THE

EDINBURGH PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF

THE PROGRESS OF DISCOVERY IN NATURAL PHILOSOPHY, CHEMISTRY, NATURAL HISTORY, COMPARATIVE ANATOMY, PRACTICAL MECHANICS, GEOGRAPHY, NAVIGATION, STATISTICS, AND THE FINE AND USEFUL ARTS,

FROM

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CONDUCTED BY

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TO CORRESPONDENTS.

The Editor has again to apologise to his Friends for the non-appearance of Communications, and also to request, that communications for the Journal will be sent to him at the latest on or before the first day of March, June, September, and December.

PREPARATIONS FOR PULLING DOWN THE GREAT GABLE. FRIDAY EVENING 19th NOVr

PLATE V.

PLATE V.

Etched W. H. Lizars

APPEARANCE OF THE RUINS ON THE EASTERN SIDE OF THE PARLIAMENT SQUARE THE INSTANT AFTER THE MINES WERE SPRUNG AT NOON ON SAT.Y 20.TH NOV.R 1824.

Fig. 1.

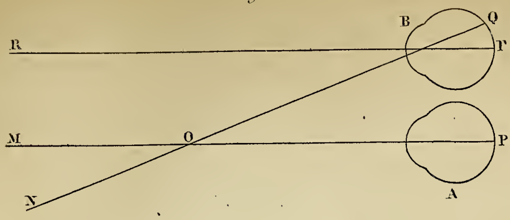
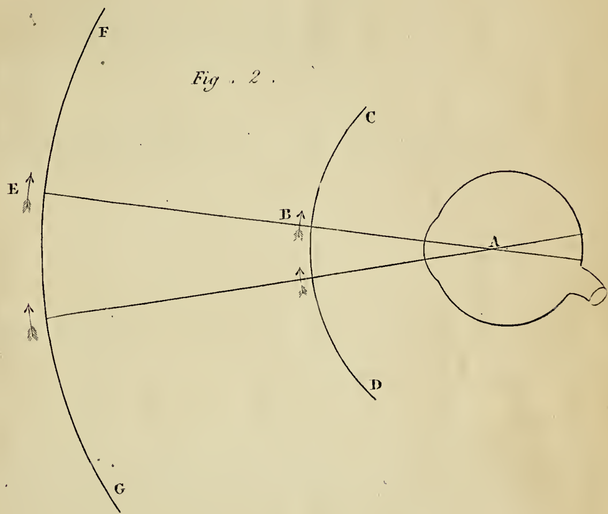


Fig. 2.



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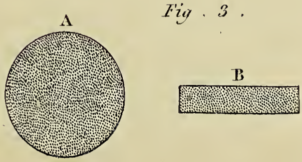

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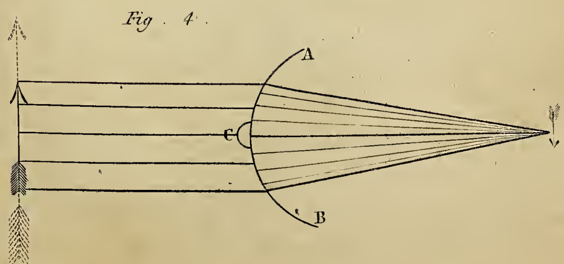

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Art. I.—*On Crystallisation.* By H. J. Brooke, Esq. F.R.S.

Little is at present known concerning the nature of those forces or influences which determine mineral bodies to assume a crystalline form, or concerning the causes which produce such a diversity of forms among crystals. Haüy states, that "when the molecules of a body are suspended in a fluid, which afterwards, either by evaporation, or through some other cause, abandons them to their reciprocal affinities, if no disturbing force should interfere, the molecules would unite by those planes the most disposed to such union, and would, by their combination, produce the regular solids which we term Crystals."

But this explanation of the manner in which a change of state from solution to solidity may take place, does not assist our inquiry into the nature of the causes which predispose the molecules to form solids of particular shapes, or which determine particular planes of those molecules constantly to unite with each other.

We may, for the purpose of adapting a theory to the facts we observe, suppose the molecules of bodies influenced by different forces; one of which acts only within very small distances, and may be termed the *cohesive* force; the others, acting at greater distances, introducing attraction or repulsion among the particles subject to their influence, and possibly bearing some close analogy to electricity. We may suppose these latter forces acting upon molecules held in solution at considerable distances, and predisposing them to approach each other, and to arrange themselves at the same time in some regular order; and we may imagine the same forces continuing to exert themselves, until the particles are brought within that distance from each other at which the cohesive force begins to operate. We may then imagine this cohesive force to fix and retain the molecules in those positions in which, when their numbers are sufficient, they will constitute, by their aggregation, visible and regular solids.

It is evident that we may frame other theories to account for the formation of visible solids; but there does not appear to be any hypothesis capable of accounting for the variety of forms under which crystals present themselves.

I shall, however, proceed to consider shortly the general phenomena of the production of crystals, and the circumstances under which the crystallisation of minerals probably takes place.

The different hypotheses which assign an aqueous or an igneous origin, to what has been termed the crust of our earth, a small portion only of the depth or thickness of which has been yet penetrated by the industry of man, suppose the minerals which have been discovered upon or beneath its surface to have been produced by corresponding causes.

It is, however, certain, that many of the natural crystals with which we are acquainted, were not formed contemporaneously with the bed in which they have been discovered, but that they have been produced at different periods, and possibly under very different circumstances. Sometimes their origin may be ascribed to the action of heat, sometimes to the solvent power of some fluid, and in other instances to the united influence of both these causes.

The observations of Sir Humphrey Davy " upon the state of water and aëriform matter in cavities found in certain crystals," printed in the *Phil. Trans.* for 1822, render it not improbable that natural crystals are formed under very different states both of pressure and temperature.

There are several appearances not uncommon among crystals, from which we may infer that they have been sometimes slowly formed, and that accompanying crystals of different minerals have been deposited at very different periods.

The crystals of carbonate of lime which are found at Ecton in Staffordshire, frequently contain numerous minute crystals of copper-pyrites, apparently first deposited on small crystals of the carbonate of lime. This substance has then formed over the pyrites, and produced a larger crystal of the carbonate of lime, upon which a second deposit of copper-pyrites has taken place. This has been again enclosed within a still larger crystal of the calcareous matter, upon which other crystals of pyrites have been again deposited. And we may discover, when the crystals are large, several alternations of these two minerals successively covering each other.

The crystals which are termed *pseudomorphous*, afford very distinct evidence of successive formation, as the period at which these were produced must have been posterior to that of the crystal whose form they imitate. I have observed in one instance a mould in preparation, if I may so term it, for a pseudomorphous crystal, from which a part only of the model, a crystal of fluate of lime, had been removed.

The mould itself was crystallised quartz, which had coated the crystal of fluor. The size of this crystal was originally more than a cubic inch; but it had been subsequently reduced to a rounded mass, loose within the mould, of about half that bulk, with an irregular and smooth surface, like that of partially dissolved salts.

Hollows of various forms, contained within crystallised quartz, are not uncommon; but I do not recollect any other instance of the crystal, whose removal had produced the vacuity, being only in part destroyed, as if its dissolution had been recently going on. Numerous other examples might be cited as evidences of the gradual and the successive formation of crystals, by processes which are probably still in operation, although we are uninformed with respect to their nature.

There are circumstances which render it almost certain that some crystals have been produced from solution in a fluid. The water found in the cavities of certain crystals of quartz, would seem to refer their origin to solution in that fluid; and we know, from the copious deposit of siliceous matter from the waters of the Geysers in Iceland, and from the hot-springs in the island of St Michael's, that quartz may be held abundantly in solution by water.

Whether the metals have been deposited from chemical solutions, or from a state of fusion, are points upon which we possess no certain information; nor do the few facts with which we are acquainted tend to throw much general light on the subject.

Some specimens were described by Mr Aikin in the *Geological Transactions*, which were brought from Torre del Greco. Among these were some minute octahedral crystals of red oxide of copper, attached to the surface of a fused, and partly oxidated, mass of copper and iron. These must have been produced by sublimation of the particles which composed them.

It appears from a paper by Dr Wollaston, published in the *Philosophical Transactions* for 1823, that the metallic titanium which he discovered among the slags from some iron-works, is wholly infusible; but he conjectures that it might have been precipitated, in its present crystalline form, from a state of oxide, in which it might have been sublimed; and in this manner crystals of the metals and their ores may possibly have been deposited upon quartz or upon other earthy substances.

The red oxide of mercury produces sometimes very distinct crystals by sublimation; and crystals of calomel and of other substances may be produced in a similar manner.

The processes of the laboratory are the only means we possess of investigating the phenomena of crystallisation. The art of the chemist has, however, as yet succeeded in imitating the composition of very few only of the natural minerals; and the number of these which he has reduced to crystalline forms is still less. Some minute crystals of quartz are said to have been deposited from an alkaline solution of that substance, after long standing; and crystals of carbonate of lime have been observed in vessels which contained the elements of that mineral in solution. Lead may be produced in thin metallic plates, from the decomposition of acetate of lead by metallic zinc; and the crystallisation of metallic silver will take place in an equally well known chemical experiment. Bismuth, antimony, and some other metals, may also be made to crystallise by fusion. But these few facts afford no conclusions which will explain the natural processes of crystallisation; nor are the causes which produce the almost endless variety of crystalline forms capable of explanation, from the phenomena attending the production of artificial crystals. With a view, however, to investigate those causes, many experiments have been made, from which several curious and interesting results have been obtained.

Most bodies have a tendency to crystallise in passing from a state of fusion or solution into a solid state.

Ice may, in the strict language of chemistry, be said to become fusible at 32° of Fahrenheit; and water, on the other hand, may be said to crystallise at that temperature, although it does not exhibit regular cleavage-planes when broken. Highly concentrated acetous acid becomes solid, and assumes a crystalline form, at about 50° Fahrenheit; and mercury crystallises at about 72° below the freezing point of water, and when in a solid state it is brittle, and exhibits a distinct crystalline fracture, if broken. Lead, antimony, and most other metals, become fluid at different temperatures above that of boiling water; and, when suffered to cool gradually from the melted state, they may be brought to crystallise with more or less regularity.

For this purpose, they are to be melted in deep vessels, and when the metal has become solid at the surface by slow cooling, that surface is to be broken, and the metal which remains fluid within to be poured out. The hollow which remains will frequently be found lined with very regular crystals.

Among the slags from furnaces regular crystals will also frequently occur, not only of metallic, but of earthy substances. The crystals of titanium, from the iron-works of Merthyr Tydvill have been already alluded to. I have seen, in the possession of Mr Rose of Berlin, some crystals in a slag, which were black, opaque, and had the form and measurements of pyroxene. The same gentleman has also shewn me a portion of a fused crystalline mass, resembling, in appearance and measurement, the pyroxene from Ala in Piedmont. This mass was produced, by fusing, in a porcelain furnace, a mixture of the elements of pyroxene, in the proportions in which they occur in that mineral; and it is said to be similar to pyroxene in hardness and specific gravity.

But the experiments which have been most frequently repeated on the formation of artificial crystals, are those in which the crystals have been deposited from solution in a fluid. Mr Brochant has collected together, from various authorities, and inserted in his volume on crystallisation, much interesting information on this head, and many of the following remarks are given from the authorities cited by him; but I have also made many experiments on the production of artificial crystals from solutions, some of which have corresponded in their results with those described by Mr Brochant, and others have very widely differed.

I propose to consider the artificial crystals produced from solution in a fluid, in reference

To *the general circumstances attending their deposition*;
To *their size*;
To *their forms*, whether *simple or compound, regular or irregular*; and
To *the character of their planes.*

I shall also have to refer occasionally to natural crystals for the better illustration of the subject.

The variations in the temperature and hygrometric state of the air, but more particularly the latter, will influence the deposition of crystals generally.

When the air is dry, evaporation proceeds more rapidly than when it is moist, and crystals are then deposited more freely.

Heat, as it promotes evaporation, predisposes a solution to deposit crystals; but these are only formed when the evaporation has been moderate, and as the solution cools. The precipitate from a solution which has been entirely evaporated at a temperature much above that of the atmosphere, does not generally produce crystals. A pellicle is first formed on the surface, and as the evaporation proceeds, an irregular mass is deposited at the bottom of the vessel, and it increases until the fluid is entirely dissipated.

The state of atmospheric pressure sometimes influences the production of crystals.

Thus, if a concentrated solution of sulphate of soda be inclosed, while hot, in a tube, it will not deposit crystals on cooling; but if the air be admitted to it, and it be at the same time slightly agitated, the whole mass becomes almost instantaneously solid. If, however, gas of any kind be admitted to the solution, M. Gay Lussac states, that a similar effect is produced. He also states that sub-carbonate of soda will crystallise in a vacuum, but not when exposed to the air. Many other salts crystallise equally well in vacuo, and under exposure to atmospheric pressure.

It happens not unfrequently that crystals are very slowly deposited from solutions in perfectly closed bottles, which have remained a considerable time at rest, and from which little, if any, evaporation could have taken place.

There is a considerable diversity in the manner in which the crystals belonging to different salts are deposited. Sometimes they stand singly, scattered, in a greater or less number, over the bottom of the vessel containing the solution. Nitrate of lead affords an example of this nature.

In other instances, their tendency is to form into groups, the crystals of which appear sometimes to radiate from a common centre. This character is very conspicuous among natural crystals in wavellite, in some varieties of sulphate of lime, in arseniate of cobalt, and others.

The crystals of sulphate of magnesia, of rhombic sulphate of nickel, of nitrate of potash, and of many other substances, if rather rapidly produced, form slender prisms, which so intersect each other that the axes of the prisms lie in almost every direction.

Some substances have a tendency to run up the sides of the vessel containing the solution, and to produce there very irregular and imperfect crystals, long before any regular ones are deposited. Muriate of ammonia possesses this character in a remarkable degree.

Chromate of magnesia does not crystallise, if the quantity dissolved be small, until the bulk of the solution be nearly equal to the bulk of the crystals that are produced from it. And the solutions of other salts are known to require a high degree of concentration before they will deposit any crystals.

The nature of the surface of the vessel containing the solution, will influence the precipitation of crystals. This crystallisation is said to take place more rapidly in rough earthenware than in glass vessels; and it is well known that threads, horsehair, fine wire, sticks of glass, and other foreign bodies introduced into a solution, will be covered with crystals in preference to the surface of the containing vessel.

These facts may be explained by the supposition, that a particle deposited on a point, in which it is nearly surrounded with other particles, will be more quickly covered by them than where it rests on a plane, and when only a smaller portion of its surface is accessible to fresh particles.

When a solution is ready to deposit crystals, they will be immediately produced, if a crystal, or even a fragment of the substance dissolved, be introduced into it. If a fragment of any irregular shape be introduced, it will not retain this shape as it increases in bulk; but the irregularities will be first found to disappear, and then a regular form will be produced, which will be enlarged as the evaporation proceeds.

The *size of the crystals* is generally influenced by the volume of the solution, and by its depth. When the volume and depth are considerable, and the evaporation slow, large crystals will generally be produced.

But in operating upon small quantities of fluid, crystals of different sizes are frequently produced in the same vessel, and in apparently a capricious manner. I have seen the bottom of a small saucer covered with very minute crystals, when, on pouring the solution into another saucer, a crop of considerably larger ones has been suddenly deposited, and these have been succeeded by smaller and larger, without any degree of regularity, as the fluid has continued to evaporate.

I have not been able to connect these alternations, with any degree of certainty, with the changes of the atmosphere, for I have observed the deposits, both of large and small crystals, become more copious as the atmosphere has become more dry. But Mr Beudant has remarked, that solutions charged with electricity have deposited smaller crystals than when in their natural state; and the changes just alluded to may possibly be connected with changes in the electrical state of the atmosphere.

Magnetism is also supposed sometimes to influence the process of crystallisation. Thus, it has been stated, that if, into a a glass tube, bent like a syphon, and placed with the curve downwards, there be introduced a small portion of mercury, not sufficient to close the connection between the two legs; and if to this a solution of the nitrate of silver be added, so as to rise in both limbs of the tube; it is said, that, when the tube is placed in the plane of the magnetic meridian, a rapid precipitation of the arbor Dianæ will take place; but that this process will be slow, when the tube is placed in a plane perpendicular to the same meridian. I have taken two bent tubes of nearly the same size, and have placed nearly equal quantities of mercury in them, and have added to these nearly equal portions of a dilute solution of the nitrate of mercury. I have then placed one tube in the plane of the magnetic meridian, and the other in a plane perpendicular to it, but have not been able to observe any decidedly marked difference in the deposit of silver in the two tubes. If the precipitation was more copious in one than the other, it was in that which stood in the plane perpendicular to the magnetic meridian. In this tube also, the branches of silver were more copious towards the west, and in the other tube towards the south. But, upon reversing the ends of both tubes, the branches of silver in each became more prominent in the direction of those already most distinctly formed, that is, the arborization now increased in the directions of east and north. Thus, in this experiment, the precipitation of the silver does not appear to have been influenced by the position of the tubes.

Some salts, of which the sulphate of copper and nickel, and the sulphate of copper and zinc, are examples, will deposit much larger crystals during the cooling of a smaller quantity of the solution, which has been saturated while hot, than from the spontaneous evaporation of a much greater volume, at the actual temperature of the atmosphere.

The next branch of our inquiry relates to the *forms of crystals.*

These may be either primary or secondary, simple or compound, regular or irregular.

The primary forms very rarely occur among either natural or artificial crystals; nor has experiment yet pointed out any means, by which these may, with certainty, be produced.

Several experiments have been made by Mr Beudant, from which he concludes, that *simplicity* of form may be influenced by art. He states, that *mechanical mixtures*, if they remain permanently suspended in the solution of a salt, will not produce any effect on its form; but if an impalpable powder be suffered to occupy the lower part of the vessel, the forms of the crystals deposited in that, will be more regular and simple than of those which are deposited above it. And certain crystals of axinite, which are coated by chlorite; the crystallised sandstone of Fontainbleau; and the primary quartz crystals, formed in an earthy ferruginous matrix, are adduced as natural illustrations of this fact.

There does not, however, appear to be much constancy in the result of such experiments; but, on the contrary, different substances appear to possess peculiar habitudes in this respect, and sometimes to exhibit very discordant results. I have observed sulphate of potash deposit *compound bi-pyramidal* crystals in a stratum of impalpable powder at the bottom of a saucer, while the crystals which rested above this stratum were all *simple.*

Chemical mixtures also influence the forms of crystals, and perhaps more frequently than any other cause, yet in a manner of which we believe at present no clear conception can be formed. Mr Brochant remarks, with great justice, that the nature of this influence is a highly important point in the history of crystallization, as it is probable that it very frequently governs the formation of natural crystals. Some *chemical mixtures* may be said to influence even the primary forms of crystals, without apparently altering the nature of their chemical constitution, while others merely occasion changes in the modifications of those forms.

Thus sulphate of nickel, if crystallised from an excess of acid, takes a *square prism* as the primary form; but if the *square prisms* thus obtained be dissolved in water, and re-crystallised, *rhombic prisms* are produced, without any apparent atomic difference in the proportions of their respective elements.

The difference between the forms of carbonate of lime and arragonite, which are probably similar chemical compounds, may have resulted from some interference analogous to this; and we may perhaps refer to the same cause the difference of figure between the common and the white iron-pyrites. The influence which chemical mixtures exert generally upon the modifications of crystals, has been stated by Mr Beudant and others to be very extensive.

The faces on which the deposited crystals rest, and those which are parallel to them, are generally extended disproportionately in relation to the other planes. But this is not invariably the case: Nor does the position of the deposited crystal, in reference to its axis, or its primary edges, always influence its form; although Mr Leblanc appears to have produced changes in figures of certain crystals, by varying their position in the solution. If the crystalline particles were constantly more numerous towards the bottom of the solution than at its surface, we might suppose that crystallisation would first take place at the bottom, and that the lower planes of immersed crystals would be the most enlarged; and this is frequently found to be the case.

But we may observe that several salts begin to crystallise almost invariably at the surface, and that, as the crystals thus formed sink and increase in size at the bottom, others are successively formed above.

I have remarked also among some crystals of nitrate of lead, which were deposited at the same time, and in the same vessel, some which were unmodified octahedrons, and others which were hemitropes. Of the octahedrons, some had their axis *perpendicular* to the surface on which they rested, and their upper summits were regularly terminated; others *rested on one of their planes*, and others were attached *by an edge* to the bottom of the vessel, consequently having one of the bases of the octahedron vertical, and the crystals being terminated by a horizontal edge.

These different crystals were deposited singly, as the crystals of nitrate of lead very frequently are; and the fact manifests the inconstancy of the form of a crystal, relatively to its position in the solution from which it is deposited.

The *natural planes of crystals* are subject to a considerable diversity of character, possessing sometimes the highest degree of brilliancy, and at others being so dull as to afford very imperfect reflections. Sometimes they are striated, sometimes curved, and commonly exhibiting greater or less degrees of inequality of surface. Particular planes of some crystals are frequently found to be marked by some peculiarity by which they may be distinguished from the others; and this character is commonly found on the corresponding planes of all other crystals on which they occur, belonging to the same species of mineral. Thus the planes which truncate the primary terminal edges of the crystals of carbonate of lime, are generally observed to be striated parallel to their edges of combination, and the terminal planes of hexagonal prisms of that substance are generally opaque and very dull.

Among artificial crystals, there will frequently be a difference in the characters of the planes, according to the circumstances under which they have been produced. But this difference is not constant in all substances. Sometimes the most perfect planes appear on those crystals which have been slowly formed; but I have also frequently observed them on such as have been deposited on cooling, from a solution which had been evaporated at a moderate heat to the point of crystallisation. Some of the double salts are difficult to be produced in good crystals by any other means. I have repeatedly tried to obtain, by slow evaporation, crystals with bright planes, of the sulphate of copper and zinc, but without success; yet they have been immediately produced by cooling, from a warm saturated solution of the salt; and I have observed the planes of crystals of sulphate of copper produced in this manner, more perfect than others which resulted from slow evaporation.

It appears from the measurements, which have been taken with great care by means of the reflective goniometer, that the primary forms of certain salts, whose chemical constitutions are essentially different, are not distinguishable from each other by the mutual inclination of their planes.

It is not, however, at all improbable, as I shall afterwards more particularly shew, that the variations in the angles and comparative dimensions of the primary forms of different substances, may be so small, as not to be discoverable by our best goniometric instruments, in the hands of our most able observers. Thus, sulphate of iron, and sulphate of cobalt, are scarcely if at all distinguishable from each other by measurement, and there are other salts which present similar apparent accordances in their forms and angles. I do not, however, know, that a rhomboid of 90° and 1″ may not exist, or even one approaching still more nearly to the cube. But I should expect to find such a crystal affected by the modifications of the rhomboid, and not by those of the cube; and this would constitute a distinctive character which it could not derive from measurement,

This view of the subject appears to be supported by the number of observed differences of measurement among crystals, which differ in their composition, belonging to all the classes of primary forms, except the four regular solids; and by the want of coincidences, except in the few cases of rhombic prisms of 60° and 120°, if these should really all measure exactly alike.

