is rather to be regretted that none of Dr. Wise's observations are taken at the same time as in the official Swiss stations.

The mean winter temperature in Davos Platz taken from 12 years' observations is November – 2·4 Cent.; December – 6·1 C.; January – 7·7 C.; February – 4·1 C.; so that comparing this winter in Davos Platz it is nearly two degrees centigrade warmer than the average.

Wind.

The wind was again measured at about 6 feet from the ground, in order to see approximately the conditions to which patients are exposed. The position though about 50 metres from the hotel we can only look upon as representing a sheltered part of Davos Dörfli. As we have previously had occasion to notice the choice of position is an extremely difficult question, and almost any result may be obtained, according to the position taken, for as a rule the wind is only a valley wind, that is to say, is quite independent of the upper currents, and it will therefore be readily understood that its exact direction varies very considerably in different parts of the valley, and consequently I have found it best only to note whether the wind blows up or down the valley. The most frequent wind here has a direction from the lake to the lower part of the valley and on one house will show itself as a north wind, while a few houses further on it will, according to the position, be north-east or north-west.

Besides this, the valley wind is really a surface wind, so that very frequently the smoke shows the direction to be from the north at the height of the roof, whereas at about double or three times this height it is blowing from the south. This occurs so often that it may almost be considered a rule when a true valley wind is blowing. Also it is often the case that in the middle of the valley the wind is from the north while at the two sides it is from the south. There must therefore on these occasions be a neutral zone, and the force must vary very greatly at different heights. This I have been able to see clearly, for on one or two days when there was a strong unpleasant wind by the ground, a vane on a pole about the height of a house showed no movement. In the two lateral valleys, Dischma and Fluela, it very often happens that the wind is blowing in opposite directions, probably in these cases the wind may either be caused in these side valleys, or be drawn by the main valley.

The direction of the prevailing valley wind depends upon various circumstances, and it has been a matter of scientific surprise to some people that the direction in Davos should be down the valley, and the cause has often been sought in the wrong place, but it seems to me that the explanation is a simple one, for although the direction is from N.E. to S.W. the main mountain masses lie to the south, so that the air being more warmed over these mountain masses the current is thus drawn to the south although the valley falls in this direction. That this is the probable explanation receives the strongest support from the lower part of the valley. In Wiesen which is south of the gorge of the Züge, near the main mountain masses, the valley wind seems to have a frequent or prevailing direction from the south. As the Swiss meteorological observations are now only printed in most cases as monthly means, it is very difficult to make any detail comparisons, but through the courtesy of the pastor who takes the observations in Wiesen I was, however, able to see some of the March figures, and the direction of the wind was mostly the reverse of that in Davos and the days that I have been there this has been the case. Further comparison must however be made.

It does not seem to some people that places within 20 miles can really be as different as they are, and this cannot be thoroughly understood without fully taking into consideration the winds and their origin, but when it is seen how much they depend upon the neighbouring configuration then it can be appreciated.

Those who know Davos are well aware that there are great complaints as to the depressing influence of the föhn (or perhaps more properly fön) wind, but whether this is due to the first change, or whether—which I think is more probable—the most depressing time is when the real föhn is over and when the air is becoming damper is a question of great importance yet to be solved.

The föhn is the favonius of the Romans, and is now in the Engadine favoun, and when residing in that valley I took a good deal of trouble to find out whether the conception of the favoun was a definite one among the inhabitants, and found that while most associated the direction with the warm wind, there were some who would call any warm snow melting wind in the spring favoun.

Among the visitors the term is used very loosely, and much is attributed to the föhn which has nothing to do with it, nor is it scientifically a very satisfactory term. Dove, Hann, and others have long since shown that the

Sirocco, or distant origin of this wind, is not a tenable theory, but that it has a local origin. To explain shortly the present state of knowledge with regard to this important climate factor! If air rises or comes into less barometrical pressure it must expand, and this expansion requires heat, which is taken from the air brought to that spot, and thus the temperature falls. Should on the other hand the air descend or come into greater barometrical pressure the contrary effect takes place, and the temperature rises. If the air be quite dry the difference of temperature thus caused is 1° Cent. for each 101 metres that the air has risen or fallen. The air, however, is never quite dry, and therefore the calculation is not quite as simple as this, for when air containing moisture rises it is lowered in temperature, and so gradually reaches its dew point, when some of the moisture will be precipitated as snow or rain, and in this way the latent heat is set free, so that the fall of temperature of air containing moisture is less than that of dry air rising to the same height. In descending the temperature of the air rises, but the amount of absolute moisture remains the same, so that the air is constantly becoming relatively drier, and it will thus be seen that the rise of temperature when the air descends is more rapid than the fall when the air ascended. Thus air with a temperature of 20° Cent. and 86 per cent of relative moisture would in passing over a mountain 2500 metres higher deposit a part of its moisture, and coming down to the level from which it started would on the other side of the mountain have a temperature of 30·5 cent, and relative moisture 29 per cent.*

I wish, as far as possible, to avoid in any way entering into the merits of the rival places of Davos and St. Moritz, but in consequence of the different configuration, the föhn affects the two places so differently that in St. Moritz we hardly ever hear anyone speaking of it, whereas in Davos

* For fuller explanation see Mohn "Meteorologie," 2nd ed., p. 174.

it is a stock subject of conversation. St. Moritz Dorf is the highest part of the valley of the Engadine, and, therefore, when a föhn wind is blowing in the neighbourhood it frequently deposits its moisture in St. Moritz, or if not snowing, or raining, is a damp wind. In Davos, on the other hand, the föhn wind has to descend from a greater height, and has passed over a range of mountains, and is in consequence of its descent a warm and dry wind, at any rate for part of its duration. The winter of 1882-1883 gave some very interesting examples, showing that the theory given above was sufficient to explain what was taking place. On the days with strongest föhn, viz.: November 7th St. Moritz had at 1 p.m. +3·2 Cent., while Davos had +13 Cent.; November 8th St. Moritz had +2·1 Cent., Davos +7 Cent.; December 4th St. Moritz was at 1 p.m. −5 Cent., Davos was +4 Cent.; January 30th St. Moritz was −0·8 Cent., Davos was +5 Cent.

It will be seen that whereas St. Moritz has no depressing föhn, its absence at such times has to be paid for by a colder and damper air together with a strong wind (which is more trying as it is cold). My own opinion is that for some individuals the disadvantages of the föhn outweigh the disadvantages of the colder and moister air, while others can better bear the bracing and cold air than the depressing one, and as such places as Arosa, Pontresina, the neighbourhood of Schuls, &c., have been thought of as winter health resorts, it becomes important first to study how the wind affects each of them; for, as I have elsewhere said, I believe that the difference of some of these places, quite near together, is as great as between Brighton and Torquay.

In order, therefore, to study the influence of the wind on people, we ought first of all to know the force at about the height of a person, and then we ought to know the direction (and if possible the force) of the main upper current, for of course it is not to be supposed that the physiological influence of air blowing from the south, though merely locally turned from the north, is the same as air brought from the north. In order to have data concerning the upper currents available for those who may in the future wish to study their climatic influence a vane was subscribed for, and put upon the Bremenbühl at a height of about 700 metres (2,300 feet) above the valley. It can be seen from Davos Dörfli from which it is 2,600 metres; and from Davos Platz, a distance of about 2,100 metres. This I observed from Dörfli for two months, and Mr. Rzerwuski observed it for January and February from Platz. The vane is on a principle devised by Mr. Hugo Leupold,* and has two large triangles below the vane, and by the position of these the direction of the wind is read with a key. There is also a very ingenious force measurer, consisting of a flap which moves a ring above the vane: and by the height of this ring the force is read. As the instrument was only put up at the beginning of the winter when the snow was on the ground, there has not yet been the opportunity of testing its action, and these force measurements are therefore omitted. The telescope which I used was not large enough for reading this part of the instrument on unfavourable days. People living in English fogs will be surprised to hear that with only two exceptions this vane could be seen every day for four months. The table of this upper wind is given at the end of the paper.

The wind in the valley in the position already mentioned, was:—

	Davos Dörfli.	Davos Platz. 1881-1882.	St. Moritz. 1882-1883.
September, 1884	1281	....	....
November, „	759	561	1965
December, „	761	727	1422

* A New Method of reading the direction of the wind on exposed heights, &c.; by H Leupold, F.R. Met. Soc., C.E. 2 J. R. Met. Soc., Vol. xi., Jan., 1885.

		Davos Dörfli.	Davos Platz. 1881-1882.	St. Moritz. 1882-1883.
January,	1885	785	283	1674
February,	,,	1402	597	1556
March,	,,	1859	1656	2740
April,	,,	1850		

We are not able to make comparisons between the figures obtained in Davos and St. Moritz, although taken by the same Robinson's anemometer, as the position was a more open one in St. Moritz than in Platz or Dörfli. I, however, put the figures side by side so that they may be readily referred to.

It must of course be remembered, that the amount registered so near the ground is much less than it would be at a greater height, and further, we must also not forget, that an amount of wind which is pleasant in summer is unbearable in winter. As I before said, for a pleasant winter day, the wind registered should not be above a mile an hour. I refer again to this, as Dr. C. Theodore Williams, in a discussion before the Meteorological Society, said that I found that there was very little wind in St. Moritz. I certainly have not intended to write anything which should make me responsible for such a statement, but to avoid making imperfect comparisons between rival places merely gave the figures, for each to draw their own conclusions, and while there are many advantages in the hotel and neighbourhood, making it a pleasant place for those who are strong enough to stand the climate, did not return there, simply because I felt that a more sheltered position was advisable for me.

Sunshine Recorder.