The subject has been, however, very differently regarded by an able and intelligent chemist, M. Mitscherlich, who has published several papers upon it, which may be found in the *Annales de Chimie.* In his first memoir M. Mitscherlich supposes, that these apparently similar forms are really identical; and that this identity is a necessary result of a similarity in their *atomic constitution;* and he also supposes, that wherever this atomic similarity exists, identity of crystalline form will always be the result.

From the first of this ingenious author's papers upon the subject, it appears, that this similarity of atomic constitution relates to the proportions of oxygen contained in the components of each of the supposed isomorphous crystals. Thus he says, oxygen in *phosphorous* and *arsenious* acids, is to that in the *phosphoric* and *arsenic* acids as 3 to 5. In the biphosphate and binarseniate of potash, the oxygen of the potash is to that of the acids as 1 to 5, and to that of the water of crystallisation as 1 to 2.

Hence, the only difference between these salts consists in the radicle of the one being phosphorus, and of the other arsenic; and all salts which differ only in this manner, are said to present identical crystalline forms.

But the instances which Mr Mitscherlich has adduced in support of his theory, or we may almost say as its foundation, are not in accordance with it.

He states, that the crystalline forms of the *sulphates* of *lead*, of *barytes*, and of *strontian*, are *identical.*

It is true, that the crystals of these three substances belong to the same *class* of *primary forms*; but they differ too much in the inclination of their planes, to allow us to regard the forms as identical, and to ascribe the differences either to errors of measurement, or to imperfection of the measured crystals: For the crystals of these substances are among the most perfect and brilliant that occur, and they have been measured often, and with corresponding results.

Their primary forms are *right rhombic prisms*, and the planes M incline on M′ at the following angles:

Sulphate of Lead,	103°.42
Barytes,	101 .42
Strontian,	104 .00

These, we may remark, are *natural* crystals, and they evidently do not appear to support our author's theory.

Nor do the artificial salts of those three substances in all cases better accord with it. The nitrates certainly agree in having for their common form a *regular octahedron*, but their acetates differ even more than their sulphates. The *primary form* of the acetates is a *right oblique-angled prism*, the planes M and T inclining to each other as follows:

Acetate of Lead,	109°.32
Barytes,	113 .12
Strontian,	96 .10

This theory is not better supported by the carbonates of lime, of iron, and of zinc, which are stated to be isomorphous. The primary forms of these substances are rhomboids, and the inclination of P on P′ has been ascertained to be as follows:

Carbonate of Lime,	105°.5
Iron,	107 .0
Zinc,	107 .40

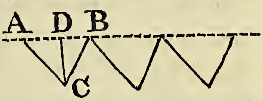
Under these circumstances it appears, that the theory of isomorphous atoms cannot be sustained; and I am told, that it has, upon more mature consideration, been abandoned by its author, who will probably admit, that *apparently* similar forms belonging to substances which differ in composition, do really differ from each other in measurement, by some small quantity which the goniometer does not detect.

Art. II. — *Observations on Radiant Heat.* By William Ritchie, A. M. Rector of the Academy at Tain.

THE theory of radiant heat, which we have illustrated in the last number of this Journal *, will enable us to explain, in a novel manner, some of the most striking facts discovered by Professor Leslie, and accounted for by that ingenious philosopher upon the supposition, that caloric is conveyed from one body to another by the pulses excited in the ambient air.

If a polished metallic surface be rubbed with sand-paper, or ploughed into fine parallel flutings, its radiating power will be greatly increased.

Let the surface of the body be fluted by the point of an equilateral triangle, as is represented in the figure. Draw CD perpendicular to AB. Then the quantity of caloric radiated from AC, in lines parallel to CD, is to the quantity radiated from AC, in lines perpendicular to AC, as the sine of ∠ ACD, is to radius. But the angle ACD is 30°, the sine of which is equal to half the radius. Hence the quantity of heat thrown off from AC, in lines parallel to CD, is equal to the quantity thrown off from AD, in the same direction. Now, as the same may be demonstrated with regard to CB, it follows, that the quantity of caloric which radiates from both sides of the prismatic furrows, is equal to the quantity radiated from the space AB of the plane polished surface, the temperature of the body being the same. But the caloric radiated from the lower half of AC, at right angles to that surface, will impinge upon CB, and be reflected in lines parallel to CD. Now, as the same thing takes place with the heat thrown off from the lower half of CB, it follows, that the caloric radiated from AC and CB, and reflected in lines parallel to CD, is equal to the quantity thrown off in the same direction from the original plane surface AB, provided none of it had been absorbed by the sides of the flutings. But since a metallic surface is an excellent reflector, it follows, that the portion absorbed will be very small when compared with the whole quantity radiated; and, consequently, the effect produced upon the bulb of the differential thermometer will be nearly doubled.



* No. XXII. (Oct. 1824), p. 281.

This curious property, which I have endeavoured to explain according to the known laws of radiation and reflection, is stated by Professor Leslie, at page 81. of his "Inquiry into the Nature of Heat."—"The power of the blackened side of a canister being denoted by 100, that of a clear side was 12. Another side, which had been slightly tarnished, was scraped to a bright irregular surface: the effect was now 16. Another side was ploughed in one direction, by means of a small toothed plane iron, used in veneering, the interval between the teeth being about $\frac{1}{30}$th or $\frac{1}{50}$th part of an inch: the effect was farther increased to 19. The first smooth side was now scraped downwards, with the point of a fine file: its effect was 23. But the filing being repeated, and more thoroughly covering the surface, the effect rose to 26 *."

From this experiment, it is obvious, that the quantity of caloric which was thrown off from the canister to the reflector, increased as the sides of the furrows became better adapted to reflect the heat radiated from each other. If these furrows be ploughed by others, crossing them at right angles, the quantity of reflected heat will evidently be diminished, and the effect upon the focal ball will be less than formerly.

The investigation which we have now given of the property of a striated surface, is corroborated by another fact discovered by the same indefatigable observer of the secrets of nature:—"The action of glass, or paper, or blacking, is not perceptibly modified by destroying their superficial gloss." When the surface of the body is a bad reflector, the caloric which impinges on the sides of the furrows will, in a great measure, be absorbed; and, consequently, the effect upon the focal ball will scarcely be altered by cutting the surface of the heated body into grooves or furrows. On the contrary, the more perfect the surface of the body be as a reflector, the greater will be the difference of effects produced by its polished and its striated surface.

The preceding investigation has led us to the discovery of the following remarkable property. If the plane surface of a body be ploughed into triangular prismatic furrows, the quantity of caloric radiated from the plane surface, in lines perpendicular

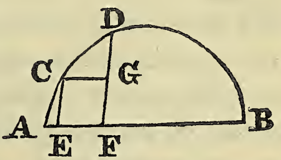
* Leslie's Inquiry into the Nature of Heat, p. 81.

to that surface, is equal to the quantity radiated in the same direction from the sides of the furrows, whatever be their number or depth. For, since the quantity radiated from AC, in lines parallel to CD, is to the quantity thrown off from AC, in lines perpendicular to AC, as the sine of $\angle$ACD is to radius. But the sine of $\angle$ACD is to radius, as AD is to AC. Hence the quantity of heat thrown off from AC in lines parallel to CD, is equal to the portion which would have been radiated from AD, had the plane surface remained; and, consequently the quantity thrown off from both sides of the groove, is equal to what would have been radiated from the plane surface AB.

From this property, it evidently follows, that the increased effect upon the focal ball, when a striated surface was used, does not depend upon the increase of surface, but upon the quantity of heat reflected by the sides of the furrows.

From the preceding reasoning, we may also conclude, that the quantity of heat radiated from the surface of a hemisphere, in lines perpendicular to the plane of its great circle, is equal to the quantity which would be radiated in the same direction from the plane of that great circle. For, let the surface of the hemisphere be conceived to be made up of an indefinite number of plane surfaces, A C, C D, &c. draw C E and D F perpendicular to A B, and C G at right angles D F.

Then, it is obvious, from what has already been demonstrated, that the quantity of heat radiated from A C, in lines paralell to EC, is equal to the quantity radiated in the same direction, from the plane surface AE. In like manner, it may be shown, that the heat thrown off from CD in the same direction, is equal to the quantity radiated from CG, or its equal EF. Hence, the quantity thrown off from the whole hemisphere, in lines perpendicular to AB, is equal to the portion radiated from AB in the same direction. The same property evidently belongs to any other solid, terminated by a plane surface.



By reasoning from the theory of radiation, which we have endeavoured to establish, we may deduce the property which has been employed in the preceding investigations. Let AC be the surface of a heated body (see last Fig). Let us conceive the surface covered with a film of the molecules of caloric. Then, it is obvious that those molecules which radiate in lines parallel to EC, have been darted off by the repulsive energy of those which are situated directly below them. Now, it is evident, that the number of those repelling molecules, will be equal to those ranged along AB. Hence, it follows, that the quantity of heat radiated from AC, in lines parallel to CE, will be equal to the quantity which would be radiated from AE in the same direction, the temperature of AC and AE being the same. But AC is to AE as radius to the sine of $\angle$ACE ; consequently, the flow of heat from AC in lines parallel to CE, is to the flow of heat from AC in lines perpendicular to AC, as the sine of $\angle$ACE is to radius.

The agreement of this conclusion with experiment, appears to be one of the most powerful arguments in support of the idio-repulsive theory, which we have endeavoured to illustrate and expand.

Art. III.—*Account of the Erection of the Bell Rock Lighthouse.* (With a Plate.)

We so rarely meet with minute details by scientific men of the operations of our great national works, that we gladly embrace the present opportunity of giving our readers an account of one of the most difficult undertakings of which the present age can boast.

Our information is chiefly derived from Mr Stevenson's large work, entitled, "Account of the Bell Rock Lighthouse, including the details of the erection and peculiar structure of that edifice." This work extends to more than 500 pages of royal quarto, and is illustrated with 23 engravings. We understand that only 240 copies were printed for sale: the circulation must therefore be very limited, and it must speedily become a scarce book.

In an introductory chapter an account is given of the institution of the Scottish Lighthouse Board in the year 1786, and of the progress of its various works till the year 1824. The author, who was himself the engineer and director of many of the works, enters upon an account of the principal undertaking, by giving a sketch of the natural history of the Bell Rock itself. It is a sunken reef of red sandstone *, the highest part only being uncovered at ordinary ebb-tides. The nearest land to the Bell Rock is the town of Arbroath, from which it lies in a south-eastern direction, about eleven miles distant. The dimensions of the part of the rock which becomes dry in spring-tides, are about 400 feet in length, and 250 feet in breadth, and at flood-tide the whole rock is from 10 to 12 feet under water. It presents a very rugged surface. The sandstone is similar in quality, and in geognostical character, to that found at the Redhead in Angusshire, and on the opposite shores, near Dunglass in Berwickshire. The author concludes that the Bell Rock may have been the nucleus, now the remains, of a mass of land, which, at no very remote period in the history of the globe, may have formed a small island above the reach of the highest tides. Its present vegetation consists only of sea plants; some of them, such as Fucus lycopodioides, not of common occurrence on our coast. It is the occasional resting-place of the seal and the cormorant; and it is the chosen residence of numerous marine vermes. One of these (the *Limnoria terebrans*), though a despicable-looking insect compared with the *Teredo navalis*, proves equally injurious to timber placed within its reach. The author gives an account of its destructive effects, not only on the Bell Rock Beacon, but on the sea-locks of different canals; and we understand that he has still (1824) a train of experiments going forward on the Bell Rock; several specimens of fir, larch, oak, teak, and other soft and hard woods being fixed down on the rock, and a register being kept of the progress of the animal in its work of destruction upon the several kinds of timber. During the continuance of the works, opportunities were also afforded of noticing the habits of some species of littoral fishes. These were so regular in their visits to the shallower fishing-grounds, that the seamen engaged in these

* This red sandstone belongs to the old red sandstone formation which lies under the oldest secondary coal formation.—Edit.

works often prognosticated the state of the weather with wonderful accuracy, from the abundance or scarcity of particular kinds of fish.

In regard to the depth of the sea near the Bell Rock, it appears, that, at the distance of about 100 yards, in a low state of the tide, the water varies from two to three fathoms in depth. Between the rock and the opposite shores of Fife, the greatest depth is 23 fathoms; but on the south-east or seaward side, it increases suddenly to 35 fathoms. The observations made upon the currents at the rock are curious. Although a mere spot on the surface of the ocean, it produces all the remarkable phenomena of in-shore and off-shore tides, which are noticeable on the projecting coasts of the mainland, or among the Scottish islands.

Among the earlier attempts made to erect some distinguishing mark or guide for the mariner upon this dangerous reef, the exertions of Captain Brodie of the Royal Navy are particularly mentioned. He succeeded in erecting a wooden beacon upon it, which stood for some time. Mr Stevenson's first landing upon the rock appears to have been in the summer of the year 1800, when the boat's crew picked up a variety of articles of shipwreck, comprising a soldier's bayonet and a cannon-ball, a hinge and lock of a door, a ship's marking-iron and part of a cambous, several pieces of money, a shoebuckle, &c. On this occasion, he became perfectly satisfied of the practicability of erecting a stone lighthouse on this fatal spot, upon principles similar to that of the Edystone in the English Channel. His report to the Commissioners for Northern Lighthouses, and also that of the late eminent Mr Rennie, who was consulted upon the subject in the year 1805, are given in an Appendix to the work. A bill was originally brought into Parliament in the year 1803, but was lost in consequence of its embracing what was considered as too wide a range of coast for the collection of the duty. Another bill was introduced into Parliament in 1806, which passed into a law, and the works commenced in the following year.

From the insulated and distant situation of this rock, the first object was to moor a tender for the exhibition of a temporary light, and for the convenient residence of the artificers. A vessel was also provided for conveying workmen between the shore and the rock. Quarries were opened near Aberdeen for supplying granite for the outward courses of the building, and at Kingoodie, near Dundee, for supplying sandstone for the interior. The principal establishment ashore was fixed at Arbroath, where a large inclosure was procured for the preparation of the stones, connected with barracks for the accommodation of the artificers. On the 7th of August 1807, Mr Stevenson, accompanied by Mr Peter Logan, his principal assistant, and a few artificers, went off to the Bell Rock, fixed upon the site of the lighthouse, and commenced the works by cutting away a thick coating of large sea-weed (*Fucus digitatus* and *esculentus*), and tracing the foundation of the lighthouse with pick-axes upon the rock. On this occasion, it was stipulated, that those workmen who went to the rock, should remain one month without going ashore; while the workmen in their turn stated their terms at 20s. per week, " summer and winter, wet and dry, with free quarters and victuals when at the rock :—As for Sunday's work and premiums, we leave that to the honour of our employers."

In the first stage of the works, two or three hours' labour upon the rock was considered a good tide's work ; at the conclusion of which, the artificers, carrying with them all their tools and implements, had to betake themselves to their boats, and to proceed, often under many disadvantages, to the tender, which was moored in the offing. The erection of some temporary refuge on the rock, in case of accident to the boats, formed part of Mr Stevenson's original design, and he accordingly lost no time in setting about the construction of a wooden beacon-house. This indispensable accompaniment to the works was successfully completed in the latter end of September, and, as the author expresses it, " robbed the rock of much of its terrors, and gave a facility to the works which could not otherwise have been attained." The want of such an accommodation at the building of the Edystone Lighthouse, where the smallness of the superficial dimensions of the rock did not admit of such an erection, formed one of Mr Smeaton's chief difficulties. The Edystone does not lie nearly so low in the water as the Bell Rock, and consequently the cubical contents of the building projected by Mr Stevenson were nearly double those of Mr Smeaton's lighthouse. The erection of this temporary beacon-house forms perhaps one of the most interesting parts of the undertaking. The principal beams, which were six in number, were about 50 feet in length, and formed a common diameter at the rock of about 35 feet, while they met in a point at the top, and were strongly bolted and girded with hoops of iron. At their base, they were fixed to the rock with great iron stanchions, weighing about 140 lb. each, which were sunk into the rock about 20 inches, and were wedged with successive slips of fir, oak, and iron. As the works depended so entirely upon the state of the weather, and the condition of the tides, they were continued on Sundays, and at night by torch-light, during the ebb. Under such perilous circumstances, it may readily be supposed, that several hair-breadth escapes were experienced. On one occasion, the tender broke adrift, carrying with her one of the artificers' boats, and thereby leaving thirty-two persons upon the rock, liable to be overwhelmed upon the return of flood-tide ; indeed, had not a boat accidentally come from Arbroath with letters to the engineer, they must in all probability have perished. Upon another occasion, they experienced a very severe gale on board of the tender, when the vessel again broke adrift. After this, great difficulty was found in procuring sailors to man this " forlorn hope" of a vessel. Prior to the erection of the temporary beacon (or the " hurricane-house," as the sailors termed it), the smith's forge was batted to the rock ; and his great bellows having to be removed every tide, formed no small charge to the landing-masters' crew. In this state of things, it not unfrequently happened, that, while the smith was busily employed in sharping the artificers' tools, the tide would imperceptibly but rapidly rise, immerse himself in water, and effectually quench his fire in a moment. Such was the relief experienced in this particular by the erection of the beacon-house, that, when the smith's apparatus was set a-going upon it, the seamen and artificers literally shouted with joy.

In the progress of the works in summer 1808, a considerable shipping establishment was found indispensable. Besides the floating-light ship, which was permanently moored off the rock, a schooner of 80 tons was provided as the principal tender. Stone-lighters of 40 tons were also provided, for the conveyance of the materials ; and likewise three praam-boats, each capable of carrying about 10 tons upon deck. These last were employed for removing the stones from the lighters anchored off the rock, to the wharfs and cranes formed upon the rock. They were doubly fortified by a water-tight ceiling or lining, in case of damage by being grounded upon the rock, and were farther prepared for the worst by a number of empty casks, which were stowed under deck, and were of themselves capable of keeping the praams afloat. There were also several attending-boats for transporting the artificers from the tender to the rock ; and one of these was fitted up as a life-boat upon Greathead's principle. The moorings of the various craft consisted of chains, with cast-iron mushroom anchors, admirably adapted to the situation. Tracks of iron-railways were laid, upon one level, along the rough and uneven surface of the rock, on which the great blocks of stone were wheeled upon waggons, also constructed chiefly of cast-iron. The little wharfs were provided with cranes adapted to the peculiarities of the respective situations. A descriptive account is given in the volume of the various cranes, sling-cart, stone-jack, winch-machine, and Lewis-bat for quarrying purposes, of the moulds for stone-cutters, pumps, and other machinery, in a detailed manner which must be highly interesting and useful to the engineer and the architect.

While engaged in this undertaking, notwithstanding all its difficulties, the artificers seem to have spent their time in a very happy and cheerful manner, and to have been well satisfied with their rations of provisions, pay, and premiums. At first the whole time of flood-tide was a period of leisure. On these occasions, in good weather, some were seen busy at their books, others were musically inclined, and many found amusement in fishing. The only evil they seem to have complained of was sea-sickness, for which even time itself hardly proved a cure, owing to the excessive rolling of the ships. They, therefore, strained every nerve to fit up a barrack upon the beams of the beacon, which was at once to relieve them from the constant liability to sickness, and from the danger and perplexity of the movements, both by night and day, in boats to and from the rock. The force of habit, however, under such perilous circumstances is finely exemplified in the testimony borne by Mr Stevenson to the readiness with which men, little versant in sea affairs, were brought to embark with alacrity, and to work with the tool in one hand,

and the lighted torch in the other, on a solitary sunken rock, at midnight and in darkness, amidst the howling of the wind and roaring of the waves. On one occasion, the author expresses himself thus:

"The wind being at south-east this evening, we had a pretty heavy swell of sea upon the rock, and some difficulty attended our getting off in safety, as the boats got a-ground in the creek and were in danger of being upset. Upon extinguishing the torch-lights, about twelve in number, the darkness of the night seemed quite horrible; the water being also much charged with the phosphorescent appearance which is familar to every one on shipboard; the waves, as they dashed upon the rock, were in some degree like so much liquid flame. The scene, upon the whole, was truly awful."

By strenuous and unremitting exertions, the beacon-house was erected, and the foundation of the building prepared, by the middle of the month of July in the second season of the work. The foundation had the appearance of a great circular platform of compact red sandstone, measuring 42 feet in diameter, surrounded by an irregular margin of rock, rising from 18 inches to 5 feet. In the work-yard at Arbroath, where the materials were prepared, the first and second courses of the lighthouse now lay ready for being shipped for the rock. Each stone was accurately marked, so that its relative position in the building on the rock could at once be recognised. The stones were cut of a dovetail form, on a plan similar to those of the Edystone Lighthouse. The foundation-stone at the Bell-rock was laid by Mr Stevenson, with masonic ceremony, on the 10th of July 1808. Upon this occasion, the author remarks:

"Whether we consider this building as an erection of great difficulty, or, in a nautical point of view, as adding much to the comfort and protection of the mariner, and safety of property, upon a range of coast extending almost to the whole eastern shores of Great Britain, its importance is evident. If it be proper, therefore, on any occasion, to attach importance to the act of laying the first stone of a public building, that of the Bell Rock Lighthouse cannot be said to yield to any in point of interest, either for the peculiarity of its situation, or the utility of its object. Under these considerations it is obvious, that but for the perilous and uncertain nature of any arrangement that could have been made for this ceremony, instead of its having been performed only in the presence of those immediately connected with the work, and of a few accidental spectators from the neighbouring shore, counting in all about eighty persons, many thousands would have attended upon an occasion which must have called forth the first dignitaries of the country, in conferring the highest honours of masonry. The writer may, however, confidently affirm, that, situate as the work was, nothing could add to the sensation felt by all present, in having now got matters in so advanced a state, as to be able to commence the building operations."

After this period the work went on with much alacrity, from ten to twenty blocks of stone being generally laid in the course of a tide. Owing to the use of cranes, instead of the more ordinary apparatus of sheer-poles, much precision and facility were given to the operations of the builders, and, by the latter end of September, the works were brought to a conclusion for the season.

" The building, being now on a level with the highest part of the margin of the foundation-pit, or about 5 or 6 inches above the lower bed of the foundation-stone, is computed at 388 tons of stone; consisting of 400 blocks, connected with 738 oaken trenails, and 1215 pairs of oaken wedges. The number of hours of low-water work upon the rock this season, was 265, of which number only 80 were employed in building. It was further highly satisfactory to find, that the apparatus, both in the work-yard at Arbroath, and also the craft and building-apparatus at the rock, were found to answer every purpose much beyond expectation. The operations of this season, therefore, afforded the most flattering prospects of the practicability of completing the solid part of the building, or first 30 feet of the light-house in the course of another year."

The builders returned to their barracks and work-yard at Arbroath, for the winter; and, on the tender's entering that harbour, the artificers were greeted with cheers from their comrades and friends ashore, who thronged upon the quays to welcome their return. This season's success, however, was chequered with a cross accident, in the loss of a sailor from one of the stone-lighters.