An addition has been made to the instruments used by the meteorological station in the shape of a sunshine recorder. The results of which are given from the local paper:—

September	201	hours.					
October...	102⅓	,,					
November	128	,,	about	65	per cent	of possible	duration.
December.	66	,,	,,	50	,,	,,	,,
January...	137·8	,,	,,	85	,,	,,	,,
February..	104¼	,,	,,	50	,,	,,	,,

The mere statement of the number of hours which the sun shone is exceedingly misleading, as the sun appears and disappears above and below the mountains at quite different times to the hours of sunrise and sunset for these latitudes, and this difference cannot be estimated by people living at a distance. A few observations each month as to the sunrise and sunset, so that the percentage of the possible duration could be given would add immensely to the value of the figures, but this simple thing, which could so easily be done, was officially discouraged by the Swiss Meteorological Bureau. I therefore give a rough estimate of the percentage of possible duration.

Water.

I have on a previous occasion spoken about the time of snow melting, and should like at some future time to enter fully into it, as there is no doubt that many make unfortunate choice as to the time they leave and the place to which they go, but there are various dangers here during the snow melting time, some of which might be mitigated. One very important consideration is, how the drinking water is collected. After suffering for a long time from stomachic derangements, which had disappeared upon several occasions on leaving Davos for a few days, I unexpectedly found the explanation. For the purpose of washing some microscopic preparations, I added a drop of drinking water, and was surprised to find that this contained a large number of fine particles of stone, and then putting on a higher power the water was seen to be swarming with bacteria. This led me to examine the way that the water was collected, which was in a small wooden reservoir higher than the hotel, but only about 100 metres distant, and instead of being collected from a spring directly issuing from the rock it is led under the earth for a short distance, in such a manner that the water from the grassy slopes above can percolate into it. As the slopes are very thoroughly manured in the autumn, before the snow falls, and as the goats wander about here, the danger, as soon as the melting snow keeps the ground soaked, is very great. There is a second danger from the fine particles in the water, and again the amount of magnesia should be examined, as it will from some springs be considerable. Filtering the water would be a great advantage, but could not affect the organic impurities. Upon making this discovery I at once gave up drinking any water, and the results showed that I was at last upon the right track.

Being in an hotel which calls itself a Curhaus, and where a doctor has resided for many years, I had not thought that such an unsatisfactory, primitive, and dangerous method of collecting the water was possible, and though probably no other hotel obtains its supply in the same way (in fact most will now be furnished from a water supply collected in the Fluela valley some miles away), yet all should be examined; and the object of what I am saying, is to urge the English doctors who send patients here to use their influence to have an officer of health appointed, with the right to examine all sanitary questions.

Davos Platz has now become a town producing at times a veil of smoke, which in an English town we should call a fog, and this, if scientific methods were employed, could be much reduced. I am in a position to say that the sanitary arrangements in some of the hotels require entirely changing to be suitable for a place which has grown so rapidly, and with the possibility of frozen drainage, these and all other sanitary questions should be periodically examined by a competent official.

WIND DIRECTION ON THE BREMENBÜHL.

	NOVEMBER, 1884.						DECEMBER, 1884.					
	B. 9 a.m.	Valley 9 a.m.	B. 1 p.m.	Valley 1 p.m.	B. 3 p.m.	Valley 3 p.m.	B. 9 a.m.	Valley 9 a.m.	B. 1 p.m.	Valley 1 p.m.	B. 3 p.m.	Valley 3 p.m.
1	E	*n*	NNE	*n*	..	*n*	SSW	*n*	S	*n*	S	*n*
2	ESE	*n & s*	SSE	*n & s*	..	*n*	SW	*s*	S	*s*	W	*n*
3	N	*n*	N	*n*	NNW	*n*	S	*n*	S	*e*	..	*s*
4	E	*n*	SW	*n*	SW	*n*	S	*s*	SSW	*n*	S	*s*
5	WSW	*n*	SSW	*n*	WSW	*n*	E	..	S	*s*	S	..
6	S	*n*	SSW	*s*	S	*s*	*S	..	..	..	..	..
7	S	*e*	SSW	*s*	S	*s*	S	*n*	S	..	..	..
8	E	*n*	E	*n*	E	*n*	S	*n*	S	*n*	S	*s*
9	S	*s*	S	*n*	E	*n*	S	*n*	S	*n*	..	*n*
10	NE	*n*	E	*n*	E	*n*	E	*n*	NE	*w*	..	*w*
11	S	*n*	S	*n*	S	*s*	S	*n*	S	*n*	..	*s*
12	NE	*n*	NNE	*n*	ENE	*n*	..	*n*	§SE	*n*	..	..
13	SW	*n*	NE	*n*	E	*n*	E	*n*	ENE	..	E	*s*
14	NNE	*n*	NE	*n*	E	*n*	S	*n*	S	*n*	S	*s*
15	ENE	*n*	W	*n*	W	*n*	S	*s*	S	*s*	S	..
16	S	*n*	SW	*n*	NW	*n*	W	*n*	..	..	E	..
17	S	*n*	S	*n*	SW	*n*	S	*s*	S	..	..	..
18	S	*n*	..	*n*	..	*n*	E	*n*	E	..	NE	*n*
19	..	*n*	..	*n*	†E	*n*	S	*n*	SW	..	SW	..
20	NE	*n*	S	*n*	NW	*n*	SW	*n*	S	..	..	..
21	ENE	*s*	S	*n*	S	*n*	‡ENE	*n*	..	..	..	..
22	S	*s*	S	*n*	S	*s*	NE	*n*	..	..	..	..
23	NW	*n*	NW	*n*	..	*n*	NE	*n*	NNE	*n*	S	..
24	E	*s*	..	*n*	ENE	*n*	..	*n*	..	..	..	..
25	SW	*s*	WSW	*n*	S	*n*	S	*n*	S	*n*	SSE	..
26	ENE	*n*	ENE	*n*	NE	*s*	SSE	*n*	SSE	*s*	SSE	..
27	NE	*n & s*	ENE	*n*	NE	*n*	S	*n*	S	..	S	*n*
28	S	*n*	S	..	S	..	S	*n*	S	..	S	..
29	SSW	..	..	*n*	..	*n*	S	*n*	..	..	SSE	..
30	..	..	E	*n*	E	*n*	S	*n*	SSW	..	SW	..
31	..	..	..	..	..	..	SSE	*n*	SSE	..	ESE	..

	JANUARY, 1885.					FEBRUARY, 1885.				
	B. 9 a.m.	Valley 9 a.m.	B. 1 p.m.	Valley 1 p.m.	B. 3 p.m.	B. 9 a.m.	Valley 9 a.m	B. 1 p.m.	Valley 1 p.m.	B. 3 p.m.
1	NNE	*n*	NNE	*n*	SSW	SW	*s*	SW	*s*	SSW
2	SSW	*n*	SSW	*n*	SSW	SE	*s*	SW	*n*	SSW
3	SSW	*n*	SSW	*n*	SSW	NNE	*n*	W	*s*	SE
4	ENE	*n*	NE	*n*	NE	..	*n*	NE	*n*	NE
5	NE	*n & s*	NE	*n*	NE	S	*s*	SSW	*s*	SW
6	SSW	*n*	SW	*n*	SW	..	*n*	NNE	*n*	SSW
7	NE	*s*	..	*n*	..	SSW	*n*	NNE	*n*	NNE
8	SE	*n & s*	SE	*n*	S	..	*n*	NNW	*n*	SE
9	S	*n*	SSW	*n*	SSW	S	*s*	NE	*s*	NNW
10	SSW	*n*	SSW	*n*	SSW	NE	*n*	..	*n*	..
11	SSW	*s*	SSW	*s*	WSW	NE	*n*	NNW	*n*	NNW
12	SW	*n*	SW	*n*	SW	..	*s*	E	*n*	..
13	..	*n*	..	*n*	..	NNW	*n*	NNW	*n*	NNW
14	NNE	*s*	SSW	*n*	SE	SSW	*n*	SSW	*n*	SSW
15	SSW	*n*	SE	*n* / *n*	SE / SSW	SSW	*n*	SSW	*n*	SSW
16	..	*s*	SE / SSW	*n* / *n*	SE / SSW	SW	*s*	SW	*s*	SW
17	SE	*n*	SE / SSE	*n* / *n*	SE / SW	SW	*s*	SW	*s*	SW
18	ESE	*n*	ESE	*n*	ESE	SSW	*s*	SW	*s*	..
19	NNE	*n*	SE	*n*	SE	SSW	*s*	SW	*s*	SW
20	ESE	*n*	ESE	*n*	ESE	S	*s*	SW	*s*	SW
21	ESE	*n*	SE	*n*	SE	WSW	*s*	..	*n*	W
22	NE	*n*	NE	*n*	NE	..	*s*	SW	*n*	SSW
23	NE	*n*	N	*n*	N	NE	*n*	N	*n*	NE
24	NNE	*n*	NNE	*n*	NNE	S	*s*	SSW	*n*	SSW
25	N	*n*	NNW	*n*	NNW	SSW	*n*	SSW	*n*	SSW
26	NNW	*n*	N	*n*	NE	NE	*n*	SW	*n*	SSW
27	N	..	SSW	*n*	SSW	NNW	*s*	NNW	*n*	NNW
28	SE	..	SSW	*n*	SSW	ENE	*s*	NNW	*n*	NNW
29	SSW	..	SSW	*n*	SSW	..	..	..	..	..
30	SSW	..	SW	*w*	SW	..	..	..	..	..
31	SW	*s*	S	*w*	SW	..	..	..	..	..

* 11 a.m. † 2.15 p.m. ‡ 11.30 a.m. § 12 noon.

The valley wind is only given as northerly or southerly. The 1 p.m. lower wind for January and February are furnished me by Mr. Tauber, from the Meteorological Station in Davos Platz; all the others were taken in Davos Dörfli, either from the smoke in the middle of the valley, or from tapes put up for the purpose.

Annual General Meeting, April 21st, 1885.

J. P. Joule, D.C.L., LL.D., F.R.S., &c., Vice-President, in the Chair.

The Treasurer reported that enquiries had been made relative to the cost of the restoration of the old building; this would involve an expenditure of at least £500. He had much pleasure in informing the Society that one of their members, Mr. Henry Wilde, in addition to his recent benefactions to the Society had also undertaken the restoration of the building at his own cost.

On the Motion of Mr. C. Bailey, seconded by Mr. R. S. Dale, it was unanimously resolved "That the thanks of of the Society be given to Mr. Wilde for his additional benefaction."

The Treasurer also reported that the Council had accepted the offer of the Microscopical and Natural History Section to furnish the room over the Library at the expense of the Section.

A letter was read from Mr. J. Baxendell stating that on account of his continued ill health he wished to resign the office of Honorary Secretary which he had held for twenty-four years.

On the motion of Dr. Joule, seconded by Dr. Bottomley, it was unanimously resolved "That the Society has heard with great regret that Mr. Baxendell finds himself unable to continue his attendance at the meetings and his services as Senior Secretary of the Society, and cannot proceed to the election of his successor without first placing on record a hearty expression of acknowledgment of his ability and assiduity in the discharge of his secretarial duties and the superintendence of the Society's publications, and of the courtesy with which he has always met every call made upon him by the members of the Society and its Council."

Report of the Council, April, 1885.

The Treasurer again reports that the ordinary expenditure of the Society has exceeded the ordinary receipts, as will be seen from the comparative Accounts attached to this Report, and your Council can suggest no sounder means of restoring the finances of the Society to a more healthy condition than by again earnestly recommending an increase in the number of ordinary members. Fewer members have been elected this year than was the case last year, the total number upon the roll is out of all proportion to the numbers of original observers resident in Manchester and its neighbourhood.

In the last Report your Council reported that Sir Henry Roscoe had undertaken to appeal to the members and friends of the Society for funds to erect a new library and general meeting room on the land at the rear of the old building; this appeal has resulted in promises amounting to £2,308 1s., of which £2,247 have been received in the Society's financial year. For the generous gifts thus placed at the disposal of the Society, your Council returns its grateful thanks. Details of this Centenary Fund will be found in the accompanying separate account. During the year, a commodious building has been erected, but funds beyond what have been promised will be required to complete and furnish the new building, as well as to renovate the old premises. But beyond these necessities, the Society will not have worthily celebrated its centenary, unless an ample fund is set aside to ensure more frequent issues of the Society's Memoirs.

The number of Ordinary Members on the roll of the Society on the 1st April, 1884, was 144, and 3 new members have been elected; the losses have been, resignation 1, defaulter 1, deaths 7.

The deceased members are Mr. Samuel Robinson, Dr. R. Angus Smith, F.R.S., Rev. W. Gaskell, M.A., Mr. Bartholomew Stretton, Mr. W. Rayner Wood, Professor Morrison Watson, and Sir Thomas Bazley, Bart.

Mr. SAMUEL ROBINSON who died on the 8th day of December, 1884, at his residence Black Brook Cottage, Wilmslow, in his 91st year, had been a member of the Society since the year 1822. The son of a gentleman who has been described as "one of the local literati and leaders of society and a prominent man in all that concerned the prosperity of the town and the interests of culture and progress," he received at Manchester College (at that time stationed at York, which was then the resort of many of those whom a now happily obsolete prejudice excluded from the National Universities), a fair University training which, if that of a small provincial College, was yet in advance of the prevailing English scholarship of the day.

The refinement of letters Mr. Robinson never lost. Through a long life—40 years—spent in cotton manufacturing in Manchester and Dukinfield, he never failed in warm personal interest, in the moral and educational welfare of his workpeople and neighbours. The founder of the Dukinfield Library, he frequently lectured there and was for many years a daily visitor at the British School and a diligent teacher in the old Chapel School.

On his retirement in 1860 he withdrew to Wilmslow and devoted himself to the prosecution of the literary pursuits which had been for many years the resource of hardly earned leisure. He could not lay aside, nor ever wished to do so, his earnest and singularly practical work for improving the conditions of life of old and young around. As a school manager, as a poor law guardian, as an active trustee, and for 4 years up to 1871 the president of Manchester College and as an earnest promoter of the Evening Class movement at Owens College, he has certainly left a mark of his own in the civilisation of his day and district. No one who had the honour of friendly intercourse with Mr. Robinson ever left him without being in some way better for the interview. His life-long familiarity with the classical literature of Greece and Rome, of Italy and Germany, and especially of England, and a habit of even fastidious composition and of ready and earnest address, secured to him a marked eminence amongst the cultivated men of business who some years ago distinguished Manchester society.

In addition to continuous study in these directions he devoted considerable attention to mastering the Persian language and literature. Throughout his life he had much pleasure in making and publishing, more or less privately, a series of elegant translations of Latin, Italian, and German poems, but his chief work is represented by a volume which he published privately in 1883, of "Persian Poetry for English readers, illustrated by specimens of six of the greatest classical Poets of Persia, with biographical notices and notes." A portion of this work consisted of a reproduction of a paper on the "Life and Writings of Ferdosee" which Mr. Robinson read before the Society on the 24th of September, 1819, and which was printed in the 4th volume of its Memoirs in 1824.

The Rev. WILLIAM GASKELL, M.A. (Glasgow), died in June, 1884, in his 79th year. Educated for the Ministry amongst Unitarians, at the College, at York, he became in 1828 one of the ministers of Cross Street Chapel, in Manchester, an office which he held till his death.

Of fine and faithfully developed scholarship, especially in English subjects and literature, he lectured for many years in these departments in Manchester New College, and in the evening classes at Owens College, and to private pupils. Many Manchester men and women gladly acknowledge the influence of his varied learning and his refined taste. He was for many years Chairman of the Portico Library, where his assiduity and judgment did much to maintain the character of that important institution.

Within the limits of his own religious association he was an honoured leader, and during all his long service in Manchester, was widely known for his personal attention to every call of kindness amongst his own flock and the poor in many parts of the City and district.

He became a member in 1840, and was frequently re-elected to serve on the Council, and from 1869 to 1876 was one of the Vice-presidents of the Society. He was much interested in its working, and in the details of administration; but its increasing tendency to absorption in scientific research and discussion did not invite the exhibition of his exclusively literary accomplishment. A course of lectures on the Lancashire dialect which he published in 1854 was first read as notes to the Society. Completely occupied in his ministerial duties and his teaching he found little time for original authorship beyond the preparation of his Discourses. This was always with him a matter of conscientious deliberation, and his style, while simple, devout, and direct, was singularly polished and effective.

He published in 1839 a small volume of Temperance Rhymes, which had considerable popular approval, and in 1859 a volume of "Life and Letters of Mr. John Ashton Nicholls," a former member of the Society, and many sermons on special occasions.

He was interred in the chapel yard at Knutsford by the side of his wife, the well-known authoress of "Mary Barton," and other works.

Sir THOMAS BAZLEY, Baronet, who died at Lytham on March 17th, at the advanced age of 87, was born at Gilnow, near Bolton, and was educated at the Bolton Grammar School. In the commercial world he was well known as the proprietor of factories for the spinning of fine cotton and lace thread. In connection with his public career it may be mentioned that he was formerly boroughreeve for Salford. In 1845 he was elected president of the Manchester Chamber of Commerce. He was one of the royal commissioners of the great exhibition of 1851. In 1858 he was elected M.P. for Manchester, this honour was repeated at the general elections in the years 1859, 1865, 1868, 1874. In 1869 he was created a Baronet for his public services. He was elected a member of this Society January 26th, 1847.

Since the close of last Session the enlargement of the Society's premises has engaged the constant attention of the Council. To carry out their project, they engaged the services of Mr. Clegg, of the firm of Clegg, Son, and Knowles, as architect, and the contract for the building was let to Messrs. Southern and Son; the cost of the building, apart from library fittings, to be £1,498. At the close of the Session a Committee was formed to consult with the architect whenever occasion might require; in this commission the Council beg to acknowledge the valuable services of Mr. H. Wilde.

The new building consists of a basement room, library, and a room above. The new premises are lighted with gas; they are also fitted with appliances for electric lighting, and are now sufficiently advanced towards completion to enable the members to judge how far the Council have successfully carried out their undertaking. A Committee has been appointed to consider to what additional uses the new rooms may be put and to report to the Council thereon.

An invitation was sent to this Society by the American Association for the Advancement of Science to send representatives to their Annual Meeting, held at Philadelphia in September of the past year. At the request of the Council Professor Milnes Marshall consented to act as their representative.

During the Session a copy of the following letter, signed by the President and Secretaries, was presented by Sir H. Roscoe to the Council of the British Association: —

Manchester, Nov. 14th, 1884.

In the name of the Literary and Philosophical Society we beg cordially to invite the British Association for the Advancement of Science to hold their meeting in 1886 or 1887 at Manchester. Situated in a central position this city has always proved to be a convenient one for members coming either from the north or from the south. It is surrounded by a wide and densely populated district, and is abundantly supplied with buildings suitable for the purposes of the Association. The Society which we represent will do whatever may be in its power to contribute to the success of such a meeting.

The following papers and communications have been read at the Ordinary and Sectional Meetings of the Society during the Session :—

October 7th, 1884.—"The Pink Sun-Glow," by Alfred Brothers, F.R.A.S.