In the spring of the year 1809, the operations recommenced. Every thing was found to have withstood the effects of the winter's storm; all the courses which had been laid, and the beacon itself, now in the third year from its erection, remaining quite entire. The tried stability of the beacon-house rendered the artificers more confident and more impatient of the inconveniencies inseparable from landing and relanding from the attending ship; and, before the beacon-house was fully fitted up as a barrack, they took possession of it throughout the day. On one of these occasions, however, they were overtaken by a sudden gale of wind, which prevented the boats from taking them off in the evening. Mr Peter Logan, and Mr Francis Watt, two of the overseers at the rock, with eleven of the artificers, were necessarily left there for 30 hours, while the waves occasionally washed over their yet imperfectly formed abode. On this occasion, the mortar-gallery immediately below them was carried away by the seas, and one of the cranes was broken to pieces by the violence of the waves. During the early part of this season, one division of the artificers was employed at completing the railways upon the rock, while it was accessible; and when it was covered by the tide, this squad was occupied in fitting up the beacon-house as barracks. Hitherto the operations of the builders were wholly confined to the low-water work. From the great exertions, however, made by the shipping department, in supplying materials this season, the builders now made rapid progress. On some occasions, no fewer than 50 blocks of stone were brought to the rock in the course of a tide; 30 of which, during the same period, were sometimes laid by the builders.

In the month of June 1809, the work met with some check by the fall of a crane; on which occasion, one of the artificers was severely bruised, and several of them narrowly escaped. The building having now attained the height of the ninth course, the guy-ropes of the usual description of beam-crane became too upright, or *taunt* (to use the sailor's phrase), and it was found necessary to resort to other measures. A new machine, called a *Balance-crane*, was therefore put in preparation for the use of the works next season: in this, the upright shaft was to be retained in an erect position, by a weight acting on the opposite end of the loaded beam, which was thus to be kept *in æquilibrio.*

The light-house now began to make a considerable appearance upon the rock at low-water; and the tides'-work, in moderate weather, extended to five or six hours, or an hour or two after the rock was under water. The beacon-house was now fully occupied as a barrack, smithy, and mortar-gallery; and between this fabric and the rising walls of the light-house, a rope-ladder of communication was distended.

Sunday, the 20th of August 1809, was a remarkable day upon the Bell-Rock, the entire 22d course of the building, consisting of 51 blocks, being this day laid; after which, for the first time, prayers were read in the beacon-house, the whole workmen being assembled in one apartment, and two of them joining hands to form a desk to support the bible during service. On the 25th of this month, the building operations were brought to a conclusion for the season.

"To-day," says Mr Stevenson, "the remainder of the Smeaton's cargo was landed, and the artificers laid 45 stones, which completed the 24th course, reckoning above the first entire one, and the 26th above the rock, This finished the solid part of the building, and terminated the height of the outward casing of granite, which is 31 feet 6 inches above the rock or site of the foundation-stone, and about 17 feet above high-water of spring-tides."

At the commencement of the works in spring 1810, a great stock of prepared materials was in readiness at Arbroath, excellent sandstone having been procured from Milnefield Quarry, in the Frith of Tay. The stones for the cornice and light-house, which had been procured from Craigleith near Edinburgh, had, in like manner, been prepared, and were in readiness for shipping at Leith. It still, however, remained a matter of doubt, whether it would be practicable to complete the light-house in all its compartments during this season. But, calculating from the success of the two former years, while the work was low in the water, and when about 1400 tons of stone had been landed and built, it was reasonable to conclude that 700 tons of masonry might be erected, together with the light-room and its apparatus, in the course of the summer months.

A large gangway or bridge of timber had been prepared during the winter, to render the communication between the beacon-house and light-house more perfect than by means of the rope-ladder. This gangway was also calculated to be of great use for raising the materials upon the building. At taking possession of the beacon-house, in the month of May 1810, the lower parts of the principal beams, and the joisting of the lower floor, were found thickly coated with a fine downy conferva, while the upper parts were whitened with the mute of the numerous sea-fowl which had roosted upon it during winter.

The first circumstance attended to in commencing the building operations of 1810, was to fix upon the proper position of the entrance-door of the light-house. In this Mr Stevenson was assisted by carefully observing the range of the sea upon the solid part of the building, and by tracing the growth of fuci and confervæ on the walls. The heaviest seas being in this manner determined to be from the north-east, the door was consequently laid off towards the south-west. This and other preliminary steps having been taken, the first cargo of stones was brought to the Rock about the middle of May; and, from the very complete and systematic arrangement of the works, the building operations were brought to a close during the month of August, without any material obstacle having been experienced. This greatly increased facility in building was ascribed partly to the experience acquired by practice in former seasons, in landing and raising the materials, and partly to the admirable adaptation of the Balance-crane, formerly mentioned, for laying the stones in their places upon the building.

The works were, however, occasionally interrupted, by the shipping being dispersed in gales of wind, when they were sometimes driven upwards of forty miles from their station. At such times the artificers were closely cooped up in their barrack upon the rock, in a state of painful inactivity, and with prospects often very forlorn. A curious, and rather alarming effect of the *limnoria*, was discovered this summer on the beams of the Beacon-house. Though the lower parts of the fabric were regularly charred with blazing furze, and coated with thick pitch, to prevent the attacks of this insect, while the upper parts were laid over with white-lead paint; yet these insects had made their way under the soles of the several beams, where they rested on the rock, and which could not be reached with such applications: the beams were found to be hollowed out to some extent by the depredators, while the exterior fibres of the timber, to a considerable thickness, were left quite entire.

The several departments of this work seem to have been laid out by the engineer in a manner which gave much promptitude and effect to the operations. "In particular, Mr David Logan, clerk of works at the work-yard at Arbroath, was held responsible for providing every thing contained in the requisition of the foreman-builder at the Rock; while Mr Kennedy, engineer's clerk, was answerable for the other parts of the respective requisitions from the tender and beacon, and for the dispatch given in the loading and sailing of the vessels. The masters of the stone-vessels were accordingly directed, on their arrival by night or day, to deliver all letters at the office. In the same manner, before leaving the Rock, regulations for the proper conduct of the works there were also instituted; where the assistants were also held responsible for the duties of their several departments; Mr Peter Logan, for the execution of the masonry; Mr Francis Watt, for the good condition of the Beacon-house, railways, and machinery; Captain Wilson for the state of the praams and other boats employed in the landing of materials, and for the safety of the stones and building-materials in transporting them from the ship's hold till they were placed upon the waggons on the Rock. The steward, Mr John Peters, was answerable for making the necessary requisitions for a sufficient stock of provisions, water and fuel: while Captain Taylor, master of the tender, was to see a proper stock of these articles landed and kept in store upon the Rock. From the great hazard with regard to fire, the Beacon-house being composed wholly of timber, tnere was no small risk from accident; and on this account, one of the most steady of the artificers was appointed to see that the fire of the cooking-house, and the lights in general, were carefully extinguished at stated hours."

It deserves also to be remarked, that in the whole course of these extensive operations, not a single stone was lost, or even so damaged as to render it unfit for the building, notwithstanding the numerous changes and shiftings from hand to hand, which each stone underwent before it was finally laid with mortar. In some instances, indeed, blocks of stone were lifted from their beds by the *run* of the sea; but none were carried entirely away.

The fixtures for the door and window-hinges are of a peculiar construction, and seem to be admirably suited to the situation; their composition, of tin and copper, is the best that could be devised. Their form cannot easily be described, but will be readily understood by examining Plate XIX. of Mr Stevenson's work. The weight of a set of these hinges, with their Lewis-bat tails and boxes, is no less than 2 cwt. They are so applied as to be easily withdrawn and replaced, without interference with the masonry.

The trenailing and wedging with oak timber was continued to the height of upwards of forty feet, or throughout the solid part of the building. But Mr Stevenson is induced to conclude, that trenailing should be resorted to only under very particular circumstances, as the boring of the trenail holes is apt to disturb the bond or connection of the last laid course. It is only, therefore, where the walls are to be exposed to the heavy wash of the sea that trenailing should be applied. The staircase was constructed like that of the Edystone.

When the light-house had attained the height of the staircase, it admitted of full day's work to the artificers; when materials could be landed, they had even, not unfrequently, pay for six extra hours per day, and were thus in the receipt of about two guineas of wages and premiums per week, while the foremen had double allowance. The whole were kept board-free at the rock; and even the postages of their letters were paid.

In Plate I. we have given an elevation and section of the light-house, to which we refer our readers. We have already noticed the manner of attaching the lower courses of the stones, which was similar to that resorted to at the Edystone, and we shall now advert to the plan followed for the upper or habitable part. At the stone stair-case, leading from the door to the first floor, the walls are of the medium thickness of about seven feet; this thickness gradually diminishes upwards, till, under the cornice of the building, it extends only to eighteen inches. The stones of the walls of the several apartments are connected at the ends with dove-tail joints, instead of square joggles, as in the solid and the stair-case; while the bed-joints are fairly embedded into each other by means of a girth raised upon the one stone and sunk into the other. The floors are also constructed in a manner which adds much to the bond or union of the fabric. Instead of being arched, which would have given a tendency or pressure outwards on the walls, the floors are formed of long stones radiating from the centre of the respective apartments, and at the same time forming a course of the outward wall of the building; these floor-stones are also joggled sidewise, and, upon the whole, form a complete girth at each storey. In this manner the pressure of the floors upon the walls is rendered perpendicular, while the side-joggles resemble the *groove-and-feather* in carpentry. In the stranger's room or library, the roof takes an arched form, but the curve is cut only upon the interior ends of the stones of the cornice, the several courses of which it is composed being all laid upon level beds.

Towards the latter end of August the masonry of the light-house was completed, and the operations of erecting the light-room were commenced. The beacon-house, which had hitherto been crowded by more than thirty persons during the summer, was now more thinly peopled. The Engineer must have been glad to take leave of his cabin, after an uninterrupted residence of about six weeks upon the rock:

" In leaving the Rock, the writer kept his eyes fixed upon the Light-house, which had recently got into the form of a house, having several tiers or storeys of windows. Nor was he unmindful of his habitation in the Beacon, now far overtopped by the masonry; where he had spent several weeks in a kind of active retirement, making practical experiment of the fewness of the positive wants of man. His cabin measured not more than four feet three inches in breadth on the floor; and though, from the oblique direction of the beams of the Beacon, it widened towards the top, yet it did not admit of the full extension of his arms when he stood on the floor; while its length was little more than sufficient for suspending a cot-bed during the night, calculated for being trussed up to the roof through the day, which left free room for the admission of occasional visitants. His folding-table was attached with hinges, immediately under the small window of the apartment, and his books, barometer, thermometer, portmanteau, and two or three camp-stools, formed the bulk of his moveables."

Although the sea at times shook the beacon-house, yet, being of an open construction, the waves rolled along with little impediment; and while the artificers were wetted, and even driven off the top of the walls of the light-house, when sixty-four feet in height, the sea did not rise upon the beacon more than about twenty-five feet.

In the course of this month, the writer notices an incident of some interest. Among the visitors who came to see the works, was the late eminent Mr Smeaton's daughter, Mrs Dixon, who being accidentally in Scotland, and hearing of the progress of the Bell Rock works, on principles similar to those of the Edystone, was desirous of visiting them. Accompanied by Mr Stevenson, she embarked at Leith on board of the stone-lighter, which had been named " The Smeaton," in honour of her father. The author adds, that, on stepping on board, " Mrs Dixon seemed to be quite overcome with so many concurrent circumstances, tending, in a peculiar manner, to revive and enliven the memory of her departed father."

Toward the end of the month of October, the balance-crane and bridge of communication were dismantled; the former was no longer necessary, and in place of the latter the rope-ladder was again distended; the Beacon-house being still occupied as the place of accommodation for the artificers employed in fitting up the lighthouse and reflecting apparatus. When the keepers came to take possession of the lighthouse in the month of December, in their descriptions of the state of the sea upon the rock during stormy weather, they represented that the beacon-house, though upwards of 50 feet in height, appeared at times to be wholly under water; and the small boat suspended upon it during the summer months, which had not yet been removed, was washed from its davits, though placed 30 feet above the rock. During one of these occasions, it was remarked, that the sprays of the sea had risen upon the light-house to the height of no less than 104 feet. At this early period of the possession of the light-house, the inmates were panic-struck when they first felt, with alarm, the tremulous motion of the building, when those heavy seas struck it in certain directions.

About the middle of the month of December, the whole apparatus and stores having been safely landed, and lodged in the house, the light was advertised for exhibition on the 1st of February 1811. On the afternoon of that day, it was accordingly exhibited; and the floating-light was extinguished as no longer necessary.

To distinguish this light from those formerly established on the coast, the reflector-frame is made to revolve upon a perpendicular axis, exhibiting periodic flashes of light of the natural appearance, and also light tinged of a red colour, produced by interposing shades of red glass; between each appearance of light, periodic intervals of darkness occur, when the angular point of the frame comes opposite to the eye of the spectator. From these characteristic distinctions, the Bell Rock is now steered for with confidence by the mariner in the darkest night, instead of being shunned as an object of terror.

The total mass of matter in this interesting building is estimated at 2083 tons, and the net expence is stated at L. 61,331, 9s. 2d. A detailed account of the expence is given in the Appendix, which, as shewing the prices of labour and provisions, will form a valuable document in future times.

We have now traced this arduous undertaking to its completion; but for many interesting particulars about the light-house and its mode of management, we must refer the reader to Mr Stevenson's volume, and especially to the concluding chapter. During the first winter after the exhibition of the light, every opportunity was seized by the attending vessel for landing at the rock, and inquiring into the state of the building, its apparatus and inmates; and it is satisfactory to find that every thing continued in the highest order. The keepers consist of a principal, a principal assistant, and two other lightkeepers, three of whom are always at the light-house, while one is on leave ashore with his family at Arbroath. Their pay is from 50 to 60 guineas per annum, according to their rank. They have rations of provisions while at the light-house; but while ashore they find themselves in provisions. In their regular turns, each keeper is six weeks at the rock, and a fortnight ashore, or from the one set of spring-tides to the other; but, during the winter months, their turns depending upon the state of the weather and tides, they are sometimes kept at the rock for a period of three months together. It has repeatedly happened that no communication could be had with the light-house during two months. In such cases, carrier-pigeons, which are taken off to the rock by the tender, and let fly from the light-house, with billets tied round their legs, have been found extremely useful. The pigeon-house and breeding-place for these carriers, is, of course, at the settlement ashore; and it has been remarked, that the pigeons, when dispatched from the rock, do not fly directly to their home, but invariably make for the Red Head, the nearest high land, and thence trace their course along the shore. There is always in the light-house an extra stock of salted provisions and biscuit, equal to a consumpt of 70 days. This is annually renewed, but has never as yet (1824) been required to be used, the ordinary fresh supplies carried out by the tender, when she relieves the keepers, having been found sufficient for their maintenance. Attention to the necessaries and comforts of people so situated, in the service of the public, upon a sunken rock, far in the ocean, under circumstances the most alarming at times to human feelings, was to be expected from just and enlightened policy: And we have the pleasure to say, that the Lighthouse Board has spared no pains to render their situation as comfortable as possible. The interior walls of the apartments, not admitting of being plastered, are smoothly polished and painted, while the several rooms are neatly and suitably furnished. Besides a small library, the keepers have a weekly newspaper, and one of the monthly journals, supplied to them; their families are meanwhile comfortably lodged at Arbroath, and have the accommodation of a piece of garden-ground, and a pew in the parish church. Every third year the light-keepers are furnished with a suit of uniform clothes.

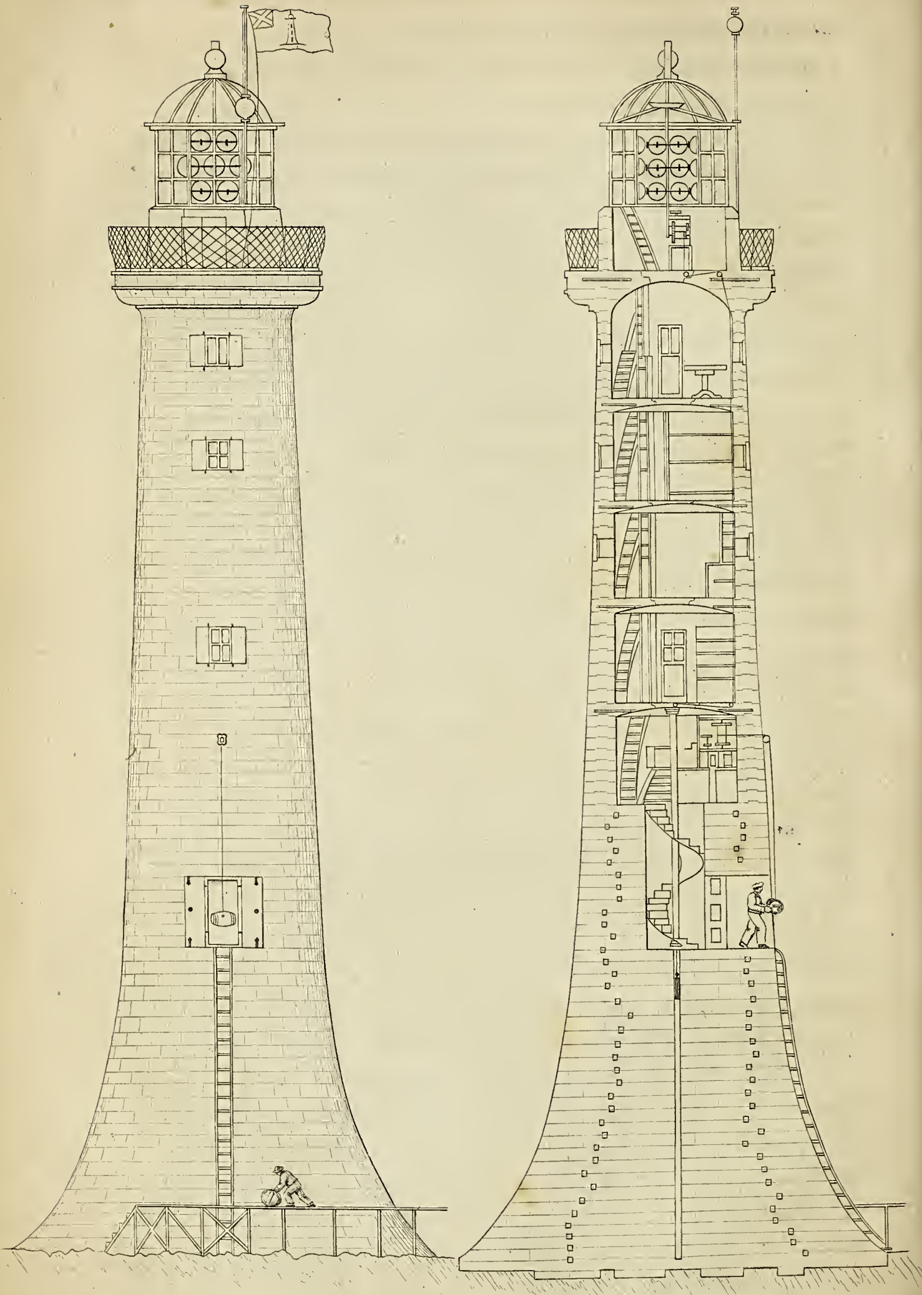
Since the completion of the lighthouse, the beacon-house has been removed, and also part of the iron railways, leaving only such tracks of them upon the Rock as were thought necessary for landing the stores, and communicating with the light-house. Instead of a rope-ladder, the communication between the rock and the entrance-door, a height of about 30 feet, is now formed by a brazen stair, which answers also for part of a thunder-rod, and facilitates the raising of the stores, by a peculiar sort of crane adapted to this purpose. The fortunate position of the entrance-door rendering it seldom necessary to shut it in summer, an inner door of brass has been hung, which is found to be a great conveniency to the inmates. During storms, when their double doors, double windows, and storm-shutters are closed, the light-keepers mention, that they occasionally feel a tremour in the building, from the shocks of the sea, but that all is quiet within, and they hear nothing of the dashing and roaring noise of the sea.

We may remark, that the plates which accompany Mr Stevenson's work, extending to twenty-three in number, are executed in a very masterly style, and contain numerous diagrams illustrative of the structure of the building, together with several maps of the coast. The frontispiece, engraved by Horsburgh from a drawing by Turner, representing the lighthouse during a storm from the NE., has been altogether got up in a manner highly creditable; nor can we omit praising a vignette, shewing the effect of the lighthouse when approached under night, from a sketch by Miss Stevenson. The most general map is constructed rather upon a new plan, having numerous sections, which, at one view, shew the relative depths of the German Ocean at various places. The building itself has justly become an object of curiosity to distinguished foreigners, and to all who feel interested, either as amateurs or professionally, in the mechanical arts. The eminent French engineer Dupin, who had visited the Bell Rock in 1817, occupies a considerable portion of his last volume (1824) on the Public Works of England in describing this Lighthouse. An album is kept at the lighthouse, and it already includes the names of many celebrated individuals.

In the Appendix is given a design for a light-house on the Wolfe Rock, situate off the Land's-End of England, where, we believe, the erection of a lighthouse has been deemed nearly impracticable. This design we cannot help considering valuable, as the result of the ample experience, both practical and scientific, of Mr Stevenson, on the subject of marine buildings.

In the preceding account, we have noticed some points in which the Edystone and the Bell Rock Lighthouses closely resemble each other, and also some things in which they materially differ. As we have been at some pains in tracing these, it may not be uninteresting to our readers to have them brought into a condensed view.

At flood-tide, the top of the Edystone rock is barely covered by the rise of the water, while the site of the Bell Rock Lighthouse is nearly on a level with low-water mark. Our Scottish fabric contains more than double the cubical contents of the masonry of the Edystone, the first entire course of which measures only 26 feet in diameter, while that of the Bell Rock extends to 42 feet. This disparity of circumstances and dimensions necessarily rendered a different system of landing materials upon the Bell Rock necessary, and the use of an apparatus for building, which, in many respects, was entirely new. We allude to the balance-crane and moveable beam-crane employed in place of the sheer-poles used by Mr Smeaton. It is, however, mentioned by Mr Stevenson, with proper feelings of respect for the high merits of Mr Smeaton, that the Edystone Rock being of no greater extent than was necessary for the foundation of the building, the difficulties of the work were thereby increased to such a degree, that he is induced to conclude that the lower courses of the Bell Rock were, perhaps, upon the whole, not attended with greater hazard and difficulty than those of the Edystone. The larger dimensions of the Bell Rock, gave greater facilities for the establishment of a more efficient working apparatus. The introduction of praam-boats, and a landing-master's crew, for bringing the materials to the hands of the builders; and the general application of machinery, varying in its construction and use, according to the position and circumstances of the work, will perhaps be the means of enabling the practical engineer, at some future period, to extend his operations to far more difficult situations than have hitherto been contemplated.—The same principle of dovetailing and connecting the stones of the lower courses, have been observed in both build-



Scale of Feet

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W. H. Lizars sculp^t

ings; but, in the upper or habitable parts of the the Bell Rock Lighthouse, a new mode of attachment has been adopted. This we have already alluded to; but shall here more fully explain. In the outward walls, as will be seen from the section given by us in Plate I., the courses of the void are all indented perpendicularly into each other by belts, or *zones,* as Mr Stevenson terms them. This mode of binding the work, consists in previously forming a belt or member upon the *upper bed* of each stone, which belt is received into a corresponding groove cut into the *under bed* of the stone to be next laid. In the Edystone, the end-joints of the stones of the void are secured by detached joggle-pieces, which are slipped into them; instead of which, the end-joggles at the Bell Rock are cut into dovetails upon the stones themselves, excepting at the floors, where separate dovetail pieces are employed.—The principles upon which the floors of the two buildings are constructed, are essentially different. At the Edystone the floors form so many domes, the arch-stones of which are built in concentric rings in the usual manner, and have a tendency or pressure outwards upon the walls. To counteract this pressure two strong iron chains are imbedded in the courses, immediately below and above the floors. At the Bell Rock, the floors are so constructed, that the pressure upon the outward walls is perpendicular; and they are so connected as respectively to form girths or binding-frames to the building at each storey. The floor-stones are like those of the Edystone, in so far as they are dovetailed into the centre stone, but they are of a sufficient length to form at the same time part of the floor and outward walls. As a further security, they are otherwise joggled edge-ways, and may thus be conceived to form an entire stone, as will be partly understood from Plate I.—In all the minor details, the Bell Rock works have of course benefited by the more recent improvements of the Lighthouse Department. The construction of the light-room itself, the reflecting-apparatus, and alarm-bells for sounding in foggy weather, are all the most perfect of their kind. We learn also from Mr Stevenson, who has lately officially visited the Tour de Corduan, at the entrance of the Garonne, that M. Fresnel, one of the engineers connected with the department of *Chaussées et Ponts,* under which the lighthouses of France are placed, has devised and constructed, upon the most scientific principles, an apparatus with *lenticular lenses*, which, from a lamp with four concentric wicks, transmits a most powerful light; and that this apparatus is likely to be adopted as a permanent improvement on the coast of France. On this subject, it is not a little curious to remark, that, not many years since, when the Edystone Lighthouse came into the hands of the Trinity Board, the light had, till that period, been produced from two dozen of tallow candles, unaided by reflectors.

Since this article went to press, we have seen the Report to the *Institute of France* on Mr Stevenson's work by M. Navier, an engineer of great promise, who is now constructing an extensive chain-bridge over the Seine at Paris. This report is discriminative, but, at the same time, highly laudatory to our countryman. The general character of the work is thus summed up: "L'ouvrage de M. Stevenson ne laisse rien à désirer sur l'histoire et la description de cet important édifice. Cet écrit dont être placé au premier rang, parmi les livres utiles publiés par les ingenieurs, pour transmettre à leurs successeurs la connaissance de procédés qu'ils ont employés."

ART. IV.—*On the Principles and Practice of Warming and Ventilating Buildings.* By THOMAS TREDGOLD, Civil Engineer, and Honorary Member of the Institution of Civil Engineers.

IN winter we require artificial heat, and during a short part of summer we seek for coolness, but at all times we need pure and wholesome air. These, however, are comforts which are not always to be commanded, and particularly where we desire to join economy with healthiness and comfort. The principles concerned in the movement of invisible elastic fluids are seldom understood by those who engage in the management of ventilation; and, in the still more recondite subject of heat, we too often find that the most absurd opinions are entertained. On the other hand, persons rarely take the trouble to think for themselves; and, most likely, because very little pains have been taken to reduce the subject to principles, or to render it accessible to those who would wish to be acquainted with it; and more especially those who would wish to be able to distinguish quackery from science.

The object of this paper is to give a concise view of the principles of the art of managing heat, as far as regards warming buildings, showing the various modes of applying it; but preceded by those of the still more important subject, ventilation.

Of Ventilating Buildings.

I do not know of any thing more grateful to the senses, or more essential to health, than pure and wholesome air; nor any subject on which less care and less science has been bestowed. It seems an anomaly that can be explained only by the powerful influence of habit, which leads us in the steps of our forefathers, while in other arts changes have been made which render it necessary to improve the ventilation of our dwellings. For in their "large mansions the wind was suffered to blow freely through them, and a current of air to circulate through the wide space between the pannelled wainscot and the wall."

It must be habit also that renders the constant attendance at the bench or the bar supportable in the noxious atmosphere and elevated temperature of a court of justice. It must be habit which makes the offensive effluvia of an hospital be disregarded by medical men,—for surely these are not necessary evils; but before I visited hospitals, courts, manufactories, and poor-houses, for the express purpose of seeing how they were ventilated, I had no idea of the magnitude of these evils. All places are not equally ill-ventilated, for there are some where it is much more effectively done than in others; and in a few cases I have observed that cleanliness has in some degree compensated for the want of fresh air.

We owe much to the labours of Dr Hales on this interesting subject; but most, if not all, of those who have attended to it since he wrote, have confined their attention to improving the means of admitting that quantity of air which Dr Hales had shown was injured by respiration. If such a change would have preserved the mass of air in a room in a state of purity, the prime object of ventilation would have been accomplished; but it is an obvious truth, that, unless we extract all the air which is injured, it must accumulate; for, in consequence of the tendency of gaseous bodies to mix, when suffered to remain long in contact, the air given off from the lungs must mix with, and so far deteriorate all, the air in the room. Now, the mere change of a portion of this mixture for an equal portion of fresh air, will only improve the air of the room, by the removal of as much of the whole quantity of injured air, as is expressed by the fraction of which the numerator is the air extracted, and the denominator the bulk of air in the room. Therefore, either a very great proportion of air must be removed by ventilation, or, we must endeavour to find the means of removing that which is unfit for supporting life, as soon as it is generated.

In practice it is always inconvenient to introduce fresh air in large quantities; it is expensive in winter, and fills every thing with dust in summer; and, in this variable climate, the process becomes quite unmanageable in spring and autumn. Hence we are compelled to seek for the means of removing the noxious air before it has had time to mix with the air of the room; and we are not a little encouraged in the research, by observing that our Creator has provided for the removal of the air we eject from the lungs in such a manner that we cannot inspire it again in a free atmosphere. The air in respiration loses its oxygen, and this loss is replaced by about an equal bulk of carbonic acid gas, which is heavier than oxygen in the ratio of 1 : .725; but the air expelled from the lungs is given out at a temperature of about 90°, and is nearly, if not quite, saturated with the quantity of vapour due to that temperature, which vapour and azote are both lighter than common air. Consequently the mixture of azote, carbonic acid gas, and vapour ejected from the lungs, is specifically lighter than common air, and ascends with considerable velocity; the remarkable pause, which occurs immediately after an expiration, gives time for its ascent, and for a fresh supply of air to approach for the succeeding inspiration.

It may be remarked, that the ejected air gradually diffuses itself among the air it rises through, which renders it necessary to provide for the removal of a much greater quantity than that which is expired; but it will be evident, that, if the whole mass of air be ascending with a slow current, and there be apertures for its escape at the top of the room, the diffusion will be less than in still air, and much less than it would be, if the ascent were interrupted by descending streams of cold air. While the vitiated air retains its heat, it may easily be shown that it will be lighter than common air, and consequently will ascend with greater velocity, and go off by the apertures; but if it be retarded, so as to become of equal temperature with the common air, it will descend, become diffused, and deteriorate the rest of the air in the room.

It will be evident, then, that ventilation should be continual, during the time a room is in use; that the heated air should be given out at the highest parts of the room, and the cooler fresh air should enter at the lower parts. That, previous to a room being used, it should be ventilated freely; and also, immediately after it has been used, in order that any effluvia, which has collected through imperfect action of the ventilating process, may be removed. In warm weather, the latter change would be assisted, by washing, or sprinkling with water.

But it is too common to let a room acquire an oppressive temperature before ventilation is given; to provide no places for supplying cold air, except what chance furnishes; or if it be supplied at all, it is at the upper part of the room, so as to interrupt the ventilation, instead of amending it.

It will sometimes happen, that, through want of attention to ventilation, the air will arrive at that state of density, which renders it in equilibrium with the external air, though of a higher temperature. In such a case, opening windows, or ventilators, produces no effect in still weather; and it becomes necessary to resort, either to mechanical power, or heat, to change the air. In hospitals, and buildings of a like description, it is therefore desirable to provide such means of ensuring a regular change of air.

Whatever abstracts from the air the carbonic acid gas, which has accumulated by respiration, or otherwise, renders it more fit to sustain life, but I do not imagine the simple increase of carbonic acid gas to be the cause of air being unhealthy; it seems more likely to be owing to the avidity with which carbon unites with nearly every species of effluvia, and bears it to that part of the human frame which is most susceptible of injury. Not only the gas from the lungs, but also the whole portion of carbonic acid which the air contains, is soon charged with deleterious matter, when ventilation is not properly attended to; and the effluvia must either be neutralised by the agency of a volatile acid, which possesses a greater affinity for it, or the carbonic acid must be removed.

In considering the principles of ventilation, it must be obvious, that it is much more necessary in some places than in others; in isolated houses it may be neglected with impunity, but, in the confined streets of extensive towns, it must not be left to chance. Even in planning towns, the importance of thorough scope for the winds to follow the valleys, should be regarded, that the heavy impure air may be driven away. When a narrow street crosses a valley, without being crossed by another street, at the lowest part, it becomes very difficult to keep it in a proper state. But, in many cases, we meet with streets on level ground, planned as if it were to render it impossible for a current of air to follow them; and from the very circumstance of their not being pervious to the fresh air, they become the resort of the wretched, with a tenfold increase of filth and misery. By forming the New Street in London, much good has been done; and one cannot well let this opportunity pass, without expressing a wish, that other openings may be effected, planned with a more direct view to the health and convenience of the metropolis, unencumbered by massive colonades. The giant members of the Doric column were never designed for a screen to a toy shop.

The usual construction of prisons renders them similar to the interrupted and confined streets of towns, but the improvement of raising the cells above the ground storey must be very beneficial; and the extensive area, inclosed by the walls, and the isolated buildings of some of the best prisons, must render them very healthy, when a proper attention to cleanliness is observed. An elevated site is clearly the best for any building which is to be inclosed by high walls; there should be as few internal divisions of the area as possible; and long rectangular yards, with open railing at the ends, seem better adapted for ventilation and exercise, than the polygonal figures of many of our new prisons, and, perhaps, quite as favourable for other objects. Where a prison is in a low and unhealthy situation, it would be desirable to adapt a machine for changing the air of the prison to the tread-wheel to work, when there was a deficiency of more profitable employment for the power. This would surely be better than either working vanes against the wind for no purpose, or working against the friction of a brake-wheel.

The atmosphere of London is truly a problematical subject; but it is important that it should be studied. It contains upwards of a million of human beings, each of which consumes 32 cubic inches of oxygen per minute, and ejects an equal bulk of carbonic acid gas in the same time; there is also an immense number of animals, all tending to vitiate the atmosphere. The greater part of the carbon of nearly two million chaldrons of coals is also converted into carbonic acid gas in one year, at the expence of an equal bulk of oxygen. But the evolution of so much carbonic acid gas, immense as it is, almost always takes place at a temperature, and under circumstances, very favourable for its diffusion in the atmosphere; while the power of carbon to absorb animal effluvia, very probably renders it an important agent in improving the quality of the air of the metropolis. We must, however, regret, that the ascending currents of smoke are almost always charged with considerable quantities of soot; and that of the ingenious methods which have been tried to remedy this inconvenience, very few have been, in any material degree, successful. There are two principles which may be resorted to; the one consists in causing the soot to precipitate from the smoke before it ascends, or during its ascent up the chimney; the other consists in providing the means to consume the soot; and whichever of these principles be acted upon, the draught of the chimney will be impaired. Hence, for all operations which require a strong fire, there must either be a very high chimney, or the neighbourhood must be annoyed by smoke. A well managed fire will afford very little sooty smoke when it is properly constructed; but how difficult it is to get a fire well managed; and, therefore, while every exertion to reduce the quantity of sooty smoke should be encouraged, we can scarcely expect more than a slight amelioration of the evil. But, while the more extended benefit of open streets, and the free access of currents of fresh air, must be left to the care of public bodies, it is in the power of individuals to increase and improve the ventilation of their own dwellings.

I have already noticed, that the air which is given out in respiration is lighter than common air of the same temperature; and that, being of a greater temperature than common air, it ascends as soon as it is expelled from the lungs: hence its proper outlet is at the upper part of a room; but, in some cases, the same opening will give admission to a stream of cold air, unless it be of a peculiar construction. To avoid this defect, there should be a free supply of fresh air to the lower part of the room, and the openings contrived so that their action shall not be interrupted by winds. It will be found an advantage to let the ascending air flow into the space between the ceiling and roof. We will suppose a case where the vitiated air passes immediately through the ceiling into the space in the roof, as shewn in Fig. 3. Plate II., where its course is indicated by the dotted lines, the apertures through which it ascends being concealed by ornamental plates, AA, placed at a little distance below them. If cold air be forced in at the top or otherwise, it will occupy the lower part of the space, as at BBB, and cannot make its way into the tubes DD, unless it be in greater quantity than fills the space above the level of the tops of these tubes. The top C should not be longer than is required for the intended purpose, and the greater height it has the better, but it should not, in any case, be higher than the chimneys of the building, as it may cause them to smoke. Where a room is required to be ventilated, and is not next the roof, the air-tube should be got by the most favourable direction into the space in the roof. In all cases the apertures should be provided with registers that can be opened or closed at pleasure. The most simple is constructed in the same manner as the throttle valve of a steam engine. It consists of a plate A, fixed on an axis in some part of the air-tube, and is represented in Fig. 1. It should not be made to move too easily, in order that it may stand at any opening at which it is set.

The apertures for admitting fresh air ought to be abundantly large, and covered with wire-gause, that rapid currents may

PLATE, II.

Edinr. Phil. Jour. Vol XII page 44.

Fig. 1.

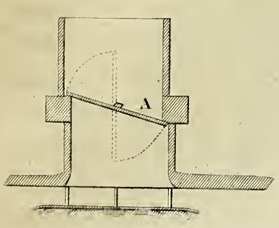


Fig. 2.

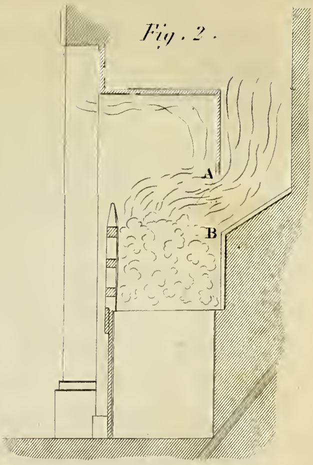


Fig. 3.

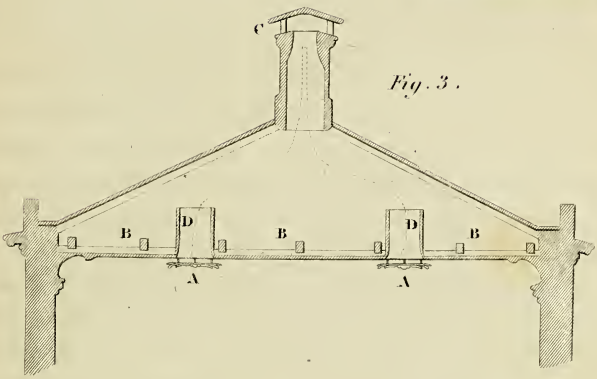


Fig. 4.

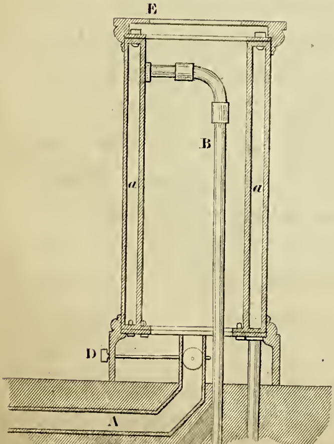
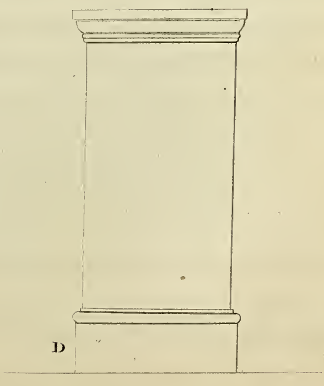


Fig. 5.



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W. H. Lizars sc.

be avoided. The modern mode of finishing rooms is not well adapted for admitting fresh air, as it seems to have been a direct object of research to exclude it. But it is only necessary to provide the means of warming fresh air before it enters, during the winter season, and then the motive for excluding air is done away, and the same channel may supply it in summer, when it becomes as agreeable as it is necessary.

When workmen were less skilful, our apartments had a plentiful supply of air, and the want of ventilation was never felt; but now that walls are rendered impervious to the air by plastering, and floors are made double, and doors and windows are fitted with scrupulous accuracy, the consequent decrease of the fresh air admitted, renders it necessary to attend to ventilation, which formerly there was very little reason to provide for. Yet, it must be admitted, that, with a system of ventilation which we can regulate, in respect to quantity, at pleasure, rooms must be more comfortable than when the wind entered on every side, and could not be excluded. When one improvement is effected many others become evidently desirable; it is thus that art has made such rapid strides of late years; but the improvement in the construction of buildings has been slow, compared with that in some other arts, and the effect of close rooms on health has not been so soon nor so distinctly perceived, as one would have expected. The comfort of a warm room is sought for much more than that of a pure and healthy atmosphere.

It has been shewn, that there ought not to be less than four cubic feet of air removed per minute by ventilation for each individual in a room *; and in the same work the following rule is given for the area of the ventilators through which the heated air is to ascend. Let N be the number of people the room is intended to contain, h the height from the floor of the room to the top of the ventilator tube in feet, T the temperature of the internal air, and t the temperature of the external air; then,

$$\frac{N}{75}\sqrt{\frac{450 + T}{h(T - t)}} = \text{the area of the ventilator in feet.}$$

It will be obvious, that the largest ventilation is required

* Principles of Warming and Ventilating Buildings, p. 72. Lond. 1824.

when there is only a small difference between the temperatures of the external and internal air. When the difference does not exceed 10°, and the internal air is at 60°, then,

$\frac{.95\,N}{\sqrt{h}} =$ the area of the ventilator in feet or $\frac{N}{\sqrt{h}} =$ area with sufficient accuracy.

There will be much advantage in dividing this area, so that the air may rise through several outlets instead of one; and, consequently, operate more uniformly in ventilating the room. When the cold air enters, the apertures should be not less than double the area of the outlets for hot air.

The same rule applies to the ventilation of churches, courts of justice, and the like; and it is exceedingly simple and easy of application.

It is not difficult to cause the ventilators to open or close in proportion to the temperature of the room. The difference between the expansion of iron and zinc rods might be made the means of opening the registers, whenever the temperature rose above the intended degree. The same thing may be done by expansion of mercury; and, perhaps, still easier by the expansion of air. Attendants seldom think it necessary to open ventilators till the heat has become oppressive; the influx of cold air is then dangerous; and, therefore, it is desirable that ventilation should be self-acting. They should begin to open as soon as the temperature exceeds 54° of Fahrenheit, and be quite open at 70°.

In cases where the ventilation is likely to be interrupted by winds, it may be much assisted by placing a lamp in the upper tube, the heat of which will serve to maintain an ascending current; but it will in most cases be quite sufficient to depend on the heat generated by the individuals in the room; which must, at least, be sufficient to raise the temperature of four cubic feet of air 10° in a minute for each individual *. The advantage to be derived from using a lamp, consists in establishing a current at first, and, by that means, preventing the cool walls from con-

* It is shewn, in the "Principles of Warming and Ventilating Buildings," p. 161, that the breath alone will warm 2½ cubic feet 5° per minute, and the heat given off by the surface of the body will be equivalent to the rest.

densing the vapour when many people assemble in a room that has not for some time been used.

(To be concluded in next Number.)

ART. V.—*On certain Antediluvian Plants susceptible of being illustrated by means of species now living within the Tropics.* By Dr C. F. P. DE MARTIUS. Read at a Meeting of the Royal Botanical Society of Ratisbon.

TO acquire a distinct conception of the various changes which our terraqueous globe has undergone; to discover the manner in which the different strata have been superimposed upon the internal nucleus of the earth, as well as their relative position; to contemplate the first origin of living beings, and determine the point from whence they have proceeded to overspread the whole surface of our planet, are justly considered as among the most elevated pursuits, and the most becoming in which men can engage. For thus deriving knowledge from those primeval and silent monuments, we transform ourselves into spectators of ages unseen by mortal eyes, and discover the first principles on which to found our reasonings with regard to the origin, evolution, and increase of our race.

There is but little, indeed, regarding the first history of our planet, and that little very doubtful, that we can avail ourselves of, in contemplating the various conditions of inorganic bodies in former times, and hence we form a very difficult and uncertain judgment concerning the primitive mass of the earth and its chaotic changes. For, so far is it from being the case, that the light which has been thrown upon geology by the wonderful discoveries daily made in chemistry and natural philosophy, has dispelled the whole of the darkness in which it has been involved, with respect to the evolutions of the primordial elements, that, rather while it illustrates some things, it is per-

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* A copy of this Memoir was obligingly communicated for this Journal by the author.—EDIT.

petually bringing out others which are doubtful, and the more so in proportion as we direct our attention to the more remote periods of our planet, which have been occupied in the formation and arrangement of the mere inorganic stamina of things. But, inasmuch as we find the first elements of organic life disseminated through this inanimate reign of the ancient world, bound in the fetters of eternal sleep, the investigation becomes more easy: We are already acquainted with the determinate limits of different periods, the recession of the ocean from the summits of the mountains, the limits of the lakes and sea; we have a more extended and precise perception of the laws which nature has followed, both in destroying the more ancient parts, and in renovating them after being much destroyed; and from thence directing our minds toward higher objects of investigation, we can form a judgment of the primitive nature of plants and animals, their original place, their mode of life, and the manner in which they have been propagated over the terraqueous globe.

The present age is highly distinguished for the investigations made in regard to these subjects: in France, the illustrious *Cuvier* and *Faujas de St Fond*, and in Germany, *Blumenbach*, *Count Sternberg*, and *Baron de Schlotheim*, have observed the monuments of organic beings with the greatest attention, and by reducing them with wonderful sagacity to still existing genera of animals and plants, have nobly restored to the science its true dignity, which it had formerly lost, since, although far from being neglected, it had fallen into the hands of men more prone to contemplate the wonderful, than anxious to acquire materials for explaining the formation of the earth, and who represented those precious monuments as sportings of nature, and, as it were, the illicit progeny of the parent of things.