"Notes on the Structure, the Occurrence in Lancashire, and the Source of Origin, of *Naias graminea* Del. var. *Delielei* Magnus," by Charles Bailey, F.L.S.

October 21st, 1884.—"Note on the Visibility of the Moon during Total Lunar Eclipses," by Joseph Baxendell, F.R.S., F.R.A.S.

"On the Diamond-bearing Rocks of South Africa," by Professor H. E. Roscoe, LL.D., F.R.S., &c.

"Note on Envelopes and Singular Solutions," by Sir James Cockle, F.R.S., F.R.A.S., &c., Corresponding Member of the Society.

November 4th, 1884.—"On the Eggs of the Duck-billed Platypus of Australia," by Professor W. C. Williamson, LL.D., F.R.S., President.

"On the Discharge of Electricity through Gases—illustrated by experiments," by Arthur Schuster, Ph.D., F.R.S.

November 10*th*, 1884.—"On the Trap-door-nest Spider, Nemesia cœmentaria (Latr.)," by Mark Stirrup, F.G.S.

November 18*th*, 1884.—"On the Reversion of the Minima of the Double-period Variable Star R *Sagittæ*," by Joseph Baxendell, F.R.S., F.R.AS.

December 2*nd*, 1884.—"On the double foliar fibro-vascular bundle supposed to exist in Sigillaria," by Professor W. C. Williamson, LL.D., F.R.S., President.

December 8*th*, 1884.—"On the Caernarvonshire Station of *Rosa Wilsoni*, Barrer," by Charles Bailey, F.L.S.

December 16*th*, 1884.—"Note on Envelopes and Singular Solutions," by Sir James Cockle, F.R.S., F.R.A.S., &c., Corresponding Member of the Society.

"Some novel phenomena of Chemical Action attending the efflux from a capillary tube," by R. S. Dale, B.A.

December 30*th*, 1884.—"Notes on the early History of the Manchester Literary and Philosophical Society," by James Bottomley, D.Sc., F.C.S.

January 13*th*, 1885.—On the Composition of Projections in Geometry of Two Dimensions," by James Bottomley, D.Sc., B.A., &c.

January 27*th*, 1885.—"On the Morphology of the Sexual Organs of Hydra," by Professor A. Milnes Marshall, M.D., D.Sc.

February 10*th*, 1885.—"On some undescribed tracks of Invertebrate animals from the Carboniferous rocks, and on some inorganic phenomena, simulating plant remains, produced on tidal shores," by Professor W. C. Williamson, LL.D., F.R.S., President.

February 16*th*, 1885.—"A proposed revision of the species and varieties of the subgenus Cylinder (Montfort) of Conus (L.)," by J. Cosmo Melvill, M.A., F.L.S.

"On the Growth of Everlasting Flowers in the neighbourhood of Manchester," by Thomas Alcock, M.D.

February 24th, 1885.—"On Unipolar Convolutes," by the Rev. H. London, M.A.

March 10th, 1885.—"On making Sea Water Potable," by Thomas Kay, Esq., President of the Stockport Natural History Society. Communicated by F. J. Faraday, F.L.S.

March 16th, 1885.—"On the Breeding of the Reed Warbler, *acrocephalus arundinaceus* in Cheshire," by Francis Nicholson, F.Z.S.

"On Lagena crenata," by Thomas Alcock, M.D.

"The Post-Glacial Shell Beds, at Uddevalla, Sweden," by Mark Stirrup, F.G.S.

March 24th, 1885.—"On Peculiar Ice Forms," by Arthur Wm. Waters, F.G.S.

Volume 8, Ser. 3, of the Society's Memoirs has been completed, and several of the above papers will appear in volume 10, which is now being printed, volume 9 being Dr. R. Angus Smith's "Centenary of Science in Manchester."

The Council consider it desirable to continue the system of electing Sectional Associates, and a resolution on the subject will be submitted to the Annual General Meeting for the approval of the Members.

The Librarian reports that the Society continues to receive the publications of the Associations in correspondence with it and that the number of books, pamphlets, and part volumes received during the year has been 1910, of which 1110 are British and 800 foreign.

The number of learned bodies, etc., now exchanging their proceedings, memoirs, etc., with us, is 323, of which 213 are foreign and 110 British.

During the past year no books have been bound owing to the want of funds for this purpose. (In 1883 there were 180 volumes bound.)

There is a large accumulation of books and periodicals that require binding, and as many of the books will be transferred to the shelves in the new room, this would be an opportune time for having the binding done.

Many important works have been purchased for, or presented to, the Library during the year; amongst them may be named the splendid publication being issued by the Government, entitled a "Report on the Scientific Results of the Voyage of H.M.S. 'Challenger.'" 13 volumes have now been received on Zoology and one volume on Physics and Chemistry.

The "Fauna und Flora des Golfes von Neapel," vol. VIII, and the second part of the third volume of "A Treatise on Chemistry." Two periodicals have been added during the year, the "Illustrated Science Monthly," and "The American Naturalist."

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

THE CENTENARY FUND.

Charles Bailey, Treasurer, in Account with the Society, from 1st April, 1883, to the 31st March, 1885.

Dr.

1883-4.	£	s.	d.
Dr. J. P. Joule	50	0	0
Sir H. E. Roscoe (first donation)	50	0	0
Dr. R. Angus Smith, the late	50	0	0
Mr. H. Wilde (first donation)	100	0	0
Dr. James Young (Glasgow)	50	0	0
	£300	0	0

1884-5.	£	s.	d.
1884—April 1—To Balance	86	8	0
Dr. Thomas Alcock	10	0	0
Mr. Charles Bailey	10	0	0
Mr. Joseph Baxendell	10	0	0
Dr. James Bottomley	5	5	0
Mr. Wm. Brockbank	20	0	0
Dr. Henry Browne	50	0	0
Mr. Chancellor Christie	5	0	0
Mr. Robert E. Cunliffe	10	0	0
Mr. Hastings C. Dent	10	0	0
Mr. F. J. Faraday	5	5	0
Dr. Wm. Chas. Henry	200	0	0
Miss Henry	50	0	0
Mr. Charles J. Heywood	100	0	0
Mr. James Heywood	50	0	0
Mr. Oliver Heywood	100	0	0
Mr. Wm. Hy. Johnson (first don.)	50	0	0
Mr. Andrew Knowles	100	0	0
Mr. Edward Lund	21	0	0
Mr. J. Cosmo Melvill	10	0	0
Mr. Ludwig Mond	50	0	0
Mr. Francis Nicholson	5	5	0
Mr. Charles O'Neill	10	0	0
Mr. Henry D. Pochin	100	0	0
Mr. Wm. Radford	10	0	0
Dr. Wm. Roberts	50	0	0
Mr. J. Rhodes	5	0	0
Mr. J. Ramsbottom	50	0	0
Sir Henry E. Roscoe (second don.)	200	0	0
Mr. Archibald Sandeman	25	0	0
Dr. Edward Schunck	100	0	0
Mr. Joseph Sidebotham	50	0	0
Mr. B. Stretton, the late	20	0	0
Mr. Arthur Wm. Waters	5	0	0
Mr. H. Wilde (second donation)	400	0	0
Mr. W. C. Williams	5	5	0
Dr. W. C. Williamson	10	0	0
Mr. M. Bateson Wood	10	0	0
Mr. G. S. Woolley	20	0	0
Mr. Thos. Worthington	5	0	0
	£2033	8	0

Cr.

1883-4.	£	s.	d.
Spottiswoode and Co. — Printing and Binding Centenary Vol.	213	12	0
1884—March 31st—By Balance	86	8	0
	£300	0	0

1884-5.	£	s.	d.
Clegg, Son, and Knowles, Architects	50	0	0
Wm. Southern and Sons, Builders	1200	0	0
1885—March 31st—By Balance	783	8	0
	£2033	8	0

1885—April 1—To Balance............£783 8s.

Dr. CHARLES BAILEY, TREASURER, IN ACCOUNT WITH THE SOCIETY, STATEMENT OF THE ACCOUNTS

1884-5.	£	s.	d.	1884-5. £	s.	d.	1883-4. £	s.	d.
To Cash in hand, 1st April, 1884				248	11	5	88	7	1
To Members' Contributions:—									
Arrears 1882-3, 3 Subscriptions at 42s.	6	6	0						
,, 1883-4, 12 ,, ,,	25	4	0						
,, ,, 2 Half ,, 21s.	2	2	0						
Old Members, 1884-5, 117 Subscriptions at 42s.	245	14	0						
,, 1885-6, 1 ,, ,,	2	2	0						
New Members, 1884-5, 5 ,, ,,	10	10	0						
,, 1883-4, 2 Admission Fees ,,	4	4	0						
,, 1884-5, 6 ,, ,,	12	12	0						
				308	14	0	295	1	0
To One Associate's Library Subscription				0	10	0	0	10	0
To Sectional Contributions for 1884-5:									
Physical and Mathematical Section	2	2	0						
Microscopical and Natural History Section	2	2	0						
				4	4	0	4	4	0
To use of the Society's Rooms:— Manchester Geological Society to 31st March, 1885				30	0	0	30	0	0
To Sale of the Society's Publications				1	17	2	14	3	5
To Natural History Fund:— Dividends on £1,225, Great Western Ry. Co. Stock				59	15	9	59	17	7
To Bank Interest, less Bank postages				14	17	1	6	0	0
To Anonymous donation for six years' subscriptions to the Pali Text Society							5	5	0
To Centenary Fund:—(See separate Account.) Donations				1947	0	0	300	0	0
				£2615	9	5	£803	8	1

1885.—April 1. To Cash in Manchester and Salford Bank, Limited £846 16 11

NOTE.—The detailed accounts of the session 1884-5 (of which the above account is an abstract) are in course of audit by Mr. J. A. BENNION and Mr. A. BROTHERS.