They have shewn that the vegetable remains of the antediluvian world belong to very different genera, some of which are already well known to us; while others, on the contrary, have eluded the research of so many observers occupied in investigating them, and in attempting to refer them to forms still in existence. We, moreover, recognise the type of others in plants which inhabit the same places, where they lie overwhelmed, the vast ruin of primeval times; others are found in countries very remote from their original one, or from those in which similar plants now grow, thus shewing that the heat has been much greater in former times. For this reason, I directed my attention, on a journey made by me through Brazil, toward the investigation of those forms of plants, which might be considered as prototypes of the antediluvian vegetables discovered in our own countries; nor have my efforts been altogether without success, as some things occurred to me capable of throwing light upon the nature of antediluvian plants, and which I now proceed to announce.

The *tree-ferns*, which constitute so beautiful a feature of the tropical regions, exhibit several characters by which they may be compared with the ancient plants; but as they have been seen but by few botanists, and their structure is consequently very little known, they can scarcely afford us much assistance in our efforts to discover the nature of the vegetables dug up from our coal-mines. Indeed, when I saw the first specimens of *Polypodium corcovadense*, so remarkable for the tesselated surface of its caudex, I was not only struck by the novelty of the circumstance, but immediately called to mind the figures of certain petrified forms described by *Sternberg*, under the name of *Lepidodendron;* on comparing which, after I had returned, with the stems of eight arborescent species collected upon my journey, I found them connected by so intimate an affinity, that I could entertain no doubts of their generic identity; and I trust I shall be able to shew that their characters are in perfect accordance.

The *caudex* or stem of arborescent ferns is fixed into the earth by roots, which are small in proportion to the size of the plant, short, and branched: it is straight, scarcely ever flexuose, unless in the weaker species, rising, somewhat attenuated upwards, from the base, which is often invested with long subsimple fibres running down upon the root, to a height varying from 6 to 25 feet, shaded by terminal fronds, perpetually shooting up from the apex of the stem by a sort of renovation, the former fronds decaying, and giving place to a more beautiful covering: The *fronds* arise from the stem in spiral order, sometimes densely, at other times sparsely diffused over it, and articulated by an elliptical or rhombiform base, and fall off at the end of two or three years, leaving *cicatrices* of various forms upon the surface of the stem *.

In their mode of growth, therefore, the tree-ferns are very similar to palms, the evergreen stem of which throws off the fronds which are inserted into the bark, in the space of about three years, and is then marked with transverse rings, from the insertion of the base of the petiols; they differ, however, from palms, in this respect, that, as the base of the petiols is not amplexicaul, the fronds, on falling, do not leave annular cicatrices, but of various forms, according to the base of the stipes. The more robust the stipe of the frond, the deeper it is inserted into the stem, and the more marked the cicatrix which it leaves. We see some species, such, for example, as *Polypodium corcovadense*, whose rhombiform and deeply impressed cicatrices are so approximated as to occupy almost the whole surface of the bark; others again, and those of very frequent occurrence, have a portion of the bark between the petiolar cicatrices free, and exhibiting areas of various forms. This part of the surface is covered with *paleæ*, which in some are more densely, in others more sparsely arranged, erect, arid, commonly lanceolate, or oblong, entire at the margin, or variously fringed, investing the stems, especially when young, with a singular rough covering, and at length gradually falling off, or becoming obliterated. These paleaceous appendages derive their origin from the epidermis of the caudex, which is either smooth, or elevated into warts, tubercles or wrinkles; and as they are, for the most part, arranged in a very dense body, in young plants, or those which have suffered little from external injury, they usually conceal entirely the singular, and, in so far as I know, hitherto undescribed structure peculiar to all the stems of ferns. This peculiarity consists in the bark's being excavated by scrobiculi, either elliptical or oblong, from one to two lines in depth, and from

* These cicatrices have been called *Laubansätze* by the celebrated *Nees Von Esenbeck*, in his excellent Handbuch der Botanik, 1. p. 243., but they have nothing in common with stipules, nor are they properly organs at all, but merely the marks left by the stipules after they have fallen off.

two to four long, which are disposed in a determinate order, differing in different species, and, as has been observed, only come into view after the paleæ have disappeared. These *diverticula* are filled with a very fine ferruginous powder, appearing under the microscope to consist of oblong or subangular semi-transparent or opake bodies, covered with very slender hairs, and sticking together, and if I be not egregiously mistaken, are in some way subservient to the function of fructification. But, as I intend to treat in another place on this subject, as well as the internal structure of ferns, I need not prosecute it farther at present, what refers to the external characters being sufficient for our object. I shall only add, that the petiolar cicatrices shew various semicircles near the margin, and in the disk, which are the rudiments of fasciculi of vessels passing from the stem into the stipes, remaining under the form of warts and tubercles, after the petioles have been disengaged from their adhesion.

After premising this much regarding the stems of ferns, the characters by which the *arborescent filicites* are to be described, are easily laid hold of, and may be applied to the specimens which occasionally come in our way, provided due attention be paid to the various modes in which they may present themselves, whether the specimens be actual petrifactions or casts. For it is properly observed by the celebrated *Rhode* *, that the antediluvian plants of our coal-mines occur in four different conditions, and these of the greatest importance for distinguishing the genera: some consist of vegetables converted into carbonaceous clay *(Kohlenschiefer* or *Schieferthon)*, and still invested with their bark, reduced to the state of charcoal;—others exhibit impressions of the same plant, with the surface entire, upon clay, slate, or sandstone;—others are decorticated vegetables themselves;—and, lastly, others are impressions of these decorticated plants. Before coming to any conclusion, therefore, with regard to a petrified fern, in order to determine to what sort of cast or petrifaction the specimen under examination is to be referred, it is necessary for this purpose that the characters which we derive from the entire specimen only, and not from its impression, be properly understood, and duly applied.

* *Beytræge zur Pflanzenkunde der Vorwelt;* Breslau, 1820, fol.

An *Arborescent Filicite* is distinguished by the following marks:

An *arborescent stem*, without ramifications, or knots, straight, of nearly equal diameter, marked all over with *areolæ* (caused by the insertion of the stipes), arranged in a spiral manner from the base upwards, and not diminishing in size. Rhombiform or oblong *areolæ*, plane or concave, sometimes variously impressed or tuberculated with rows or lines of tubercles (being the rudiments of the cicatrices of the spiral-vessels). Discrete subreticulated *spaces* or *interstices* between the areolæ. Pinnate or compound *fronds*.

This genus comprehends various species of *Lepidodendron*, described by the illustrious *Count Sternberg*; those, namely, which are destitute of true scales, for areolæ are not scales, but cicatrices engraved in the stem, nor can they be separated from each other but by art, and on this account are only divided from the internal part of the plant, in being ordinarily converted into charcoal, while the latter is changed into stone. It is necessary, therefore, to distinguish between areolated plants and those which are scaly, which may easily be done, by keeping in mind, besides other marks, that scales are imbricated upon each other upwards.

The species of this family with which I am acquainted, are the following:

1. *Filicites quadrangulatus.*

With regularly rhombiform areolæ, deeply impressed at the base, the thin interstitial spaces similar.

Palmacites quadrangulatus. Schlotheim, *die Petrefactenkunde, auf ihrem jetzigen Standpuncte*, p. 395. n. 7. pl. 18. fig. 1.

Of the older coal formation, from the coal mines of *Opperoda*, in the dukedom of Anhalt, and of *Manebach*, in the dukedom of Gothe. Scloth.

It corresponds with the stem of *Polypodium corcovadense*, figured by *Nau*, pl. 3.

2. *Filicites tesselatus.*

With rhombiform areolæ, having acute angles, the upper straight sides somewhat longer, marked below the middle with a narrow linear cicatrix; the interstices thin.

From the quarries in the older coal formation at St Imbert, in the Rhine Provinces of Bavaria. I have seen an impression in slate-clay in the Museum of the University of Munich.

3. *Filicites rimosus.*

With attenuato-rhombiform or fusiform areolæ, having the lateral angles rounded, with two rhombiform cicatrices in the middle; the interstices longitudinally reticulato-rimose.

Lepidodendron rimosum, Sternberg. Flora der Vorwelt, i. p. 21. Pl. 10. fig. 1.

Many species of arborescent ferns, as we have already observed, are invested with fibres over nearly the whole surface, but especially the lower parts toward the root. The present species is of this kind.

From the quarries at Radnitz, in Bohemia. *Sternb.*

4. *Filicites incisus.*

With rhombiform areolæ, attenuated at either end, having the lateral angles rounded, marked in the middle with a rhombiform cicatrix; the interstices narrow.

Palmacites incisus, Schloth. p. 395. n. 10. pl. 15. f. 6.

From the quarries of Wettin and Eschweiller, in Silesia. *Schloth.* I have also seen it from the quarries of St Imbert.

5. *Filicites obovatus.*

With ovate acuminate areolæ, marked at the base with a semicircle of cicatrices and with twin cicatrices, rhombiform reticulate interstices, the lateral angles rounded.

Lepidodendron obovatum, Sternb. p. 20. pl. 6. f. 1. pl. 8. f. 2.

At Radnitz, in Bohemia. At St Imbert.

6. *Filicites aculeatus.*

With ovate acuminate areolæ, emitting a knotted line from the base, which is marked with a semicircle of cicatrices and twin-cicatrices; the interstices reticulate, rhombiform, attenuated at either end, with the angles rounded.

Lepidodendron aculeatum. Sternb. pl. 6. f. 2. Rhode's Beytrage, pl. 1. f. 5.

From Radnitz in Bohemia, and Silesia.

7. *Filicites curvatus.*

With rhombiform areolæ, longly attenuated at either end, the lateral angles rounded, marked at the middle with a row of subovate cicatrices emitting a line upwards and downwards; the interstices thin.

Palmacites curvatus. Schloth. p. 395. n. 9. pl. 15. f. 2.

At Eschweiller and Waldenburgh, in Silesia.

8. *Filicites squamosus.*

With rhombiform areolæ, the lower sides shorter, the lateral angles rounded, a double line of cicatrices towards the base; the upper subrectangular, the lower semicircular; the interstices thin.

Palmacites squamosus. Schloth. 395. n. 6. pl. 15. f. 5.

From the coal mines of Eschweiller and St Imbert.

9. *Filicites trilobatus.*

With rhombiform areolæ, the lateral angles rounded, a trilobate mark of cicatrices in the middle; the interstices reticulate and rhombiform.

Figured by Nau in Den Denkschriften d. k. Acad. zu München. 1820. pl. 2.

I have seen specimens of this, the stems of which were upwards of two feet in diameter.

10. *Filicites punctatus.*

With ovate acute areolæ, marked toward the base with a cicatrix having the form of a horse's shoe, and at the upper margin with a row of dots; the interstices broadish, reticulato-confluent.

Lepidodendron punctatum. Sternb. p. 19 pl. 4.

This is the most distinct of all the species, both in regard to the size of the cicatrices and the rudiments of the fasciculi of spiral vessels. Sternberg says that he found the stem hollow, which, as it occurs in the adult stems of ferns, shows that the structure of this does not differ from that of living ferns.

Found at the river Moldaw, in the county of Kaunitz, in Bohemia.

To what species Schlotheim's *Palmacites verrucosus* may belong (see pl. 15. f. 4.), the impression of which is not very well expressed, I cannot venture to determine.

It is scarcely necessary for me to remark, that, in eliciting these characters, I have had more in view the distinction of the different species of petrified trees, than the application to each part of the name which would answer in the living specimen. For the areolæ, such as I here name them, are not solely formed of the cicatrices of the fallen fronds, but partly also of the bark, which, under the immense pressure which these trees have undergone, being of a softer texture than the cicatrices themselves, has been corrugated to their shape. The interstices, therefore, as named above, are only a part of the bark raised into a fold or wrinkle, which differs according to the form of the cicatrix, but the rows of warts in the areolæ accurately point out the place of insertion of the fronds. It hence appears, that the base of the frond in most of the species here enumerated has scarcely been an inch in diameter, and that the fronds themselves have been much smaller, although more numerous, than we observe in the living species.

As very numerous examples of these arborescent, as well as of herbaceous, ferns, occur in the older Coal Formation, it can scarcely be doubted, that this order of plants has been different with regard to its numerical relation to the other families of vegetables, in those remote times in which the Earth buried its vegetation under chaotic ruins, from what it is at the present day. For although we can say nothing with certainty as to the number of species which may have existed of the different genera of ferns, we are yet authorised, by many circumstances, to infer, that the dense forests of the primitive world, afterwards destroyed by various catastrophes and reduced to charcoal, have been very abundantly stocked with ferns. Nor is the hypothesis founded upon less powerful and plausible arguments, which ranks the genera of this order of plants as among the first stamina of vegetation expanded over the surface of the globe, either when newly formed, or when renovated after the destruction of a previously existing state. That ferns are the basis of other vegetation, and prepare the soil for the growth of other tribes springing up upon their remains, has already been well observed by Linnæus. For as their vegetation is especially directed to the formation of very large fronds, which, from the system of fructification being, as it were, depauperated and depressed by the evolution of foliaceous parts, exercise all the vigour of life in decomposing the air, and in deriving nourishment rather from the elements of the atmosphere than of the earth, they seem pre-eminently adapted for exciting the rude and inert power of the earth to produce more perfect tribes of vegetables. I do not, however, mean to assert from this, that those primitive forests consisted chiefly of ferns: for the woods of the equinoctial regions, which are pre-eminently rich in ferns, consist of trees much more robust than the ferns, which occupy only a secondary rank in them. In like manner, we learn from a comparison of the various specimens of plants dug up, that, in the antediluvian woods, the fern stems were interspersed with much larger trees, and, on the general destruction of the forests, have been converted, together with various kinds of herbaceous plants, into coal, now constituting thinner strata among the carbonaceous remains of other trees. Thus it is ascertained that many plants, described by authors under the name of Poacites, belong to the genus Scleria; others, to other genera of Gramineæ and Scitamineæ, occurring in the woods of tropical countries.

The determination of these different kinds of carbonised trees has been a subject of much investigation among the learned, many referring all the vegetables of the primeval periods to the monocotyledonous series; while a few, on the other hand, have observed the remains of dicotyledonous plants among coal.

(To be concluded in our next.)

Art. V. — *Short Account of the Forest Trees and Timber Trade of the Interior of Russia.* By William Howison, M. D. Lecturer on Materia Medica, and Theory and Practice of Medicine, Edinburgh *.

The most common species of wood, in the immense tracts of forest extending over the northern parts of the Russian empire, consist, for the most part, of the Pine tribe. In some parts of the country the pine-trees grow to a great height and size. The species denominated in this country the Scotch Fir (*Pinus sylvestris*), is by far the most abundant; and as it retains its luxuriant foliage during the long winter, it affords shelter to man,

* These observations were made by Dr Howison during his residence in Russia.—Edit.

and to the wild animals of the forest: it also enlivens greatly the dreary prospect of these bleak regions. The greater the intensity of the cold, the firmer, and more dense it becomes in the texture of its timber. This tree furnishes the peasantry with materials for constructing their cottages, boats, fences for inclosure, and with fuel. It is from the ashes of this tree that the potashes of Russia are principally obtained; and from the roots, an abundant supply of turpentine is afforded to the peasantry, by very rude methods of distillation.

The next most abundant species of tree in the forests of Russia is the Common Birch: this, however, is confined to particular tracts of land. It is met with principally towards the coast, in Finland; and in the neighbourhood of large towns, as Petersburgh and Moscow. It is found chiefly by itself, and intermixes but little with the extensive regions of forest. It is generally rather stunted in its growth, and seldom attains to any considerable size. It is only made use of for fire-wood, of which, in this country, where no coal is found, except in Siberia, an immense quantity is required. For this purpose, it is cut into billets, in the woods of Finland, and the surrounding districts; and it is forwarded in barks to the large towns. This tree also supplies the natives of the interior with a sort of wine. During the spring-season, when the trees contain the greatest quantity of juice, the Russians pierce the trunks, and suspend a vessel to receive the juice, as it exudes from the apertures. A large tree will afford a considerable quantity of juice; but this bleeding always proves injurious to its future growth. The juice being fermented, becomes a tolerably good kind of wine, having some resemblance to champaign. It sells in Moscow for about two roubles a bottle.

The birch-tree supplies the natives with brooms for the use of their vapour-baths, and of these they use a vast quantity during the year. They cut the branches in summer, when the trees are in full leaf, tie them together in small bunches, and preserve them in the apartments of the bath. From the birch-tree the peasantry make their various household utensils for holding milk, quass, &c.; and with its bark they make basket-shoes.

The other trees in the forests of Russia are, the Beech, the Maple, Elm, Alder, Willow, and Ash, many of which grow to a great height. These, however, form but a very small proportion of the forest, in comparison with the pine; and they are applied to no very particular purpose, except that of being made use of indiscriminately with the others as fire-wood. From the roots of the ash, in the great towns, beautiful pieces of furniture, as small tables, are made.

The Mountain-ash, or rowan-tree of Scotland, is to be found in great abundance upon the outskirts of the forests, as also about private pleasure-grounds. In the summer months, it forms a lively addition to the appearance of the other trees by the showiness of its flowers, and in the autumn by its still more showy fruit. On this account it is much esteemed by both Russians and foreigners for ornament. Its fruit, preserved in spirits, gives a species of liquor well adapted for the cold of this northern climate: preserved with sugar, it forms a marmalade. The native Russians use the berries, salted, with other wild fruits, at their ordinary meals.

The brushwood, covering a vast extent of forest-country, consists almost entirely of the hazle, the dwarf-birch or *Betula nana*, the alder, the willow, and the juniper. This last grows to a large size, and is generally loaded with fruit.

The surface of the earth, in the forests, is covered with the various kinds of mosses, and heath, with several species of wild berries, particularly the cranberry, and the *Bruisnika* or bilberry. These various species of wild berries are produced in the greatest abundance, and supply the peasantry with an ample and constant addition to their other food. They use them when fresh during the summer, and salted for winter. The peasant and his family seldom or never sit down to a meal which is not one-half composed of these preserved fruits.

It may perhaps appear surprising, that amongst the trees now specified I have not mentioned the Oak, "the monarch of the wood." But in the great tract of country through which I have passed, upon the Moscow road, in the neighbourhood of that town, as also of Petersburgh, I do not recollect of ever having seen one above the thickness of a man's arm, and even of these very few indeed.

When in Moscow, I was told by Mr Rodgers, a British agriculturist, settled for a great number of years in that neighbourhood, a gentleman of extensive information, and who had devoted particular attention to the subject, that whenever an oak, exceeding in thickness a man's arm, made its appearance in the surrounding forests, it was immediately cut down by the woodmen, taken to the large cities, as Moscow, and sold to the carriage-makers, who paid a considerable price for it, to make the axle-tree of sledges or of *droschkas*, for which, from its durability, it was peculiarly adapted; and that, of late years, such a tree can scarcely be met with. That gentleman had repeatedly mentioned the circumstance to Count Romanzoff (upon whose estate he is settled), as also to various noblemen about Moscow, pressing them to put a stop to it, but as yet without success. The alder-trees suffer nearly to the same extent. When the peasantry meet with them in the woods, they immediately cut them down, and make snow-shoes of the twigs and bark, for the winter; so that they also are becoming rapidly scarce. The hares also prove very destructive to the alder by barking it for food, during the winter months. In the southern parts of Russia, however, as in the neighbourhood of Kasan, there are forests of oak; and from these the timber which is used in the construction of the Imperial Navy is furnished.

I shall now make a few remarks upon the numerous and important benefits which these forests contribute to the general comfort and wealth of the proprietors and peasantry of this great empire. 1*st*, They furnish them with fir-timber of the finest kind, possessing the most durable and dense texture, and in the most profuse abundance, with no trouble but that of cutting down. Of this timber, as already mentioned, with the addition of a little dried moss stuffed into the interstices, they construct their *isbas* or cottages, vapour-baths, and other buildings. In the interior, they make little or no use of brick, stone, or lime, excepting in the construction of churches, *peatches* or stoves, and chimneys. Their wooden isbas are warm and comfortable, and are far superior, in a climate such as this, to those built of brick or stone; they are soon heated, and when once this takes place they retain heat long. Of this timber their furniture and utensils are also made. In large cities, and in the houses of the nobility in the country, of late years, they are gradually introducing mahogany, which they get from America, at a reasonable rate, by vessels coming for Russian produce, which would otherwise arrive in ballast; and this they prefer, from its beauty, to the timber of their own growth, for making furniture.

The peasantry have little or no tallow or oil; what they can procure is entirely consumed at the shrines in the churches, and before the images in their isbas. To supply the place of candles, they take long billets, of that species of fir-tree which abounds most in resinous matter; these they dry carefully near their peatches, during the tedious winter, and split, as occasion requires, into long pieces, resembling lath for a house. When a traveller arrives, or when a light is required, one of these is lighted at the peatch, and fixed in a wooden-frame, which holds it in a horizontal position. It gives a bright flame, and burns for a short time; when another is substituted.

The extensive forests furnish to the proprietor a considerable addition to his revenue, from the potashes, charcoal and turpentine which they afford. The potash, or vegetable alkali, is made from every species of wood indiscriminately. When a sufficient quantity of ashes is collected, they lixiviate them, and pack them up into casks. These are conveyed down from the interior, by means of inland navigation, to Petersburgh, Riga, and other sea-ports, where they are kept in extensive warehouses belonging to government. There they are broken up, the ashes collected in heaps, the good carefully separated from the bad, and repacked, in the presence of the foreign merchant who purchases them.

In passing through the country, during the night, we repeatedly saw great volumes of flame issuing from the forests; and, during the day, whilst travelling in the woods, we observed that many of the finest trees had their internal wood burnt completely into charcoal, from the fire ascending up the centre of the trunk, whilst the bark remained entire and seemingly uninjured. To make charcoal, they cut down every species of wood indiscriminately, form it up into large cones or piles, covered over with turf, set fire to them, and allow the combustion to advance in a slow progressive manner for some days. The cone is then pulled down or scattered, the charcoal collected, and sent to Petersburgh, Moscow, and other great towns, where it is consumed in the large works of government, as powder-manufactories, founderies, and in kitchens, in great quantities. The mass of wood consumed in these various ways must be very great.

The forests supply turpentine with little labour, and at almost no expence. It is the different species of fir-tree or pine which yield this article; it is distilled from the bottom of the trunk and the roots, which are left in the earth after the tree is cut down. These are dug up, and broken into chips by the hatchet, then put into the boiler, and the turpentine extracted by distillation; the refuse of the boiler furnishing fuel for the next fire. During the course of the day, with one of these boilers, a peasant will obtain, upon an average, from 4 lb. to 5 lb. of turpentine; and even this quantity might be considerably increased. If the number of stills, upon a larger and more economical principle, were increased, the quantity of turpentine which might be obtained in the course of a year upon a proprietor's estate, might be very considerable, and would much enlarge his revenue.

The forests also furnish materials for the roads. The young fir-trees having their branches lopped off, are laid longitudinally across the road, close to each other, and covered with a layer of earth or sand, to fill up the interstices. Roads of this description are formed by the peasantry over hundreds of versts, and through marshy ground, which could only be done in a country where wood is in such abundance. Upon one part of the great Moscow road, however, they have lately been collecting large masses of stone, which they break down by fire of peat or moss placed under them, when they are rendered brittle by the severe frosts.

It is amongst these forests that the wild honey is got, for which Russia is celebrated. Mead made from it is in great estimation among the peasantry, and is sold in the towns as a substitute for sugar, and various other purposes. Considerable quantities of this honey are annually exported to Great Britain and other countries. The wild bees make their hives in the hollow trunks of the aged or injured trees, where they are sought after by the straggling woodmen.

The exportation of timber affords a considerable addition to the revenue of the government, as well as to the private fortune of the proprietors. It is a grand source of labour to the industrious peasantry settled upon the estates, and likewise to the shipping and inhabitants of other countries. These forests consist entirely of natural wood, which receives neither the care nor industry of man during its growth. Labour, however, might be employed to much advantage in thinning and clearing away the superfluous trees, when young, so as to allow the air to circulate freely amongst those which might be permitted to remain and grow up to a full size. In the forests, the trees are so thick that they destroy each other before they attain to any considerable size; and, in that way, it is only a few of the strongest which survive the general wreck. The wood of considerable girth, which was to be found in the vicinity of the road-sides, rivers, lakes, or canals, particularly in the neighbourhood of great towns, has been of late years cut down, and little or none but that of a stunted description remains in its place. The timber cut for the use of government, and for exportation, is now procured from a very great distance,—hundreds, and, sometimes, thousands of versts, into the interior, and that distance is gradually increasing. Even there, it becomes necessary to bring it a considerable way, from amongst the forests, where it is cut down, to the lakes or rivers, by means of which it is floated to the sea-port towns. Labour, however, in the interior of Russia is of little value. It costs the nobleman next to nothing. The peasantry upon his estate, being a kind of slaves, receive no regular wages.

The mercantile transactions throughout Russia are conducted by native merchants, who, although feudal dependants of the nobility or of government, with a few exceptions, understand both the Russian and English languages. They are of course well acquainted with the country, the people, their manners and customs, and with the mode of travelling. Many of them pass the winter months in the villages of the interior. Hemp, flax, tallow, iron, and the various productions of the empire, are purchased in this way. Originally these articles are produced upon the estates of the nobles in the interior. They are purchased upon the spot, by the native merchant, who is a middleman, having no direct connection with the goods. They are forwarded to the great towns, where they are resold by him to the British, or foreign merchant or agent, with considerable profits; who again sends or sells them to his correspondent, the merchant in Britain or other countries abroad. All these important articles, therefore, must pass through this long and intricate course, in which the various individuals concerned have their profit, to afford them the means of life, and some even amass fortunes. At home, the merchants, retailers, or shop-keepers, must likewise have a share, before the articles reach the consumers.

The Russians, of all ranks, act with great prudence and circumspection in their mercantile transactions. They know well, and daily experience tends to confirm it, that foreigners must have their produce at all events; and, on that account, they never enter into a bargain, or deliver the goods, unless the whole of the price be paid in advance; and even one-half of it some months before they are delivered; consequently they are protected against every risk of loss. A Russian, in his transactions with a foreigner, makes no bad debts, whatever may happen when matters are reversed. The native merchants, who are bearded and whiskered men, form a considerable, and, I may add, opulent body of individuals, some of them being possessed of large fortunes, and, of course, from their low origin, made entirely in trade.

This class of men are remarkably jealous of the English or foreign merchants, who, of late years, have been in the habit of sending their sons or relations, at an early age, to board in the villages of the interior, with a view to learn the language, which is very difficult, and become acquainted with the trade. These young men, in after life, becoming merchants, may go to the interior, purchase the goods, and transact their own business with the noblemen, to the exclusion of the native merchants, and with the saving of his large profits. It is surprising to see what wealth these bearded gentlemen display in Moscow and Petersburgh, on particular holidays, in their equipages, horses, in the livery of their servants, and in the dresses, ear-rings, and necklaces of their wives and daughters.

My friend was a gentleman under the peculiar circumstances now alluded to, he and his partner having resided a great number of years in Russia; both they and their predecessors having had extensive contracts to supply the British Government with timber for the Navy during the wars. From an early period of life, one of them had been in the habit of transacting their business in the interior, and in that way had gradually acquired a knowledge of the country, the language, the manners, and mode of living of the natives. They transacted their business direct with the noblemen, to the entire exclusion of the native merchants; of course, enjoying both his profit and their own, to which their active and increased industry so justly entitled them. This, however, is a rare instance, and by no means common, few or no other British merchants being in the habit of doing so. From those peculiar circumstances, and the liberality of these gentlemen, an opportunity was afforded me of visiting a part of the country, seldom or never before viewed by any foreigner, of travelling in the particular manner which we did, and of living among the natives, where not a word of any language but Russian was spoken. This could not have happened to me under any other circumstances, and it was during this journey that the matter contained in these pages was collected.

Having made these remarks, I shall trace the system gradually as it applies to the timber trade, from the period when the proprietor first disposes of the timber, to the period when it is shipped for exportation.

When the Russian proprietor wishes to dispose of the timber upon his property, and to convert it into money, he goes himself, or sends a qualified person to Petersburgh, or other towns, for that purpose. On his arrival, he sends for a merchant, who probably enters into an agreement with him for a certain number of trees, of such dimensions, and of such a quality, to be delivered there, at a certain price, agreeing, at the same time, to go out to his estates in the country, as soon as the timber shall be cut down and prepared, to measure and receive it. When he cannot procure a foreign merchant who will do so, he applies to the native merchant; and in both instances, a considerable part, generally the half of the money agreed upon, is paid him in advance. Having completed the bargain, and got the articles of agreement legally made out, he returns to his estate, and sets his peasantry to work in picking out, cutting down, and dragging the trees from the forests, to the lakes or rivers. This work generally takes place during the winter months, in order that every thing may be ready for sending it off to its destined port, as soon as the winter breaks up.

The male population of the country are brought up from infancy as woodmen. Every individual carries a small hatchet in his belt, and is employed in the forests from the one year's end to the other. These men, and likewise the females, are in a manner the property of the nobleman, and must submit to every species of drudgery in his service. They cannot leave the soil upon which they are born, without his permission; and when they are allowed to do so, and to go to any distance, they continue in the same state of bondage, paying him annually a certain sum of money, in proportion to his avarice, and the extent or success of their own industry.

These woodmen are sent into the forests under the charge of an overseer, where they pick out the trees whose trunks are of the dimensions required. These are always the largest, and soundest in their timber, which can be found; and, at times, such are scattered over a considerable extent of forest, so as to be discovered with difficulty. When they have found a tree of the dimensions and quality required, so many of the people commence with their hatchets, and cut it down from the root. They then lop off the branches completely, and the top. Thereafter they strip off the bark, which is reserved for other purposes. They round the stem at the top, and cut a circular notch a little way down, for the rope to which the horses are afterwards attached, to drag it to the river or lake. At the opposite end, they make a circular hole in that part of the wood which remains projecting after the tree has fallen, and which is formed by the outer timber on both sides of it, being removed by the repeated strokes of the hatchet in cutting it down. The intention of this hole is to fix handspikes into, so as to enable them to move it in any direction which may be found necessary, and to steer it clear of every obstruction, whilst the horses are dragging it from the forest to the water-side. All these trees are of great size, and, in the density of the timber, from the intense cold of this northern region, they may be said to be the finest in the world. These men, by being accustomed to handle the hatchet from their earlier years, and from possessing great strength of body, have acquired such dexterity that they accomplish the work now mentioned in a much shorter space of time than can well be imagined.

This work is carried on during the winter, when the forests are covered with several feet of snow. At times, before the intensity of the frost has taken such effect as completely to harden its surface, to make it strong enough to sustain a person's weight, the woodmen are obliged to make use of snow shoes, to enable them to traverse the woods in search of trees, and to prevent them from sinking in the snow. Every individual has them, and becoming expert in their use through practice, he easily makes his way over the surface of the snow, when without them he could hardly advance a few steps without sinking to his middle, and the work could not go on.

When the fir tree is cut down, and the branches and bark taken off, they next drag it to the ice of the river, or lake, upon which it is afterwards to be rafted. For this purpose, ropes are fixed to the circular notch cut round the upper extremity of the tree, and horses are yoked. These horses are the hardy natives of the country, small, lively, and animated, very shaggy, and generally of a brown colour. In the interior they are generally unshod, but will traverse any sort of ground up to their middle in snow. During the winter months, they are seen toiling in a cold of twenty degrees below the freezing point of Reaumur, as white as snow, covered with icicles and hoar-frost. During summer, they labour under the extreme of heat, and covered with perspiration. Such were the animals, which, along with their brethren from the banks of the Volga, Kuban, and Don, composed the irregular cavalry of the Russian army; and which sustained uninjured the fatigues of the campaign, as also the severity of the winter, which, upon setting in, in the short space of one night, proved destruction to nearly the whole of those of the French army, natives of a warmer climate, during its disastrous retreat from Russia.

The peasants yoke from five to nine horses to each tree, according to its size, the nature of the country, and the distance they have to go. They are all yoked in a straight line, one before another, as the intricate narrow paths through the wood will not permit of their going in any other way. One man mounts upon the leading horse, and another upon the middle one, whilst others support and guide with handspikes the large and distant end of the tree, to raise it over the elevations of the snow, and to make it glide smoothly along. The conveyance of these large trees, the long line of the horses, the number of boors accompanying them through the forests, and across fields of snow, present an appearance very interesting. The dragging of these trees out of the forest to the lakes or rivers, is at all times a business of great fatigue and labour, which can be done with most facility during winter over the surface of the snow. If the frost is severe, it is managed with less difficulty, as the tree then glides more easily along the surface.

To accomplish it in summer would be a much more serious piece of work, many of the trees being above 70 feet in length, and of a large diameter; from the ground being covered with heath and brush-wood, and from the intense heat of the summer. Almost the whole of the warm season is required, after the timber is brought down to the water side, to raft it, to forward it through a long and intricate navigation, over a great extent of country, in some instances above 1000 versts, to the great towns, where it is delivered to the merchant. When delivered there, it must remain during another winter, to be shaped, and fitted for exportation, in such a manner as to take up as little room as possible on shipboard; so that, with every possible dispatch, it is generally impossible to send it abroad before the second season. In this way it does not reach England till nearly two years after being cut down.

The trees conveyed in the manner described to the ice of the nearest or most convenient lake or river, and gradually collected from the different parts of the forests during the winter, remain until a little time before the opening of the waters, when the timber-merchant and his assistants arrive from the towns to receive it. The nobleman, or his overseer, then meet the merchant, when they examine every tree separately, in its qualities and dimensions. When satisfied, the merchant puts his private mark upon each, with a sharp instrument made for the purpose, and numbers them, all which are entered in his book, and also in the cheque-book of the proprietor. Such trees as are defective in quality are rejected, and denominated *Braake.*

Those received are rafted together, to be sent to their destination.

Our journey was made for this purpose, and, on the examination of several hundred trees, the proportion of those rejected was as one to ten. Much discernment and discrimination, acquired only by experience, are necessary in the examination of the trees. It is chiefly by the strokes of a hatchet along the trunk, and the sound arising from it, that they judge of its soundness or rottenness within. A small blemish or discoloured spot upon the surface of a tree, which would appear as nothing to the inexperienced observer, sometimes denotes rottenness existing in its interior, to such an extent as to render it good for nothing. Of this I saw several instances, and to be convinced of it, I laid open the suspected part with a hatchet, when I was surprised at the extent of rottenness which it exposed. When satisfied of its sound qualities, the quantity is ascertained by measurement, and the tree is marked off. This is a very laborious employment, it becoming necessary to turn every tree over and over amongst the snow. During the course of a night, it frequently happens that the labour of the preceding day is rendered useless by a fresh fall of snow, which, freezing firmly around the trees, wedges them so completely, that the frozen snow must be knocked away before a tree can be moved: this the peasants do by means of wooden handspokes. The wood-merchant is generally obliged to take up his residence in the uncomfortable isba of the boor, or, as sometimes happens, if none of these are in the neighbourhood of the timber, in a wretched temporary hut, constructed of the branches of fir-trees. In neither of the circumstances is much comfort to be found. In the former, he must live on eggs, milk, black bread, and quass, amongst the boors, with a hard wooden bench for his bed; whilst in the latter, he must exist in the miserable hut, amidst the smoke of the green wood, which they burn, sleeping and eating in the best way he can.

It is surprising at what a cheap rate the wood-merchant purchases these trees in the interior of the country. For the finest which the forests produce, the proprietor of the estate never receives above sixty roubles, which, at the present rate of exchange, does not amount to £3 Sterling; for inferior ones proportionally less; and for that sum, besides the labour already bestowed, he engages to float it to the sea-port, or place of its destination, free of every expence. To balance this, the proprietor always receives his money in advance before the timber is sent off, and is insured against any loss; whilst the foreign merchant has to advance the money, pay his travelling expences, custom-house dues, &c. before he receives any return.

The timber separated from the *braake*, is formed into rafts by the boors, by making the trees fast to each other at both extremities, and crossing these again with others. The rafts are made of a size proportioned to the depth and breadth of the water upon which they are to be floated. Upon each raft a small wooden hut is constructed to afford shelter and a place of residence for the boors who guide it along, and in which they keep the provisions necessary for their voyage. This work is performed upon the ice of the lake or river upon which the trees have been collected; and as soon as it gives way at the opening of summer, the raft gets afloat. The timber of large dimensions must be rafted; whilst that of a small size, or when cut into deals, which of late years the boors in this part of the country are enabled to do by means of mill-saws, may be placed in the large flat-bottomed barges peculiar to the country. Each raft is put under the charge of so many boors, according to its size, who live upon it, and direct it towards its destination. As these men are the feudal slaves of the noble, and as they carry their provisions with them, although absent for months on their journey, they cost him very little. When they have once set off, they proceed along the lakes, canals, and rivers, through that vast extent of country lying betwixt the Biel Ozer or White Lake and Petersburgh. The rafts are propelled along by sails, by pushing with paddles, or by horses; and when on the rivers, by the currents always running from the interior towards the sea. In this way, winding along, day and night, they traverse many hundred versts. The timber which my friend received, and marked off, during our journey, was rafted upon the water of the Biel Ozer or White Lake; and in its course towards Petersburg, in the neighbourhood of which the nobleman had engaged to deliver it, traced its way along the Korja River, across the Maria Canal, part of the Onega Lake, the River

Swer, and from that to the Ladoga Canal. Across these great lakes, resembling seas in extent, the navigation is at times difficult and dangerous. Storms and sudden gales of wind frequently occur, driving the vessels and timber-rafts from the sides into the middle of the lakes, out of sight of land, often proving destructive to them, and fatal to their crews. In order to prevent such accidents, Peter the Great set a-going the Ladoga Canal; and after its completion, the vessels which formerly navigated the lake were conducted along the Canal, protected from every risk. The rafts having passed along the Ladoga Canal, enter the mouth of the River Neva, and the stream carries them down to Petersburgh.

The timber when collected into the yards of the merchant, undergoes a farther preparation. Each tree is cut into a square form on the sides, or reduced to a log, so as to occupy as little room as possible on shipboard. When that operation is finished, it is floated down to Cronstadt, where it is taken up by vessels appointed to receive it, and transported into other countries.

Art. VII.—*On the modes of Notation of Weiss, Mohs, and Haüy.* By A. Levy, Esq. of the Academy of Paris, &c.

Although the geometrical problems afforded by crystallography are all very simple, and may be solved by means of one or more plane or spherical triangles, yet it is convenient to have formulæ for the cases which occur most frequently, giving immediately the values of the unknown quantities, in function of the data of observation. Some of these formulæ I have had occasion to investigate, and I now submit them to you for insertion in your Journal, if you think any benefit may be derived from them. On this last point, I confess I have myself considerable doubt, because they have reference to the notation of Haüy, and because many other modes of expressing the relative position of secondary planes to those of the primitive, have lately been proposed, which, if generally adopted, would of course render my investigations comparatively of little use. It is true, that it does not appear to me that any of these new methods presents a degree of simplicity, or any relations to theoretical views, which even make it necessary or opportune to alter entirely the language of Haüy. As the object in contemplation is so simple, it might have been expected that many different methods would have arisen; for the easier a thing is to do, the greater number of ways generally are proposed to do it, the differences of which are insignificant, but to which, however, great importance often is attached. To be better able to appreciate the comparative advantages of the new method of designation, I shall briefly state in what essentially consist the two principal ones, I mean those of Professors Weiss and Mohs.

In the first, all the planes of crystals are referred to three rectangular axes, in all the substances, the primitive form of which is either a rhomboid, or an oblique rhombic prism, or a doubly oblique prism. These axes correspond, then, to those of some octohedron with a rhombic or square base, which may always be assumed as the primitive. The position of any secondary plane is then determined, by giving the lengths of the parts of two of these axes, cut by a parallel plane passing through the extremity of the other; and the notation by which, according to this method, a secondary plane is represented, is $\boxed{ma, nb : c}$ a, b, c, being the lengths of the axes, and ma, nb, the parts of the two axes a and b cut off by the parallel plane drawn through the extremity of the axis c. If the secondary plane be parallel to one of the axes, to b, for instance, its corresponding sign will be $\boxed{ma : \infty b : c}$; if parallel to two of the axes, to a and b, it will be $\boxed{\infty a : \infty b : c}$. For substances derived from a rhomboid, the method is analogous, one of the axes to which secondary planes are referred, is that of the rhomboid, and there are, for the sake of symmetry, three others perpendicular to it, inclined to one another at an angle of 120°, and corresponding to the perpendiculars drawn from the extremities of the superior edges of the rhomboid upon its axis. For substances whose primitive form is an oblique rhombic prism, or a doubly oblique prism, this method will require some modification, which has not hitherto been made. It would, however, apply to forms derived from an oblique rhombic prism, if the property of these forms assumed by Haüy was found generally to obtain; for then the secondary forms might be conceived to derive from an octohedron with a rhombic base, with the occurrence of only half the number of faces which symmetry would require.

The method of Professor Mohs may be shortly stated to be this:—For each of his five or six systems of crystallisation, there are series of secondary forms, the terms of each series having to one another some simple relation, founded on properties which have been found to obtain among crystals; and the sign he uses to designate any modification, indicates the series to which that modification belongs, and its rank in that series *.

Each of these two methods may be contended to have over Haüy's the advantage of not being based upon a theory of the formation of crystals; but should that be thought an important objection to Haüy's designation, it appears to me that his signs might be retained, without any reference to decrements: they would not designate, then, the number of rows in breadth and in height, by the subtraction of which, in the superimposed laminæ, some secondary face is supposed to be produced; but they would indicate in what ratio the edges of the primitive are cut by a plane parallel to the secondary.

The method of Professor Weiss is not yet adapted to two of the most frequently occurring forms, the oblique rhombic prism, and the doubly oblique prism; and whatever modifications are made to fit it to those cases, it does not appear that it will be possible to use three rectangular axes, consequently all its geometrical simplicity and the facility it may now afford for calculation, of no avail.

The method of Professor Mohs has the advantage of expressing some very curious geometrical properties of the secondary forms, most of which had, I believe, been noticed by Haüy, in treating of what he denominates hypothetical primitive form. Thus, the sign by which Professor Mohs designates the dodecahedron of the variety *paradoxate* of carbonate of lime, shews at once that the inferior edges of this dodecahedron are parallel to the inferior edges of the rhomboid *inverse*, and that its axis is three times that of the rhomboid, the inferior edges of which would coincide with the inferior edges of the dodecahedron.

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* Se No. V. of this *Journal*, and the several papers published by Mr Haidinger, where this mode of designation is used.

But these properties are easily deduced from the sign given by Haüy for the same modification; and no greater difficulty is met with in any other case. The signs of Haüy, as well as those of Professors Mohs and Weiss, express some property of the new modification: they designate, as I mentioned before, in what proportion the edges of the primitive are cut by a plane parallel to that modification. Since some property of the modification must be used to designate it, why, when these properties are so easily deducible from each other, should the one be preferred to the other? It appears to me, besides, that the method of designation of Haüy has the advantage of shewing, in the most distinct manner of the three, the position of the secondary planes, with respect to those of the primitive. One inconvenience peculiar to the method of Professor Mohs is, that the same modification may be sometimes designated by two different signs; and two different forms, as to their position with the primitive, appear to me to be represented by the same sign. The property of a modification having its planes tangent to the edges of another, and that of the simple ratio of the axis of a secondary form to that of the primitive, when the horizontal projections of both are equal, which form the base of the signs of this method, though simple enough in the case of the rhomboid, or of octohedrons with square or rhombic bases, seem far from being so in every other case. It appears, also, that the observation of a secondary form in a particular substance, will occasionally introduce a new series in the system of crystallisation to which that substance belongs.

As to the relative simplicity of these notations, Haüy's method has certainly no disadvantage. The notation of Professor Weiss is more uniform, but not so simple; and that of Professor Mohs * does not appear simpler, if so simple.

From the preceding considerations, I would conclude, that there is not apparently sufficient ground to prefer either of the two new methods to that of Haüy; that this last mode of designation may require some alterations, but that they can be in-

* Annexed to this paper will be found the description of a crystal of Eudyalite, for which I have given both the signs of Haüy and Professor Mohs. It is is one of the simplest cases of Mohs, all the rhomboids of that form belonging to the same series.

troduced without changing altogether the notation. Indeed, unless the advantages of a new method be very obvious, ought we not to adopt that of the man to whom we are indebted for the science of crystallography?

The formulæ I am now going to explain, will therefore, I trust, be of some use; and, at all events, it is easy to deduce from the results they lead to, the corresponding signs of Professors Weiss and Mohs.

I shall begin with the forms derived from a rhomboid, which are so numerous and so interesting. I denote the different parts of it in the same manner as Haüy. I designate by (P, P) the incidence of two of the primitive faces meeting in one of the superior edges by (P, a'); the incidence of one of the primitive faces with the plane whose sign is a', and which replaces the summit of the rhomboid by a plane perpendicular to the axis. The following relation between (P, P) and (P, a'), is immediately obtained:

$$\cos\big((P, a') - 90^\circ\big) = \frac{2\cos\frac{1}{2}(P, P)}{\sqrt{3}}$$

I shall have occasion to use, in the following investigations, the tangent of the angle (P, a') — 90°; that is to say, the angle of one of the primitive faces with the axis; and in order to obtain for this new trigonometrical line a formula calculable by logarithms, I proceed in the following manner:

$$\sin^2\big((P, a') - 90^\circ\big) = \frac{1 - 4\cos^2\frac{1}{2}(P, P)}{3} = \frac{3 - 4\cos^2\frac{1}{2}(P, P)}{3} =$$

$$= \frac{1 - 2\cos(P, P)}{3} = \frac{\sin(P, P) - 2\sin(P, P)\cos(P, P)}{3\sin(P, P)} =$$

$$= \frac{\sin(P, P) - \sin 2(P, P)}{3\sin(P, P)} =$$

$$= \frac{\sin\left\{\frac{3(P, P)}{2} - \frac{(P, P)}{2}\right\} - \sin\left\{\frac{3(P, P)}{2} + \frac{(P, P)}{2}\right\}}{6\sin\frac{(P, P)}{2}\cos\frac{(P, P)}{2}} =$$

$$= \frac{-2\cos\frac{3(P, P)}{2}\sin\frac{(P, P)}{2}}{6\sin\frac{(P, P)}{2}\cos\frac{(P, P)}{2}} = \frac{-\cos\frac{(P, P)}{2}}{\cos 3\frac{(P, P)}{2}}, \text{ consequently,}$$

Fig. 1.