FROM 1st APRIL, 1884, TO THE 31st MARCH, 1885, WITH A COMPARATIVE FOR THE SESSION 1883-1884. **Cr.**

	1884-5.		1883-4.	
1885—March 31.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
By Charges on Property:—				
Chief Rent	12 12 2		12 12 2	
Insurance against Fire	12 17 6		12 17 6	
Property Tax	4 5 0		3 10 10	
Repairs, &c.	1 1 6		3 14 2	
By House Expenditure:—		30 16 2		32 14 8
Coals, Gas, Candles, and Water	19 3 9		18 8 6	
Tea and Coffee at Meetings	17 6 5		16 14 1	
House Duty	6 7 6		6 7 6	
Cleaning, Brushes, &c.	5 17 10		4 0 5	
By Administrative Charges:—		48 15 6		45 10 6
Wages of Keeper of Rooms	57 4 0		57 4 0	
Postages and Carriage of Parcels	19 16 5		14 2 0	
Attendance on Sections and Societies	9 4 0		9 9 0	
Stationery, Printing Circulars, & Receipts	14 13 6		12 3 9	
Distributing Memoirs	6 3 1		2 1 6	
By Publishing:—		107 1 0		95 0 3
Advertising Centenary Volume	0 15 0		... ...	
Printing Memoirs	55 15 6		... ...	
Printing Proceedings	25 11 0		28 17 0	
Wood Engraving and Lithographing	3 2 3		3 19 0	
Editor of Memoirs and Proceedings	50 0 0		50 0 0	
Binding Proceedings	14 10 11		... ...	
By Library:—		149 14 8		82 16 0
Binding Books	... ...		19 17 8	
Books and Periodicals	27 6 5		25 18 3	
Assistant in Library	18 0 0		11 0 0	
Geological Record	... ...		... ...	
Palæontographical Society for the Year 1885	1 1 0		2 2 0	
Ray Society ditto	1 1 0		2 2 0	
Pali Text Society (6 years' subscriptions)	... ...		5 5 0	
By Natural History Fund:—		47 8 5		66 4 11
Works on Natural History	34 16 9		18 18 4	
Grant to Microscopical and Natural History Section	100 0 0		... ...	
		134 16 9		18 18 4
By Centenary Fund (See separate account)		1250 0 0		213 12 0
By Balance		846 16 11		248 11 5
		£2615 9 5		£803 8 1

	1884-5.	
	£ s. d.	£ s. d.
Compounders' Fund:—		
Balance in favour of this Account, April 1st, 1885		125 0 0
Natural History Fund:—		
Balance in favour of this Account, April 1st, 1884	96 9 2	
Dividends received during Session 1884-5	59 15 9	
	156 4 11	
Expenditure during Session 1884-5	134 16 9	
Balance in favour of this Account, 31st March, 1885		21 8 2
Centenary Fund:—		
Balance in favour of this Account, April 1st, 1884	86 8 0	
Donations received during Session 1884-5	1947 0 0	
	2033 8 0	
Expenditure during Session 1884-5	1250 0 0	
Balance in favour of this Account, March 31st, 1885		783 8 0
General Fund:—		929 16 2
Balance against this Account, 1st April, 1884	59 5 9	
Expenditure during the Session 1884-5	383 15 9	
	443 1 6	
Receipts during the Session 1884-5	360 2 3	
Balance against General Fund, 31st March, 1885		82 19 3
Cash at Bankers, 31st March, 1885		£846 16 11

On the motion of Mr. JAMES SMITH, seconded by Mr. JOHN A. BENNION, it was resolved "That the Annual Report be adopted and printed in the Society's proceedings."

On the motion of Mr. ALFRED BROTHERS, seconded by Mr. RICHARD S. DALE, it was resolved "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 Council for the ensuing year:—

President.

WILLIAM CRAWFORD WILLIAMSON, LL.D., F.R.S.

Vice-Presidents.

SIR HENRY ENFIELD ROSCOE, B.A., LL.D., F.R.S., F.C.S.
JAMES PRESCOTT JOULE, D.C.L, LL.D., F.R.S., F.C.S.
OSBORNE REYNOLDS, M.A., F.R.S.
JOSEPH BAXENDELL, F.R.S., F.R.A.S.

Secretaries.

JAMES BOTTOMLEY, B.A., D.Sc., F.C.S.
ARTHUR SCHUSTER, F.R.S.

Treasurer.

CHARLES BAILEY, F.L.S.

Librarian.

FRANCIS NICHOLSON, F.Z.S.

Other Members of the Council.

ROBERT DUKINFIELD DARBISHIRE, B.A., F.G.S.
BALFOUR STEWART, LL.D., F.R.S.
CARL SCHORLEMMER, F.R.S.
WILLIAM HENRY JOHNSON, B.Sc.
HENRY WILDE.
JAMES COSMO MELVILL, M.A., F.L.S.

One of the Secretaries then read the following account of the life of Dr. Robert Angus Smith, which had been drawn up by Dr. E. Schunck at the request of the Council :—

Robert Angus Smith, a man whose name will always find a place in the annals of our Society, has passed away since our last annual meeting. His was a life of which it is difficult to form a just estimate, on account of the many-sidedness of his character and attainments. His contributions to science and literature will indeed always remain accessible to the judgment of posterity, but there is much in his character and his relations to the world which should be recorded ere those who knew him have also passed away. In his case, fortunately, the record may be perfectly unreserved, for here there are no blots to be concealed, no dark shadows to be passed over.

Robert Angus Smith was born in Glasgow, February 15th, 1817, being the twelfth child and seventh son of John Smith, a manufacturer of that city, and of Janet his wife, daughter of James Thomson, who was an owner of flax and other mills at Strathavon, where he held the office of baron-baillie. Of the brothers, those who attained to maturity were all men of remarkable intellect. The eldest, John Smith, was for many years a master in the Perth Academy, and paid great attention to optics, a paper of his having been printed in the Memoirs of this Society. James Smith, a man of highly original character, was the author of several works on religious and philosophical subjects. Another brother, Michaiah, was a distinguished oriental scholar, while Joseph, the youngest, devoted himself to science, but unfortunately died early. The father was by all accounts a very earnest man with profound religious convictions, and though not highly successful in worldly pursuits was able to give his sons a good education, such as the schools and universities of Scotland were and are presumably still able to offer even to men of moderate means. Two of the sons, James and Michaiah, were ordained ministers in the Scotch church. At that time, however, the Irvingite schism was exciting the minds and engaging the sympathies of many, especially the young, and it is probable that the father as well as several of the sons felt attracted by the doctrines promulgated by Irving, doctrines which could not possibly find sufficient scope within the somewhat contracted sphere of a Calvinistic communion. So far as our friend is concerned it is certain that his sympathies led him more in the direction of Anglicanism, and from the hints he let drop at various times it seems that it was only through circumstances that he was prevented, when a choice was possible, from taking orders in the English church. After passing through the usual course at the Glasgow high school, and spending some time at the University of Glasgow, a period of his life of which he seldom spoke, simply perhaps because there was little to say, Dr. Smith accepted a post as tutor to a family in the Highlands, but was soon compelled to leave from ill health. He then proceeded to England, where he was employed in a similar capacity in families, whose peculiar religious opinions give some indication of the direction in which his sympathies at that time tended. With the Rev. and Hon. H. E. Bridgeman he spent two years, and with him proceeded to Germany. So far Dr. Smith's tastes and occupations had been purely literary and theological. His education had been entirely classical, comprising a knowledge of ancient languages, such as was in his day thought sufficient for all the purposes of life, an acquaintance with science, mathematics, or modern languages being then considered of little consequence. During his stay in Germany one of the tendencies of his many-sided mind revealed itself. Hearing of Professor Liebig, whose fame was then spreading through Germany, his attention was directed towards science, this tendency being perhaps encouraged by the example of his brother Joseph, who had engaged in the study of chemistry under Professor Penny, of Glasgow, and with whom he corresponded. He accordingly proceeded to Giessen, where he worked in Liebig's laboratory during the years 1840-41, and where before leaving he took the degree of Ph.D. During his stay at Giessen he extended his knowledge of the German language and literature, and also paid much attention to German systems of philosophy, a subject that at all times interested him greatly.

It may perhaps be considered a matter for regret that Dr. Smith's early training in science was not more extensive, and that it continued for so short a time. On the other hand it is possible that a more rigorous training in natural science and mathematics might have detracted from the catholicity of mind and wide culture which were prominent characteristics of his. He afforded indeed a conspicuous example of what the conservatives in education always insist on, viz., that a thorough classical training affords a basis on which a superstructure consisting of any kind of specialty may be confidently erected, though on the other hand it is hardly a safe proceeding to found general rules on such exceptional cases as his. Soon after leaving Giessen, Dr. Smith published a translation of Liebig's work "On the azotized nutritive principles of plants." After his return to England at the end of 1841, Dr. Smith was engaged in various capacities with families of distinction, and at this time the early inclination for a theological career seems to have revived, and was probably only given up when it was found that circumstances, such as the necessity for a preliminary education at an English University, placed an insuperable barrier in the way. In the year 1843 we find him working as assistant to Dr. Lyon Playfair, with whom he had become acquainted at Giessen, and who was then engaged as Professor of Chemistry to the Manchester Royal Institution. At Manchester Dr. Smith finally settled down, here with the exception of intervals of travel he spent the rest of his life, and here all his most important work was done. With characters combining many-sidedness with great intensity of purpose it is often a mere accident that determines the direction the energies shall take. Such an accident occurred in the career of Dr. Smith. The Health of Towns Commission, of which Mr. Edwin Chadwick was the moving spirit, came to Manchester as to other towns to institute inquiries. Dr. Playfair was much interested in these inquiries, and Dr. Smith was engaged in conducting some portion of them, their object being more practical than scientific. This circumstance directed Dr. Smith's attention to sanitary matters, and led him to commence the series of investigations which occupied a great part of his time and attention from the year 1844, up to the time of his death.

At the time when Dr. Smith commenced his researches sanitary science did not exist, unless a mere collection of unconnected facts can be dignified with the name of science. Since that time much more system has been introduced into the subject, and a great portion of the merit of having developed the purely scientific side of it is due to Dr. Smith. The pathological side of the subject did not, of course, receive as much attention from him as the purely physical; nor did he, we think, at any time pronounce decidedly on the question whether the phenomena with which sanitary science deals are purely organic in their nature or whether they are not also partly due to merely physical causes. What he did was to investigate patiently the physical and chemical conditions as regards outward agents, more especially the air we inhale and the water we drink, on which health and disease seem to depend. No doubt, since the time when Dr. Smith entered the field, our views on this subject have altered considerably. It is now held that most diseases, especially those of the zymotic class, are due to the development of organic germs, but the most ardent advocate of the germ theory must allow that there are physical and chemical phenomena attending disease which must not be neglected, and to these Dr. Smith chiefly confined his attention, now and then only reverting to the general question of the causes of disease, as to which he was always prepared to change his opinions when the progress of discovery required him to do so. The results of his labours are contained in a series of papers, of which the Royal Society's catalogue contains a list, though an incomplete one, beginning with one entitled "Some Remarks on the Air and Water of Towns," published in the Chemical Society's Journal, 1845-48. His results are summed up in an independent work entitled "Air and Rain." Much of Dr. Smith's work was necessarily of a purely qualitative character, for the phenomena which he investigated are concerned with almost infinitesimal quantities of matter. Nevertheless, whenever it was possible, he introduced quantitative methods, as when examining the amount of carbonic acid contained in the atmosphere, of which an account will be found in his paper "On Minimetric Analysis," read before this Society in the session 1865-66. This paper contains a description of a very simple and ingenious little apparatus, called by him a "finger-pump," by which the amount of impurity in the atmosphere, in the shape of carbonic acid or hydrochloric acid, can be rapidly and easily determined. On disinfectants, to which Dr. Smith's attention was naturally directed, he worked much, his general views on the subject being contained in a separate work published in 1869, and entitled "Disinfectants and Disinfection." The practical result of his studies in this direction was the invention of a very useful disinfectant which was introduced by Mr. Mc.Dougall, and is still largely employed. This short résumé of Dr. Smith's labours on air and water in their hygienic relations must suffice for the present occasion, but before closing it we must not omit to name his able report "On the Air of Mines," chiefly those of Cornwall, presented to government, by whose directions the inquiry into the atmospheric conditions prevailing in mines was undertaken. Dr. Smith's memoirs on other scientific subjects are not numerous. Among them may be mentioned those on rosolic acid, on the absorption of gases by charcoal, which he supposed to take place in certain definite proportions and on the "Measurement of the Actinism of the Sun's Rays and of Daylight" (Proceedings, Royal Society, XXX, 355), in which a novel method of measurement is described. His study of peat, which treated of a favourite subject of his, was perhaps more practical than scientific in character.

This is perhaps not the place to mention in detail his work in connection with technical subjects, but one of his inventions must not be passed over in silence, viz. that for coating iron tubes with an impermeable varnish, so as to preserve them from corrosion. Of this invention experts entertain the very highest opinion, and it may safely be said that had he been endowed with more wordly prudence, he might by this invention alone have amassed a considerable fortune. Like many other inventors he never enjoyed the rewards to which his ingenuity entitled him—it is for the world to acknowledge, by words at least, the benefits he conferred on it—for those who are unable or unwilling to fight and struggle for wealth and position it has no other recompense to offer.

In the year 1864 Dr. Smith was appointed chief inspector under the Alkali Act, which had just previously been passed by the legislature, a post for which he was from his intimate knowledge of atmospheric contamination eminently fitted. Great complaints having arisen regarding the injury done to crops and other things by the emanations from alkali works, an Act was passed the object of which was to limit the amount of injurious gases, especially hydrochloric acid which should be allowed to escape from the flues of alkali works.

It was this Act the provisions of which Dr. Smith with the aid of his sub-inspectors was to see carried out by constant supervision on the part of the sub-inspectors and frequent periodical visits to various districts by himself.

That he was eminently successful in his attempts to secure for the public the benefits which the legislature had in view when the Act was passed, and on the other hand in conciliating by his prudence and tact those who were to some extent restricted and interfered with by the provisions of the Act, is universally conceded. It is quite possible that in other hands the task which Dr. Smith was called on to perform might not have been accomplished and the result might have been complete failure. To continue what he began according to methods initiated by him is a comparatively easy task. As chief inspector under the Alkali Act Dr. Smith had each year to present a report of the proceedings under the Act for the preceding year. These reports, of which the last presented in 1884 was the twentieth of the series, contain much information over and above what mere official summaries might be expected to give, and they should be carefully studied by all who are interested in hygiene in its relation to manufactures.

In the year 1876 an Act similar to the Alkali Act, though of a less stringent character was passed styled the "Rivers Pollution Prevention Act." Under this Act Dr. Smith was appointed to examine polluted waters, more especially the state of effluent fluids from sewage works, and he presented two reports to the Local Government Board as an inspector under the Act. To the results set forth in the second of these reports, presented shortly before his death, Dr. Smith attached the greatest importance. It will be for others to judge of the value of these results, but he himself considered that the discoveries described in the report would open up a wide field of research throwing quite a new light on the relations between disease and water and soil.

To those who take an interest in sanitary science it must be a matter for vivid regret that his labours on this novel field of research were cut short just when they seemed to promise important results.

It remains to say a few words on such of Dr. Smith's publications as are not of a scientific or professional character. These are partly philosophical in their tendency, partly literary or simply popular in character and in part treat of antiquarian subjects for which Dr. Smith had a great liking, and seem often to have been hastily penned to fill up a leisure hour or at the request of friends. Many of them were anonymous, but Dr. Smith's style and the current of his thought were so original that to those who knew him the disguise was only a thin one. One of the works belonging to this class must not however be passed over without special notice. During several years of the latter portion of his life he was in the habit of spending his autumn vacation on the shore of Loch Etive in Scotland, where he employed himself—his active mind never being satisfied without some special object to occupy it—in exploring this part of his native country with a view of throwing some light on its state in prehistoric times. The result was a work which is not only instructive, but highly entertaining in the best sense, called "Loch Etive and the Sons of Uisnach," a work which all should read who are interested in prehistoric research and ethnology. Dr. Smith paid great attention to Celtic languages and made a large collection of works in Gaelic. These, with the rest of his books, have since his death been presented to the library of Owens College.

Dr. Smith was elected a member of this Society in the year 1844. For several years he acted as one of the secretaries of the Society, subsequently he was elected a Vice-President and during the sessions 1864 and 1865 he filled the post of President. He at all times took a lively interest in the welfare of the Society, and was always ready with advice and active assistance when such were required in the transaction of business.

In connection with this Society he will, however, be chiefly remembered by two works, the "Life of Dalton and the Atomic Theory" and "A Centenary of Science in Manchester," which were written at our request, and form two volumes of our series of Memoirs.

Into the merits of those works it will be unnecessary to enter, as they must be well known to all the members. For the last work we are under peculiar obligations to him, as it was undertaken contrary to the advice of his friends at a time when his health was declining, and he was already overburdened with other work.

He was also a Fellow of the Royal Society and of the Chemical Society of London, and a member of several learned societies on the continent. Had he been more of a specialist it is probable that the list of societies that have sought to honour him by membership and in other ways would have been longer. In the year 1881 the degree of LL.D. was conferred on him by the University of Glasgow, a distinction which coming from his alma mater, the seat of learning in his native town, he valued highly. The same degree was awarded to him by the University of Edinburgh in 1882.

Dr. Smith's health had evidently been declining for some years. Not endowed with a very robust constitution, and unable, as it appeared to some, to take the amount of sustenance required for so active an existence as his, the great labours which were partly imposed on him, and partly undertaken voluntarily, began in time to tell on his health. To the entreaties of his friends to allow himself some rest he did not reply by a direct refusal, but continued to work on with unabated zeal, as if the stock of vigour he had to draw on were inexhaustible.

Various changes of scene were tried, but without effect, and he gradually sank, the bodily strength declining but the mind remaining clear to the last. He died at Colwyn Bay, in N. Wales, on the 12th May, 1884. His remains were interred in the churchyard of St. Paul's, Kersal, near the spot where one of his oldest and most intimate friends hopes some time also to rest.

This notice would not be complete without some reference to Dr. Smith's moral characteristics. To most of us these were familiar, but those who come after us should know that in his case an intellect of high order was united to a character of the purest and noblest type. The most marked trait in his character, it seems to us, was a wide, to some it might seem an almost inconceivably wide benevolence, a benevolence which seemed capable of embracing all except the unworthy within its folds. It was this that led him to associate with men of the most diverse character and aims, extracting from each specimen of humanity a something with which he could sympathise, putting on one side or excusing what was uncongenial to his nature in each and establishing bonds, some stronger some weaker, which in their totality gave him a sense of relationship to humanity at large. This wide toleration may serve to explain the fact which may sometimes have been observed, that two men mutually repellent and unwilling to associate together might both have been warm friends of his. To us he seemed sometimes to be the centre of a system or constellation, the individual members of which knew little of each other, but were all united to him by bonds of sympathy. His extreme conscientiousness and high sense of honour appear even in his works, leading him scrupulously to weigh all that could be said on either side of an argument, and to give every man his proper share of merit, refusing sometimes even to credit himself with what was manifestly his due. This great conscientiousness was occasionally even injurious to him by hindering him in arriving at positive and precise conclusions such as the world requires even when there is no thorough conviction.