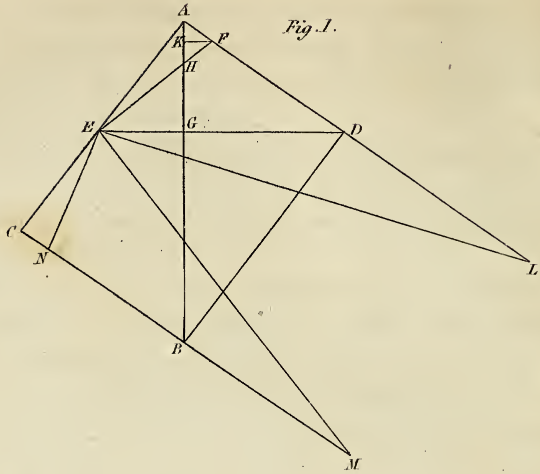


Fig. 3.

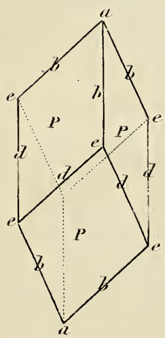


Fig. 5.

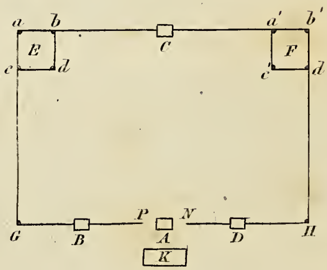


Fig. 2.

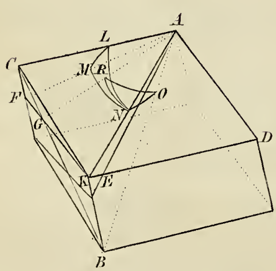
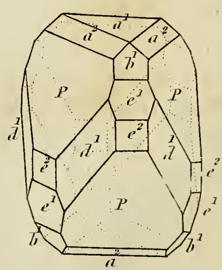


Fig. 4.

*Published by A. Constable & C.o Edin.r 1824*

W. H. Lizars sc.

$$\tan^2((P, a') - 90°) = \frac{\sin^2((P, a') - 90°)}{\cos^2((P, a') - 90°)} = \frac{-\cos 3\,\frac{(P, P)}{2}}{4\cos^3 \frac{(P, P)}{2}},$$

a formula which may easily be calculated by logarithms. The quantity $-\cos 3\,\frac{(P, P)}{2}$ will always be positive; for the three equal angles (P, P) of the summit of the rhomboid are together greater than two right angles, and less than six, consequently $\frac{3(P, P)}{2}$ is greater than one right angle, and less than two, and $-\cos 3\,\frac{(P, P)}{2}$ is positive.

I shall first consider the rhomboid derived from the primitive, and the problem I propose to resolve in this and the following cases, is the inverse of the one solved by Haüy in his Treatise on Crystallography. There he gives formulæ to calculate the incidences of the faces of a secondary form with one another, or with the planes of another modification, supposing that their indices are known; so that in each particular case where the parallelism of the edges is not sufficient to determine *à priori* the indices of the modification in contemplation, he is obliged to try in his formulæ the substitution of different numbers, till he finds that the incidences calculated are equal or nearly equal to those which have been observed. This method is uncertain, and may in many cases be very laborious. I shall endeavour, as I have already stated, to give formulæ to obtain the indices of secondary planes from the immediate data of observation.

Let ABCD, Plate III. Fig. 1. be the principal section of the primitive, that is, its intersection with a plane passing through the axis of the rhomboid, two oblique diagonals, AC, BD, and the two corresponding superior edges AD, CB. Let E be the middle point of AC, and draw a line parallel to the face of the secondary rhomboid. This line will be in one of the four positions EF, EL, EM, EN. In the two first cases, the secondary rhomboid is said to be the result of a decrement on the superior angle of the primitive. The only distinction between the two cases is, that, when the face of a secondary rhomboid is parallel to EF, the number of rows in breadth is greater than the number in height; and the contrary takes place when it is parallel to EL. The sign by which such rhomboids are represented, is a^n, n being greater than 1 in the first case, and less in the second; and

$$AD : AF :: n : 1; \text{ or } AD : AL :: n : 1.$$

When one of the faces of the secondary rhomboid is parallel either to EM or EN, it is said to be produced by a decrement in height or breadth, on the inferior angle of the rhomboid, and the sign corresponding is e^n, where n is less than 2, in the first case, and greater in the latter, and where the following proportions respectively obtain:

$$CB : CM :: n : 1, \qquad CB : CN :: n : 1.$$

The formulæ relative to the two last cases may, however, be deduced from those relative to the two first, by considering n as negative, as it will be evident if we produce EM, EN, till they meet AD on the other side of A.

It is therefore sufficient to consider the first of these four cases. From E draw EG perpendicular upon AB, this line produced will pass through D; from F draw FK perpendicular upon AB; we shall have successively

$$AK = \frac{AG}{n}, \quad KG = \frac{(n-1)\,AG}{n}, \quad KF = \frac{GD}{n} = \frac{2\,EG}{n},$$

$$KH = \frac{2\,HG}{n}, \quad KG = \frac{(n+2)\,HG}{n}; \text{ therefore,}$$

$$\frac{(n-1)\,AG}{n} = \frac{(n+2)\,HG}{n}, \quad \text{or } AG : HG :: n+2 : n-1;$$

but

$$AG : HG :: \tan AEG : \tan HEG :: \tan EHG : \tan EAG;$$

therefore,

$$\tan EHG : \tan EAG :: n+2 : n-1; \text{ or, which is the same thing,}$$

$$\tan\big((a^n, a') - 90^\circ\big) : \tan\big((P, a') - 90^\circ\big) : n+2 : n-1 \ldots (A).$$

This proportion will give the value of $\frac{n+2}{n-1}$, and consequently that of n, when the incidence of one of the faces of the secondary rhomboid with the axis, or with a plane perpendicular to it, will be known. It must only be observed in making use of it, that when one of the faces of the secondary rhomboid is parallel either to EL or EM; that is, when the planes of the secondary rhomboid are situated above the edges of the primitive, $\tan\left((a^n, a') - 90^\circ\right)$ should be preceded with the sign *minus*. With this alteration, according as the values of n deduced will be positive either greater or less than 1, or negative either less or greater than 2, we shall have respectively one of the four cases mentioned. When $n = 1$, the secondary rhomboid becomes a plane perpendicular to the axis, when $n = -2$, a six-sided prism.

It is now easy to obtain a formula giving the value of n in function of the two angles (P, P), (a^n, a^n) of the two rhomboids; for we have found generally,

$$\tan^2\left((\mathrm{P}, a') - 90^\circ\right) = \frac{-\cos^3\frac{(\mathrm{P},\,\mathrm{P})}{2}}{4\cos^3\frac{(\mathrm{P},\,\mathrm{P})}{2}}$$: we shall have also

$$\tan^2\left((a^n, a') - 90^\circ\right) = \frac{-\cos^3\frac{(a^n,\,a^n)}{2}}{4\cos^3\frac{(a^n,\,a^n)}{2}},$$ and, by substituting these values in the proportion (A),

$$\frac{\cos^3\frac{(a^n,\,a^n)}{2}}{\cos^3\frac{(a^n,\,a^n)}{2}} : \frac{\cos^3\frac{(\mathrm{P},\,\mathrm{P})}{2}}{\cos^3\frac{(\mathrm{P},\,\mathrm{P})}{2}} :: (n+2)^2 : (n-1)^2 \ldots\ldots (\mathrm{B}).$$

a proportion, by means of which we easily find the value of $\frac{n+2}{n-1}$ by the use of logarithms, and subsequently that of n. This formula leads to some curious remarks. If we call q the quotient of the first term by the second, we shall have

$$\frac{(n+2)^2}{(n-1)^2} = q, \text{ or } \frac{n+2}{n-1} = \pm\sqrt{q},$$ and consequently two different values of n. Therefore a secondary rhomboid of a given angle (a^n, a^n) may be derived in two different ways from the primitive; and if we call n' the index corresponding to the

first, and n'' that corresponding to the second, we must have

$$\frac{n'+2}{n'-1} = +\sqrt{q}, \text{ and } \frac{n''+2}{n''-1} = -\sqrt{q}; \text{ hence } n'' = \frac{4-n'}{2n'+1}.$$

This expression shews, that when n' is positive, greater than 1 and less than 4, the value of n'' is positive, and less than 1; that is to say, that, to a rhomboid produced by a decrement in breadth of less than four rows on the superior angle of the primitive, corresponds a rhomboid measuring exactly the same angle, produced by a decrement in height on the same superior angle. If n' is greater than 4, n'' is negative; that is to say, that, to the rhomboid produced by a decrement in breadth on the superior angle of more than four rows, corresponds another rhomboid measuring the same angle, produced by a decrement in height on the inferior angle of the primitive. All these results, as well as those referring to negative values of n', might easily be verified by geometrical considerations. There is no difficulty, by means of the preceding formulæ, to determine the index of a secondary rhomboid, with respect to another secondary rhomboid assumed as the primitive. If the incidences of the two secondary rhomboids are given, the formula (B) will immediately give the quantity required. If the indices n', n'' of these rhomboids, with respect to the primitive, are given, we shall have to determine the index n''' of the second. With respect to the first, the following proportion,

$$\frac{(n''+2)^2}{(n''-1)^2} : \frac{(n'+2)^2}{(n'-1)^2} :: (n'''+2)^2 : (n'''-1)^2,$$

which gives for n''' the two following values:

$$n''' = \frac{n'\,n''+n''-2}{n'-n''}, \quad n''' = \frac{-(n'\,n''-4n'+5n''-2)}{2n'\,n''+n'+n''-4}.$$

I shall now advert to the dodecahedrons derived from a rhomboid. In the forms of this kind derived from a rhomboid, three of the pyramidal edges meeting at the same summit, are in the same vertical planes with the axis, as the three oblique diagonals of the primitive, and the three others in the same vertical planes, at the superior edges. Let ABCD, Fig. 2., be the primitive rhomboid, and from one of the summits A draw AE, AG, parallel to two of the pyramidal edges of a dodecahedron derived from it. These lines, in agreement to the preceding remarks, will necessarily meet the first the edge EB, above or below the point E, and the other the oblique diagonal CB, above or below the point C. It is the on relative position of these points K and G that depends the division of the dodecahedrons, into dodecahedrons produced by decrements on the lateral angles of the primitive, those resulting from decrements on the superior edges, from decrements on the inferior edges, and finally those resulting from intermediate decrements. The first case corresponds to the coincidence of the points K and E, and we shall first investigate the formulæ which relate to it. The sign of such dodecahedrons will be e_n, placing the index below to distinguish it from the sign relative to rhomboid, produced on the inferior angle of the primitive, and it is said to be the result of a decrement by n rows in breadth on the lateral angle of the primitive; so that if E and G are joined, and the line EG produced to F, CA is equal to n times CF. The angle of two faces of this dodecahedron meeting in a line parallel to the oblique diagonal AK, will be designated by $(e_n : e_n)$; that of two faces meeting in a line in the same vertical plane, as AC, by $(e_n \,.\, e_n)$; and the incidence of one of the faces of the upper pyramid upon the corresponding face below, in the usual way, (e_n, e_n). This understood, we shall have successively,

$$\sin \text{CAF} = \frac{\text{CF} \sin \text{CAD}}{\text{AF}}, \quad \cos \text{CAF} = \frac{\text{CF}\,(n + \cos \text{CAD})}{\text{AF}},$$

hence $\cot \text{CAF} = \dfrac{n + \cos \text{CAD}}{\sin \text{CAD}}$; from A as a centre describe a sphere, and let L, M, N be the points, where it meets the lines AC, AF, AK. In the spherical triangle LMN we shall have

$$\cot \text{LMN} = \frac{\cot \text{LM} \sin \text{LN} - \cos \text{NLM} \cos \text{LN}}{\sin \text{NLM}};$$ but LNM $= 90° - \dfrac{(e_n : e_n)}{2}$, and NLM $=$ (P, P), substituting, we obtain

$$\operatorname{tang} \frac{e_n : e_n)}{2} = \frac{\dfrac{n + \cos \text{CAD}}{\sin \text{CAD}} \cdot \sin \tfrac{1}{2}\text{CAD} - \cos(\text{P},\text{P}) \cos \tfrac{1}{2}\text{CAD}}{\sin\,(\text{P}, \text{P})}$$

$$= \frac{\dfrac{n + \cos \text{CAD}}{2 \cos \frac{1}{2} \text{CAD}} - \cos\,(\text{P}, \text{P}) \cos \tfrac{1}{2} \text{CAD}}{\sin\,(\text{P}, \text{P})} =$$

$$= \frac{n + \cos \text{CAD} - 2 \cos (\text{P}, \text{P}) \cos^2 \tfrac{1}{2} \text{CAD}}{4 \cos \tfrac{1}{2} \text{CAD} \sin \frac{(\text{P}, \text{P})}{2} \cos \frac{(\text{P}, \text{P})}{2}} =$$

$$= \frac{n + 2 \cos^2 \tfrac{1}{2} \text{CAD} - 1 - 2 \cos^2 \tfrac{1}{2} \text{CAD} \left(1 - 2 \sin^2 \frac{(\text{P}, \text{P})}{2}\right)}{4 \cos \tfrac{1}{2} \text{CAD} \sin \frac{(\text{P}, \text{P})}{2} \cos \frac{(\text{P}, \text{P})}{2}},$$

and by observing that $2 \cos \tfrac{1}{2} \text{CAD} \sin \frac{(\text{P}, \text{P})}{2} = 1$ *, we shall have simply

$$\tan \frac{(e_n : e_n)}{2} = \frac{n}{2 \cos \frac{(\text{P}, \text{P})}{2}}; \text{ or } n = 2 \tan \frac{(e_n : e_n)}{2} \cos \frac{(\text{P}, \text{P})}{2} \ldots (\text{C})$$

A very simple formulæ, which will give the value of the index n, when the angle $(e_n : e_n)$ will be known, as well as the incidence of the faces of the primitive. Let R be the point where the sphere described from the point A mets AG, and O the point where it meets AB, in the spherical triangle NRO, we shall have

$$\cos \text{NRO} = \cos \text{NO} \sin \text{RNO} \sin \text{RON} - \cos \text{RNO} \cos \text{RON},$$

but

$$\text{NRO} = \frac{(e_n . e_n)}{2}, \ \text{RNO} = \frac{(e_n : e_n)}{2}, \ \text{NO} = (\text{P}, a') - 90^\circ \ \text{RON} = 60^\circ,$$

therefore,

$$\cos \frac{(e_n . e_n)}{2} = \cos \left((\text{P}, a') - 90^\circ\right) \sin \frac{(e_n : e_n)}{2} \sin 60^\circ -$$

$$- \cos \frac{(e_n : e_n)}{2} \cos 60^\circ; \text{ or, by observing that}$$

$$\cos \left((\text{P}, a') - 90^\circ\right) \sin 60^\circ = \cos \frac{(\text{P}, \text{P})}{2}, \text{ we get}$$

$$\cos \frac{(e_n . e_n)}{2} = \cos \frac{(\text{P}, \text{P})}{2} \sin \frac{(e_n : e_n)}{2} - \tfrac{1}{2} \cos \frac{(e_n : e_n)}{2}; \text{ but the}$$

formula (C) gives

$$\cos \frac{(\text{P}, \text{P})}{2} \sin \frac{(e_n : e_n)}{2} = \frac{n}{2} \cos \frac{(e_n : e_n)}{2}; \text{ hence}$$

$$\cos (e_n . e_n) = \frac{n}{2} \cos \frac{(e_n : e_n)}{2} - \tfrac{1}{2} \cos \frac{(e_n : e_n)}{2}, \text{ and consequently}$$

* See Mr Brooke's Elementary Introduction to Crystallography, p. 362.

$$\frac{(n-1)}{2} = \frac{\cos\frac{(e_n \cdot e)}{2}}{\cos\,(e_n : e_n)} \ldots\ldots\ldots\ldots (D)$$

This formula gives the value of n, without knowing the incidences of the primitive faces, and by means only of the two angles $(e_n \cdot e_n)$ and $(e_n : e_n)$. When

$$n = 3 \quad \frac{\cos\frac{(e_n \cdot e_n)}{2}}{\cos\frac{(e_n : e_n)}{2}} = 1,$$ consequently the two angles $(e_n \cdot e_n)$ and $(e_n : e_n)$ are equal, and the dodecahedron is a right, double, six-sided pyramid. We may even find the value of the angle of the primitive by means of the same angles, without knowing the index of the dodecahedron; for, in estimating n between the equations (C) and (D), we easily get

$$\cos\frac{(P,\,P)}{2} = \frac{2\cos\frac{(e_n : e_n)}{2} + \cos\frac{(e_n : e_n)}{2}}{2\sin\frac{(e_n : e^n)}{2}}.$$

(To be continued.)

ART. VIII.—*Description of Eudalite.* By A. LEVY, Esq. Member of the Academy of Paris.

AS no account of the forms of Eudalite has as yet been published, you will perhaps find room in your Journal for the following short description of a very large and well defined crystal of this substance, belonging to Mr Heuland's collection. I have also met with the same and simpler varieties in the collection of Mr Turner.

The form is represented by Fig. 3. Pl. III, and is obviously derived from a rhomboid. It is the combination of four rhomboids, with the faces of the two six-sided prisms, which are modifications of such a primitive form, and a plane perpendicular to the axis. Although any one of these four rhomboids might be assumed as the primitive *, I have found that the simplest laws are obtained for the others, by assuming as such the faces which I have marked with the letter P. The incidence of P on P, I found

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* Mr Brooke (Table at end of Introduction to Crystallography) has given, for the primitive form of the same substance, an acute rhomboid of 74° 30′.

to be 73° 40′. An acute rhomboid, Fig. 3. Pl. III., of this measurement may, therefore, be considered as the primitive. The other planes in the figure are marked with the signs designating the laws of decrements which produce them. In the present case, all these signs may be obtained without measurement, on account of the parallelism of the edges of combination. Thus, the face P is parallel to the edge of intersection of two of the faces e^1, belonging to the same summit; b^1 is parallel to the superior edge of the primitive, and a^2 is parallel to the superior edge of the rhomboid b^1. The faces d^1 and e^2 of the two six-sided prisms are also determined by the parallelisms they offer, and their relative positions. The sign of this form, according to the method of designation of Haüy, is therefore $P a^1 a^2 e^1 e^2 b^1 d^1$. According to Mohs, the same modifications would respectively be designated by

$$r,\ r-\infty,\ r-2,\ r+1,\ r+\infty,\ r-1,\ P+\infty.$$

I have calculated the incidences of the secondary faces from their signs, and the angle 73° 40′ of the primitive. They are as follow, and agree within ten minutes with observation.

$P, P =$	73° 40′	$P, a^1 =$	112° 33′
$b^1, b^1 =$	96 15	$b^1, a^1 =$	129 34
$e^1, e^1 =$	63 59	$e^1, a^1 =$	101 40
$a^2, a^2 =$	126 44	$a^2, a^1 =$	148 49
$e^2, e^2 =$	120	$e^2, a^1 =$	90
$d^1, d^1 =$	120	$d^1, a^1 =$	90

Art. IX.—*On the Cochlea of the Internal Ear of Birds.* By Dr G. R. Treviranus, Professor of Medicine, Bremen. Communicated by the Author *.

The structure of the cochlea of the internal ear of birds has been hitherto principally known by the description of Professor Scarpa, from which it appears so simple, that it is rather difficult to comprehend how a class of animals, in which many species display an acuter sense of melody and of articulate tones than most of the Mammalia, should, in respect to the perfection of this organ, which certainly is principally intended for the reception of the different modifications of audible impressions, be

* Read before the Wernerian Society, December 18. 1824.

so far inferior to them. According to Scarpa, this part contains only a hollow cartilage, in which the nerves of the cochlea ter minate. I have always considered this description as imperfect, and have found my opinion confirmed by careful examination of the internal ear of different birds. In the cochlea of the Falco *lagopus*, Corvus *glandarius*, Ardea *stellaris*, Fringilla *canaria*, and Loxia *coccothraustes*, I discovered, beneath a cuticular disc or cover, a double row of cuticular folia, on the walls of which the greater portion of the cochlear nerve is distributed, while only one branch of it is distributed to the hollow cartilage of Scarpa. On the contrary, the cochlea of the domestic fowl had none of these folia, but was simple in its structure. In the duck, the foliated arrangement was present, but not so decidedly marked as in the birds already enumerated. Probably the same is the case in the goose, but of this I have not satisfied myself by actual examination. But Scarpa appears to have examined only the cochlea of this latter bird, and hence we can explain how the structure we have pointed out has escaped his attention.

Those birds which are remarkable on account of their acuteness of hearing, are those also in which the cochlea is provided with perfectly formed *cochlear plates*. By means of the great number of these plates, a wider space is afforded for the distribution of the cochlear nerve, and probably the space is proportionally greater in birds than in the lamina spiralis of the cochlea in quadrupeds.

It is my intention soon to publish a full account of the fact, because a detailed description, without drawings, would not be sufficiently intelligible. I may add, for the information of those who may wish, by actual investigation, to satisfy themselves of the accuracy of my statement, that, in order to see the cochlear plates or folia, and the distribution of the cochlear nerve, it is necessary to harden the ear in spirits of wine, before dissection.

Art. X.—*On the Aurora Borealis and Polar Fogs.* By Professor Hansteen *.