Of the charms of Dr. Smith's conversation, only those are able to form an idea who had the pleasure of his personal acquaintance, for it was not of a kind to be reproduced in set phrases. Without being at all eloquent or indulging in harangue and giving due weight to everything his hearers had to say, he was able from the fulness of his knowledge and the originality of his views to throw a new light on almost every subject he touched on, and thus he would sometimes continue to instruct without dogmatising and entertain without wearying until it was found that not minutes but hours had slipped away in listening.

One trait in Dr. Smith's character must not be passed over, though to mention it in this age of materialism may seem to require some apology—he was a firm believer in a spiritual world, that is of a world above and beyond the senses, of the reality of which, whether we can communicate with it directly or not—and of this he never seemed quite sure—he was firmly convinced. Those who remain to lament his loss, and who share the same belief, may unite in the fervent trust that in the world of which he thought much, but spoke little, his spirit may have found not merely rest and satisfaction, but also a continuance of that mental activity and development which to him were life.

Dr. Smith was never married, but for many years his niece, Miss Jessie Knox Smith, was his constant companion and confidante, ministering to him with a zeal and devo- which could not have been exceeded had the relationship been that of father and daughter.

"On a variation in the size of an image on the retina according to the distance of the background on which it is seen," by ALFRED BROTHERS, F.R.A.S.

The effect on the retina when the eyes have been fixed intently for a few seconds on a brightly illuminated coloured object is well known, the colour complementary to the one looked at always appears when the gaze is removed to a colourless surface. It is also a matter of common observation that when the eyes have been directed to a bright light for a short time, the image left on the retina as seen when the eyes are averted is *dark*; but if the eyes are rapidly opened and closed the image is still seen *bright*. I am not aware, however, that it has ever been noticed that this image varies in size according to the distance of the background to which the eyes are directed. A circle of gas jets, perhaps, affords the simplest test. It will be seen after looking at the circle of light for a few seconds—(in some cases a more or less lengthened gaze at the light is necessary, owing to the varying sensitiveness of the retina) – that, if the vision be turned to a distant background, the size of the image is instantly enlarged, and then, if the eyes be directed to a near background, the image is reduced in size. If any difficulty should be found in seeing the reversed image of the gas jets, it may readily be seen as a bright object by rapidly closing and opening the eyelids. The effect is the same as if the image were seen through a cone —the apex of the cone being held close to the eyes. In other words, the effect is the reverse of the ordinary rules of perspective.

MICROSCOPICAL AND NATURAL HISTORY SECTION.

Annual Meeting, April 13th, 1885.

Dr. ALCOCK, President of the Section, in the Chair.

Annual Report of the Section, April, 1885.

There have been 7 meetings of the Section during the past session, at which the attendance has been satisfactory. During the same period 6 meetings of the Council have been held.

The balance in the hands of the Treasurer continues to increase, and stands at £194 3s. 11d., on the 7th April, 1885; but this amount includes the unexpended balance of a grant of £100 made for the purchase of Natural History works by the Council of the Parent Society from their "Natural History Fund." The Council of the Section consider it desirable to keep their expenditure against these grants under a separate heading, and for that reason the payments made on this account during the past session (£41 19s.) appear separate from the ordinary expenditure of the Section, in the accompanying statement of the Treasurer. The Council think it right to put on record a statement of the whole of the payments which they have made during the last eleven years against grants made from the Natural History Fund, and the Treasurer has made the accompanying abstract of the receipts and expenditure of this fund, showing a credit balance of £55 13s. 1d., on the 7th April, 1885.

The following is a list of the Members and Associates on the 7th April, 1885; viz:—

Members.

Alcock, Thomas, *M.D.*
Bailey, Charles, *F.L.S.*
Barratt, Walter Edward.
Barrow, John.
Baxendell, Joseph, *F. R. S.*, *F.R.A.S.*
Bickham, Spencer H., Jun.
Birley, Thomas Hornby.
Boyd, John.
Brogden, Henry.
Brothers, Alfred, *F.R.A.S.*
Cottam, Samuel.
Coward, Edward.
Coward, Thomas.
Cunliffe, Robert Ellis.
Dale, John, *F.C.S.*
Dancer, Jno. Benjamin, *F.R.A.S.*
Dent, Hastings Charles, *F.L.S.*
Darbishire, R. D., *B.A.*, *F.G.S.*
Dawkins, W. Boyd, *F.R.S.*,*F.G.S.*, Prof. of Geology, Owens College.
Deane, W. K.
Higgin, James, *F.C.S.*
Hodgkinson, Alex., *B.Sc.*, *M.B.*
Hurst, Charles Herbert.
Howorth, Henry Hoyle, *F.S.A.*
Marshall, A. Milnes, *M.A.*, *D.Sc.*, *F.R.S.*, Prof. of Zoology, Owens College.
Melvill, J. Cosmo, *M.A.*, *F.L.S.*
Moore, Samuel.
Morgan, J. E., *M.D.*, *M.A.*
Nicholson, Francis, *F.Z.S.*
Sidebotham, Joseph, *F.R.A.S*, *F.L.S.*
Williamson, Wm. Crawford, *L.L.D.*, *F.R.S.*, Prof. Nat. Hist., Owens College.
Wright, William Cort.

Associates.

Blackburn, William, *F.R.M.S.*
Brooke, H. S., *B.A.*, *M.B.*
Cunliffe, Peter.
Huet, Frank A., *L.D.S.*, *R.C.S.*
Hyde, Henry.
Pettigrew, John B.
Quinn, Edward Paul.
Rogers, Thomas.
Smith John, *M.R.C.S.*
Stirrup, Mark, *F.G.S.*
Sington, Theodore.
Tatham, John F. W., *B.A.*, *M.B.*
Ward, Edward.
Young, Sydney.

Total 32 Members and 14 Associates, against 33 members and 9 Associates at the corresponding period last year.

The following communications have been made, and papers read to the Section; those marked with an asterisk have been recommended by the Section for printing in the "Memoirs" of the Society.

* A paper, illustrated with specimens, "On the Nests of the Trap-door Spider, *Nemetia cœmentaria* (Latr.)," by Mr. Mark Stirrup, F.G.S.

A Demonstration "On a Method of Preparing and Mounting *Foraminifera* for Examination under the Microscope," by the President.

* A paper "On the Morphology of the Sexual Organs of "*Hydra*," by Professor A. Milnes Marshall, M.D., D.Sc., of Owens College.

A communication, with specimens, showing the regeneration of the visceral mass in *Comatula;* also some young specimens of *Pennatula*, by Prof. A. Milnes Marshall, M.D., D.Sc.

Specimens of (*a*) a piece of Chalk from Brighton, perforated by a Species of *Pholas* ; (*b*) *Stalactites* from Victoria Cave, Settle, were exhibited by Mr. Henry Hyde.

Fine specimens of *Magilus Antiquus*, and some remarkable series of various forms of *Leptoconchus* from the Mauritius, were exhibited by Mr. R. D. Darbishire, F.G.S.

Paper "On the Carnarvonshire Station of *Rosa Wilsoni* (Borrer)", by Mr. Charles Bailey, F.L.S.

The Electric Spark under the Microscope, as produced by a Chromate of Potash Battery at the extremities of two pencil points, exhibited by Mr. Alfred Brothers, F.R.A.S.

Specimens of Everlasting Flowers, exhibited, with notes, by the President.

Communication, "On the Absence of the Earth-Worm on the Prairies which lie along the track of the Canadian Pacific Railway, between Winnipeg and a district east of the summit of the Rocky Mountains," by Mr. Thos. Rogers.

Communication, "*On Pulex Penetrans*," with specimens, by Mr. John Boyd.

* Paper, "On a Proposed Revision of the Species and Varieties of the Subgenus *cylinder* (Montfort) of *CONUS* (L.)", by Mr. Cosmo Melvill, M.A., F.L.S.

Communication, with specimens, "On a Mineral Deposit (*Elaterite*) occurring at Windy Knoll, near Castleton, Derbyshire," by Mr. Theodore Sington.

Specimens of *Hydractinia racemosa*, from Japan, were exhibited, and some account was given of the British Species *Hydractinia Echinata*, by Mr. R. D. Darbishire, F.G.S.

* Paper "On the Breeding of the Reed Warbler, *Acrocephalus arundinaceus*," by Mr. F. Nicholson, F.Z.S.

* Paper "On the Post-Glacial Shell Beds at Uddevalla, Sweden," by Mr. Mark Stirrup, F.G.S.

Paper "On the Rare Foraminifer, *Lagena Crenata*," illustrated by specimens, by the President.

Mr. P. CAMERON exhibited an example of *Selandria Sixii* which had both of the recurrent nervures received in the 2nd cubital cellule, thus differing from the normal form; and pointed out that, to his knowledge, two "genera" had been created on similar variations in the neuration of the wings.

Mr. ROGERS exhibited a large and handsome form of "*narcissus*" which appeared to be identical in form with a figure published in the year 1757 in Hales Eden, under the name of "nonpareil," but which has now been recently made prominent as a florist's flower, under the name of "Sir Watkin Daffodil."

Mr. John BOYD read some notes on *Calgius* and *Lepeophtheirus*—Entomostraca Paratitic on the Cod. The subject was admirably illustrated with diagrams drawn by Mr. Boyd himself.

The following gentlemen were elected Officers and Members of Council of the Section for the ensuing year:

President.

THOMAS ALCOCK, M.D.

Vice-Presidents.

T. COSMO MELVILL, M.A., F.L.S.
A. MILNES MARSHALL, M.A., MD., F.R.S.
A. BROTHERS, F.R.A.S.

Treasurer.

MARK STIRRUP, F.G.S.

Secretary.

JOHN TATHAM, B.A., M.B.

Council.

CHAS. BAILEY, F.L.S.
JOHN BOYD.
ROBT. E. CUNLIFF.
R. D. DARBISHIRE, B.A., F.G.S.
F. NICHOLSON, F.Z.S.
THOMAS ROGERS.
THEODORE SINGTON.
W. C. WILLIAMSON, LL.D., F.R.S.

THE MICROSCOPICAL AND NATURAL HISTORY SECTION OF
IN ACCOUNT WITH THE PARENT SOCIETY FOR GRANTS

Dr.

From 31st March, 1875,

		£	s.	d.
1875. March 31.	To Grant, per Treasurer of Man. Lit. & Phil. Society ...	100	0	0
1876. March 30.	,, ,, ,, ,, ,, ,, ...	40	0	0
1877. April 30.	,, ,, ,, ,, ,, ,, ...	60	0	0
1878. April 6.	,, ,, ,, ,, ,, ,, ...	100	0	0
1880. April 15.	,, ,, ,, ,, ,, ,, ...	40	0	0
1882. March 14.	,, ,, ,, ,, ,, ,, ...	80	0	0
1885. March 17.	,, ,, ,, ,, ,, ,, ...	100	0	0
		£520	0	0
1885—April 7.	To Balance of Natural History Fund Grants......	£55	13	1

THE MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY,
MADE FOR BOOKS FROM THE NATURAL HISTORY FUND.
to 7th April, 1885. **Cr.**

Date		£	s.	d.
1874.				
Oct. 19.	By Microscopical Journal, Vols. I.—X.	3	15	0
1885.				
Feby. 10.	,, Tulasnés Selecta Fungorum Carpologia, 3 Vols.	9	15	0
,, 10.	,, Adansonia, Vols. I.—X.	6	15	0
,, 10.	,, Bruch, Schimper, and Gumbel's Bryologia Europæa ...	16	10	0
,, 10.	,, Linnæa, Journal f. d. Botanik	1	4	0
,, 10.	,, Wilson's Bryologia Britannica ..	4	4	0
,, 10.	,, Agassiz' Monograph d'Echinodermes	1	18	6
,, 10.	,, Dickinson's Flora of Liverpool	0	5	0
Octr. 5.	,, Murray's Geographical Distribution of Mammals	1	8	0
,, 5.	,, Archives du Muséum d'histoire naturelle	24	0	0
,, 5.	,, Nouvelles archives ditto	18	8	0
,, 5.	,, Bulletin de la Société Botanique de France	18	14	0
1876.				
April 5.	,, Réaumur's Mémoires p. s. à l'histoire des Insectes, 6 vols.	2	2	0
,, 5.	,, Ralf's British Desmidieæ	3	13	6
Nov. 28.	,, Reichenbach's Icones Floræ Germanicæ et Helvet., Vols. I.—XXI.	54	0	0
1877.				
April 16.	,, Zoological Record, Vols. I.—XIII.	12	9	0
Nov. 16.	,, Nature-printed British Seaweeds, by Johnstone & Croll	4	4	0
,, 16.	,, Seemann's Flora Vitiensis, description of the Plants of the Fiji Islands	4	15	0
,, 28.	,, Hooker's Niger Flora	0	7	0
,, 28.	,, Hooker's Flora of British India	1	1	0
,, 28.	,, Hooker's Flora Tasmaniæ, 2 Vols.	12	12	0
,, 28.	,, Lowe's Flora of Madeira	0	5	0
,, 28.	,, Boott's Illustrations of the Genus Carex, Vol. IV.	9	0	0
,, 28.	,, Oliver's Flora of Tropical Africa, Vol. I.	0	16	8
,, 28.	,, Harvey's Flora Capensis, 3 Vols.	1	15	0
1878.				
Feby. 4.	,, Hewitson's Exotic Butterflies	49	0	0
,, 5.	,, Ibis, for 1859 to 1876	0	0	0
May 13.	,, Lovell Reeve's Conchologia Iconica, Monograph of the Genera of Shells, Vols. I.—XIX.	115	0	0
1879.				
Mar. 14.	,, ,, ,, ,, ,, Vol. XX.	9	19	3
April 10.	,, Hewitson's Exotic Butterflies	4	10	0
1880.				
April 21.	,, ,, ,, ,,	9	0	0
Aug. 3.	,, Hooker and Bentham's Genera Plantarum	4	0	0
1882.				
Mar. 25.	,, 'Challenger' Reports, Vols. I.—III.	5	0	0
Oct. 31.	,, ,, ,, ,, IV.—V.	6	10	0
1883.				
Mar. 9.	,, ,, ,, ,, VI.	2	2	0
Oct. 22.	,, ,, ,, ,, VII.	1	10	0
1884.				
April 3.	,, ,, ,, ,, VIII.	2	0	0
,, 18.	,, Botany of California, 2 Vols.	3	12	0
,, 18.	,, Watson's Topographical Botany, 2nd Edition	0	16	0
,, 24.	,, Mineralogie Microscopique	2	4	0
May 13.	,, Hooker's Botany of the Antarctic Voyage made by J. C. Ross, 2 Vols.	10	10	0
June 28.	,, 'Challenger' Reports, Physics, Vol. I.	1	1	0
July 24.	,, Gray's Flora of North America, Vol. II., Pt. 1	1	16	0
Oct. 2.	,, ,, ,, ,, Vol. I., Pt. 2	1	5	0
,, 3.	,, 'Challenger' Reports, Zoology, Vol IX.	3	3	0
Nov. 19.	,, Owens' British Reptiles	12	12	0
1885.				
Jan. 16.	,, 'Challenger' Reports, Zoology, Vol. X.	2	10	0
April 2.	,, ,, ,, ,, Vol. XI.	2	10	0
,, 7.	,, Balance of Grants unexpended	55	13	1
		£520	0	0

Mark Stirrup, Treasurer, in account with the Microscopical and Natural History Section of the Manchester Literary and Philosophical Society, from 3rd April 1884, to 7th April 1885.

Dr.

Date			£ s. d.
1884.			
April 3.	To	Balance in Manchester and Salford Bank Ltd.	127 7 4
Dec. 20.	,,	Interest allowed by Bank	1 19 8
1885.			
March 17.	,,	Grant for Books by the Parent Society from Natural History Fund	100 0 0
April 7.	,,	Subscriptions and Arrears received during the Session 1884-5	21 10 0
			£250 17 0
1885.			
April 7.	To	Balance to the c. edit of the Section	£194 3 11

Cr.

Date				£ s. d.
1884.				
Aug. 1.	By	J. E. Cornish, Microscopical Journal, April to July		0 16 8
Oct. 3.	,,	Charles Simms and Co., Circulars		0 11 0
Nov. 10.	,,	H. H. Stainton, Zoological Record for 1884		1 0 0
Dec. 17.	,,	J. E. Cornish, American Naturalist for 1885		0 18 0
1885.				
Jan. 3.	,,	John Van Voorst, Ibis for 1885		1 1 0
Feb. 16.	,,	J. E. Cornish, Microscopical Journal, Oct. to Jan.		0 16 8
March 6.	,,	Parent Society, Sectional Subscription for Session 1884-5		2 2 0
April 2.	,,	W. Roscoe, Postages, etc.		0 19 5
,,	,,	,, Tea, Coffee, etc.		4 3 4
,, 7.	,,	Charles Simms and Co., Circulars and Cards		2 6 0
1884.	,,	By Payments on account of Natural History Fund, asunder:		
April 18.	,,	Wm. Wesley, Botany of California, 2 vols.	£3 12 0	
,,	,,	,, Watson's Topographical Botany	0 16 0	
,, 24.	,,	Dulau & Co., Minéralogie Microscopique	2 4 0	
May 13.	,,	Wm. Wesley Hooker's Botany of Antarctic Voyage	10 10 0	
June 28.	,,	T. J. Day, 'Challenger' Reports: Physics, vol. 1	1 1 0	
July 24.	,,	Wm. Wesley, Gray's Flora North America, vol. 2, pl. 1	1 16 0	
Oct. 2.	,,	Wm. Wesley, Id., vol. 1, pl. 2	1 5 0	
,, 3.	,,	T. J. Day, 'Challenger' Reports: Zoology, vol. 9	3 3 0	
Nov. 19.	,,	J. E. Cornish, Owen's British Reptiles	12 12 0	
1885.				
Jan. 16.	,,	T. J. Day, 'Challenger' Reports: Zoology, vol. 10	2 10 0	
April 2.	,,	T. J. Day, Id., vol. 11	2 10 0	41 19 0
,, 7.	,,	Balance in Manchester and Salford Bank, Nat. Hist. Fund (see separate acc.)	55 13 1	
,,	,,	Id., Ordinary Fund	137 16 11	
,,	,,	Cash in the hands of the Treasurer Ordinary Fund	0 13 11	194 3 11
				£250 17 0

April 9th 1885. Examined and found correct,

Signed { T. SINGTON. JOHN B. PETTIGREW.