I. It is well known that, with us, the Aurora Borealis presents itself to our view in the following manner. In the NNW.

* From the Norwegian Memoir inserted in the Christiania Journ. of Nat. Hist.

appears a luminous arch, the convex side of which is turned to the zenith, and the extremities of which bend towards the horizon. That part of the circle of the horizon which lies between its extremities forms a chord of the arch. The segment of the circle between the arch and the horizon is, for the most part, darker than the rest of the sky; sometimes black, sometimes dark-grey. The farther you advance towards the north, this coloured segment becomes less dark, and in the highest latitudes it becomes altogether undistinguishable. The highest point of the arch, at least in latitudes not very high, is almost always found in the magnetic meridian, that vertical plane which passes through the magnetic pole. In the North American States, where the westerly variation of the needle is only two degrees, the same luminous arch is seen, but its highest point lies due north. According to Scoresby's observations *, on the east coast of Greenland, in Lat. 65° N., the arch of the Aurora Borealis lies from north to south, in such a manner that its highest point is either to the east or west, as the arch lies on the one side or the other of the zenith. This agrees with the remarks of the missionary Andrew Ginge on the aurora borealis, in the colony of Good Hope, in Greenland (Lat. 64° 10′′ 5′); with this difference only, that the arch commonly appears low in the east or south-east, and more seldom approaches near to the zenith. He describes in the following manner such an arch, as seen on the 12th December 1786. "At half-past 4 P. M. the first faint flashes of the aurora borealis arose from the east, which a quarter of an hour after reached the zenith, and from that shot out on all sides. Soon after, these were converted into an arch, which went through the zenith, and almost touched the horizon in the north and south. This arch was white, and so brilliant that it lighted up Baals River, which is a mile broad. At 7 P. M. the declination had decreased, from mid-day, from 50° 57 to 50° 37′, that is, 20½′. At half-past 8 the arch disappeared, and in the south was seen a comb with its teeth upwards. At that time the declination was 50° 20′," &c.

From the foregoing observations, it is easy to see that this arch must be a part of a whole luminous ring, hovering over the surface of the earth at a considerable height, of which every ob-

* Scoresby's Journal of a Voyage to Greenland.

server sees his own portion. We may give an explanation of this by means of the hour-circle on a globe. Suppose a little insect creeping round the globe in the 60th parallel, it will only see a small part of the ring, as the largest portion of it will be concealed by the globe which forms the insect's horizon. The highest part of the arch which in this case it can see will be due north. If it approach nearer to the ring, it will see a larger portion of it; and when it is close under its edge, this will appear to be in the zenith. If it come nearer the Pole, and within the ring, the nearest and highest part of the ring will be seen to the south, just as the ring of the Aurora Borealis was seen at Good Hope. Now, were the pole of the earth, or rather a point of its lengthened axis, the centre of the ring of the Aurora Borealis, the highest point of the arch would be seen every where in the true meridian, or due north. But, as this is not the case, since, with us, the highest point of the arch is seen about 20° west of due north, in North America it is seen due north, and at Good Hope, in Greenland, to the east, it follows that the centre of the ring must lie about from 20° to 30° from the Pole of the earth, in a meridian passing through the States of North America. And since the arch is sometimes seen in the zenith near Iceland, and often stretches so far to the south as to pass the zenith, both here, in Christiania and in Copenhagen, and even in more southerly regions, it follows that the radius of the ring of the aurora borealis may extend from 20° to 40° and above.

It is easy now to perceive in what manner the arch of the aurora borealis will appear in different meridians. If it be viewed from a point lying in the same meridian with its centre, its highest point will appear due north; and if this rise so high as to pass through the zenith, its extremities will terminate in the east and west. If, again, it be viewed from a point lying eastward of the meridian of the ring, as with us in Europe, then the highest point of the arch will move to the west of the meridian, and the farther the more you advance to the north, till you come to the same latitude with the centre of the ring, between 60° and 70°. Here the highest point of the arch will lie due west; and if the ring extend so far as to pass through the observer's zenith, it will go from north to south, that is, it will be parallel with the meridian. Such was the case with regard to the arch seen by Captain Scoresby on the 15th of April in

Lat. 64° 41′. If the place of the observer be within the circumference of the ring of the aurora borealis, as is the case with the colonies in the western districts of Greenland, the arch will be seen to the south, provided the observer be south from its centre, and to the east, if he be east from it. These rules may be shortly expressed in the following formula. If the observer be on the outside of the ring of the aurora borealis, he will see the highest point of the arch in the same direction with the centre of the ring: if he be within the ring, the highest point of the arch will be seen in the direction opposite to that of the centre of the ring *.

That the centre of the ring of the aurora borealis does not coincide with the north pole of the earth, is a very remarkable fact. This centre coincides as near as possible with the magnetic pole in North America, the place of which we have determined in the first volume of this Journal *. From this, we are led to suppose that there must be some connection between the aurora borealis and the magnetism of the earth. This conjecture is strengthened by the observations of Captain Cook with respect to the aurora australis. When that celebrated navigator, on his second voyage, was sailing round the south pole, he often saw, in the southern parts of the Indian sea, arches of the aurora australis, the highest point of which always lay to the south-east, so long as the ship sailed between the meridian of the Indian Peninsula and the parallel of 60°. In that region the variation of the compass is between 30° and 40° W. The highest point of the arch of the aurora australis coincides here too with the direction of the needle. But as soon as he approached the meridian of Van Dieman's Land, where the variation of the compass disappears, the highest point of the arch of the aurora australis

* Accounts with regard to the appearances of the aurora borealis in Easter Finmark, as well as observations important to the physical science of the globe in general, are expected from Dean Deinboll ||, and with the more eagerness that these tracts are seldom visited by men of science, who, besides, when they do visit them, hurry back, after a short survey, from regions the winter of which the inhabitant of the south views with horror.

|| Parish clergyman at Vadsoe, near Wardhuus (the most northerly parish in Europe), and lately a much respected and patriotic member of the Norwegian Storthing.—Translator.

* Christiania Mag. of Nat. Hist. p. 19.

was found, too, in the true meridian. From this it appears that the centre of the ring of the aurora australis likewise lies at a considerable distance, from 30° to 40°, from the sonth pole of the earth, and in a meridian which passes through New Holland. And here, too, we have shewn in the first volume of this Journal *, is the south magnetic pole to be found.

If there be now an actual connection between the polar lights and the magnetism of the earth, we should expect to find similar luminous rings, or at least powerful exhibitions of the polar light in the northern parts of Siberia, and in the neighbourhood of Terra del Fuego, that is, at the two extremities of the weaker magnetic axis of the earth. And we find that this is in reality the case. Gmelin gives a splendid, almost a terrific, description of the brilliancy of the aurora borealis, as it is seen in the north of Siberia, along the coasts of the Frozen Sea between the rivers Jemsei and Lena, adding, that "here seems to be the true native country of the aurora borealis." The same thing says Horrebow, concerning Iceland; and the author of the Mirror for Kings, together with all later observers down to Ginge, concerning Greenland. We find thus, that, in the northern hemisphere, the polar lights have two different centres, one in the north-west, lying in the neighbourhood of Hudson's Straits; another in the north-east, lying in the Frozen Sea, north from Siberia. When Captain Cook sailed round the south pole, he saw no where the aurora australis, except in the tract we have just mentioned, in the Southern Indian Ocean; but the Spanish navigator Don Antonio de Ulloa mentions, in a letter to Mairan, that, when he sailed past Cape Horn, in Terra del Fuego, as often as the thick fog which prevailed there allowed him to see but a little beyond the ship's head, he always observed a perceptible illumination towards the south or south-west, which had altogether the appearance of the polar lights so well known to him in the northern hemisphere. The Abbé Molina, too, in his description of the Chiloe Isles, which lie a little to the north of the south-west coast of America, asserts, that the aurora australis was frequently seen there. *It appears, therefore, that the polar lights spring from four points on the surface of the earth,*

* Christiania Mag. of Nat. Hist. p. 32.

which, so far as we have hitherto been able to determine, coincide with the magnetic poles of the earth. The larger luminous ring is formed round the two opposite poles of the stronger magnetic axis in North America and New Holland. Whether a similar ring, as full and as regular, be formed round the poles of the weaker axis in Siberia and Terra del Fuego, is a matter which, from the few observations we are able to collect, cannot yet be so well ascertained.

The arch of the polar light is seldom seen without luminous beams shooting out from it. From the side of the arch turned away from the Pole, beams or rather columns of light dart forth in a direction nearly perpendicular to the arch, and ascend towards the zenith. If these beams are so long as to pass a considerable way beyond the zenith, towards the south, they form, in the neighbourhood of the zenith, a kind of corona or glory, which seems to be the point of their union. This corona lies from 15° to 20° south of the zenith, in such a situation that if we suppose a vertical plane passing through the highest point of the arch, which with us lies about 20° west from the meridian, and produced so as to pass through the zenith, it will come exactly upon the middle of the corona. And it is a very remarkable circumstance, *that the distance of this corona from the southern horizon, is exactly equal to the inclination of the needle at the place; so that the south pole of the needle points directly to the centre of the corona.* Such I found to be the case with regard to a pretty full aurora borealis, on the 7th of October 1816. The height of the crown was 73° 10′; its eastern azimuth 12° 11′. With regard to another, on the 8th February 1817, the height of the corona was 74° 39′; its east azimuth 14° 57′. Now, in Christiania, the variation of the compass is 20°, and the inclination of the needle about 73°. It will be understood, of course, that we cannot determine, with perfect exactness, the situation of so changing a mass of light; and that, therefore, the small deviations from the direction of the needle cannot be taken into account. At the moment when the corona is formed, and the whole heavens have the appearance of a brilliant cupola, supported by columns of different coloured light, the aurora borealis displays its full beauty and majesty. Such exhibitions of these lights, which, in the period from 1720, to about 1790, were pretty frequent, have of late years been very rare; and we live in one of the great pauses of this brilliant phenomenon. We often see but a portion of an arch; sometimes shooting beams without an arch; and sometimes only a faint glimmering towards the north, without distinguishable beams.

To give the optical explanation of the corona, would be a subject too extensive for us to enter on. I shall only briefly state here, that the formation of the corona can only be explained, by supposing that the luminous columns shoot from the surface of the earth in a direction parallel to the inclination of the needle, and to the direction of the earth's magnetism; that they first become luminous when they pass out of our atmosphere; while, in passing through it, they have the opposite effect of rendering it opaque. By this, we can explain the dark segment which appears under the arch; and also this remarkable fact, that, while the aurora borealis is in play, the sky, which is now perfectly transparent, may, in less than a minute of time, be covered with an almost impenetrable veil, which again may vanish in a time as short,—a circumstance which, in our northern regions, may very unexpectedly derange many an astronomical observation. By this supposition, too, we can explain the dark-coloured streaks of the aurora borealis, which I myself have frequently observed, and which are mentioned by several persons who have described these lights in Norway. If we turn the eye towards the magnetic zenith (if I may be allowed to give this name to that point in the heavens to which the higher, or, with us, the Southern Pole of the needle points), we here see the luminous columns from the end; and, as they are at a considerable distance from one another, in this situation the eye perceives the blue arch of the heavens between them. In all other parts of the sky, we see the luminous columns obliquely; so that the one covers the other, which consequently gives them the appearance of beams darting from the arch, connected in one body. The following figurative illustrations may make this plain. Suppose a person lying in a field of rank grass, or in a forest of tall pines, he will, in this case, see only a circular portion of the sky round the zenith. The lower part of the sky cannot be seen, concealed by the close standing stalks of the grain, or by the stems of the trees, which cover one another. If we hold a brush or a close heckle in such a manner that the bristles of the one or the teeth of the other are turned to the eye, round that place where the direction of the bristles or the teeth coincide with the axis of the eye, we can perceive the bottom of the brush or the heckle. In all other places, the bristles and the teeth cover one another, and conceal the bottom. If we now suppose a plane reaching the heavens, in the magnetic zenith which I have mentioned, and that the luminous columns shoot up perpendicularly to this plane, it will now be easy to perceive, from these examples, why the luminous mass can be seen through in these places, and forms a sort of corona, towards which all the beams seem to collect. When the arch of the aurora borealis rises so high in the sky as to reach the magnetic zenith, it seems then, at this place, to be broken off, from which we may infer, that the rings of the polar lights consist of very short luminous cylinders, parallel to the direction of the magnetism of the earth, which seem only to form one connected luminous mass, because the intermediate spaces are filled up by rows of luminous cylinders lying behind one another. We see also from this, that the shooting beams which seem to dart from the arch towards the zenith, properly neither come from the luminous ring, nor are connected with the luminous columns, but that each of them, as well as the ring itself, consists of a great number of short luminous cylinders, lying close together, and almost parallel *, of which each conceals a part of the one lying before it.

I have already hinted, that there must be some connection between the aurora borealis and the magnetism of the earth. Besides the reasons which may be derived from the facts already mentioned, I mean, that the centre of the luminous rings coincide with the four magnetic poles; and also, that the luminous columns shoot parallel to the medium direction of the magnetic powers at any one place; that they, beyond all doubt, follow the laws of repulsion of the magnetic powers, and, consequently, themselves are magnetic,—there are many other reasons as strong, if not stronger, of which I shall briefly mention only the most important.

* They are not completely parallel, as their direction is parallel to the inclination of the needle, which is different in different places.

1. When the aurora borealis is vivid, the horizontal magnet becomes restless, varies in a few minutes from three, four, to five degrees from its ordinary place, and sometimes gets into a quivering motion, which shews, that, at that time, the magnetic powers of the earth are in a state of great agitation. 2. A short time before the aurora borealis appears, the intensity of the magnetism of the earth is apt to rise to an uncommon height; but so soon as the aurora borealis begins, in proportion as its force increases, the intensity of the magnetism of the earth decreases, recovering its former strength by degrees, often not till the end of twenty-four hours. These changes are sometimes so sudden, that I once observed a considerable difference in the space of from two to three minutes. (The Professor here details an experiment made with a fine magnetic needle, suspended by the thread of a silk worm. He counted its vibrations to the amount of 360; and dividing this number into equal portions, and comparing by a chronometer the time occupied by each portion, he found a difference in the number of vibrations performed in the same time, far exceeding any thing which could arise from the inaccuracy of the observation, proving a difference during the time of the experiment in the intensity of the magnetic force.) From this, he says, it seems to follow, that the polar lights are the effect of an uncommonly high magnetic intensity, which intensity lets itself off, as it were, by the polar lights, and thus sinks under its common strength. 3. During the time of a powerful display of the aurora borealis, Mallet and others have found no uncommon strength of electricity in the air, which seem to disprove the hypothesis of Franklin. 4. The Reverend Mr Steenbuck, who was the editor, and, in a great measure, the author of the *Description of the Kingdom of Norway*, published under the name of Jessen, and who was himself born in the province of Trondheim, relates, concerning the arch of the aurora borealis, that, according to the accounts of old people, this arch was wont to appear lower on the horizon in Nordland, and nearer to the true north; that, since these times, it has risen higher in the sky, and removed from the meridian towards the west. This agrees entirely with the change of place of the North American magnetic pole, by which it lies some nearer to us, and lies in a plane which forms a larger angle with the meri-

dian. 5. The Swedish naturalist Wilcke, has remarked, that, during a vivid borealis, the corona sometimes changes its place, moving backward and forward several degrees. But since the place of the corona is determined by the angle formed by the luminous columns with the surface of the earth, it is evident that the angle must likewise change. And, in such cases, he observed, that the inclination of the needle altered in a similar manner, so that moving up and down, it always pointed to the centre of the corona. A change in the direction of the earth's magnetism, produces also a change in the direction of the luminous columns.

The perpendicular height of the arch of the aurora borealis above the surface of the earth, is to be computed from its height above the horizon, observed at two different places, which lie at a considerable distance from one another, nearly in the same meridian. From a number of those arches, the cotemporaneous height of which was observed at Rome, Paris, Copenhagen, Stockholm, and other places, Mr Mairan has found, that the ring of the polar lights above the surface of the earth, almost always exceeds 100 geographical miles. The luminous columns of which the shooting beams consist, have, in all probability, the same height *. Consider now the difficulty of answering the following questions on any other hypothesis than what I have suggested: Why do the polar lights spring not from the poles of the earth, but from four points at a great distance from the poles? Why do the direction and intensity of the earth's magnetism change so considerably, while the streams of this light are issuing forth? Why is the direction of the luminous columns parallel at every place with the direction of the magnetism of the earth, or the inclination of the needle? What can that material substance be, which has such powerful influence at so great a height over the surface of the earth? How can this, at such a height, produce a certain sound? From the manifold experience we have had of this in the north, it must be considered as a fact admitting of no question. Why do the po-

* When Scoresby talks of the shooting beams appearing to descend to the topmasts, this can be considered as nothing else but an optical deception. In the Heavens, the eye has no measure of distance. The sun and moon seem equally near us, though the first is more than 400 times farther distant than the last.

lar lights not appear equally powerful every season, but have periods of from 60 to 100 years, during which they display themselves with great splendour, after which they have pauses of nearly equal length? When we consider, I say, the apparent impossibility of answering these questions, in a satisfactory manner, on any other hypothesis, and how readily an answer to the most of them suggests itself, when we adopt a magnetic origin to the polar lights, it seems a matter of course to admit this hypothesis. Nor is it a new one. All the naturalists who have had more than a superficial knowledge of magnetism, and who can be considered as competent judges of this subject, have admitted it. I have only to mention as the first and chief of these, Dr Halley; and next to him the Swedish naturalists Celsius, Hiorter, Wargentin and Wilcke. If any person can explain all the external phenomena of the polar lights, by assuming rather an elastic material fluid, on portions of which the magnetism, of the earth can operate according to the known laws of attraction and repulsion, there still remains this important question, which our present knowledge of the sciences cannot answer, What is this material substance? Is it electricity in a neutral state, as we have learned to know it in the insulated galvanic chain in the experiment of Oersted? or, Is it an elementary substance, in some other state as yet unknown to us, and on which the magnetic powers only can act *?

(To be continued.)

Art. XI.—*Account of the measures adopted for pulling down the Ruins caused by the late great Fires at Edinburgh, on 15th, 16th, and 17th November* 1824. Drawn up by a Naval Officer present. (With Engravings).

It is not the intention of this notice to give any description of the recent destructive Fires: there was nothing respecting them, indeed, possessed of any peculiar interest, more than always attends a great catastrophe of this nature.

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* A copious statement of all the known external phenomena of the polar lights, together with a historical account of their different periods and pauses, will be found in the second part of my "*Magnetismus der Erde*," if circumstances should ever put it in my power to bring this work to light.

After the fire was extinguished, however, a new source of alarm arose, from the probable fall of the impending ruins. This danger extended, in a greater or less degree, over the whole range of the conflagration. But it was most imminent in two cases, and immediate steps were necessary to prevent them falling in the wrong direction. These ruins were, the southern gable-end of the highest house in Edinburgh, situated at the south-eastern angle of the Parliament Square,—and the back wall of the adjoining house, on the eastern side of the square. Both of these enormous piles towered far above the houses of the Cowgate and the Old Fish-Market Close, so as to threaten them with immediate destruction.

Captain Head of the Royal Engineers, was ordered by the Commander in Chief to devise some method for taking down these ruins, without injury to the neighbouring houses.

The two masses to be destroyed were differently circumstanced. The great gable, Plate IV. (A), was a tall and comparatively narrow pile, capable of being pulled down by main force. The breadth of this gable was 34 feet, and its height about 130 feet. The other (B), was more than twice as broad as the gable, and was strongly supported by a considerable portion of another wall near the middle, running at right angles to it, so as to form a compact buttress, which effectually offered an obstacle to pulling it down in every direction, but that of the houses behind.

Captain Head determined to pass a chain-cable over the great gable, in such a manner, that, by the application of a powerful purchase to one end of the cable, he should draw the upper part of the ruin towards the square, while, by a judicious adjustment and tightening of the other end, he should prevent the centre and lower part of the building from bulging outwards, to the inevitable destruction of the houses below. This idea was very skilfully put in execution, in the following manner, by Captain Hope of his Majesty's ship Brisk, who, with his officers and crew, co-operated with Captain Head in the most admirable way, during the whole of these operations.

It is impossible to speak in terms of sufficient admiration of the gallantry with which the officers and seamen climbed about the ruins, and exposed themselves to the most imminent danger, altogether indifferent to the probable consequences.

Some of the seamen were sent to the top of the house adjoining the ruin on the west, and by means of a small line which they threw over the top of the gable at C, the end of a stronger rope, to which was affixed a $3\frac{1}{2}$ inch hawser, was drawn up. This was handed down to the Square, and rove through a block attached to a beam, firmly secured by three pieces of timber, sunk many feet deep in the ground, and supported by a strong shore (O). It now became a question, whether the chain should be drawn up from behind the gable, or be sent over from above, as the line had been in the first instance. Many persons, and amongst others, the writer of this article, were of the latter opinion; but Captain Head, with better judgment, decided upon dragging the chain up from behind. The iron-cable was accordingly prepared in a coil, to the eastward of the pile, or to the left, at D, as seen in the drawing, and the end being made fast to the hawser, it was pulled up by the seamen applying their strength to the other end in the Square. The chain, when drawn over, made a gap 8 or 10 feet deep, by pulling down at first a portion of the wall, and afterwards by loosening and sawing down the masonry over which it passed (C). When enough of chain was thus dragged over, a strong purchase, consisting of two double blocks, was lashed to it, and the end of the rope was led through a block fastened to the beam. Thus far all was ready, but a difficulty arose which had not been contemplated. The corner of the great gable was studded with projecting knots, which prevented the bight of the chain (or the loop, as landsmen express it), which was to embrace the building, from coming sufficiently far up, to prevent the middle of the ruin from bulging outwards.

This was remedied, by fixing a small tackle GG, to the window of a house to the eastward, and attaching the other block to the height of the chain,—this being "bowsed" or drawn up, kept the chain clear of the corner, which operation was facilitated by taking off the weight, with another small tackle HH, which, by tricing up the chain, kept it clear of the angles of the ruins and the rubbish on the ground. When things were thus arranged, they assumed the appearance represented in Plate IV. All the party employed now took hold of the chain at KKK; and having drawn it quite tight, passed it several times round the beam, and fixed it there. This concluded the operations of

Friday, and relieved the public from all alarm of the great gable tumbling into the Cowgate.

On Saturday morning, while various minor preparations were making for drawing down the gable, Captain Head directed a series of *mines*, or *shots*, as they are termed by miners*, to be made in the lower part of the buttress before described, which supported the east wall B. It was obvious that this pile owed all its stability to this projecting wall. In the one direction it acted as a buttress, and in the other, by its immense weight, prevented the wall from tumbling back on the houses. It occurred to Captain Head, that if its base or lower extremity were blown away, the support would be removed, and the buttress would instantly be converted into a weight abundantly sufficient to drag the whole down in the direction required. Six shots were accordingly inserted at the points marked 1, 2, 3, 4, 5, 6.; each being furnished with a match decreasing in length from that at 1 to that at 6. The intention of which arrangement was, to demolish the foundation gradually, and not by one great blast, to risk overturning the whole fabric the wrong way. The whole quantity of powder used was $4\frac{1}{2}$ pounds, only $\frac{2}{3}$ds of which, or about 3 pounds, were eventually exploded.

At a little after noon, the purchase was manned by Captain Hope's people; and after several very severe tugs by the seamen, who were animated to exert themselves by the shouts of the surrounding multitude, the top of the great gable leaped from its place into the centre of the building, leaving only a lofty shaft, extending from the top to the bottom in the most singular manner. This was subsequently pulled down by the chain, which, though broken by the first crash of the gable, was sufficiently entangled with the ruins to maintain its hold. This tall remnant of the wall did not fall over, but plumped directly down by the side of the pillar which remained standing, to the height of 20 feet from the foundation.

Captain Head now required every one to fall back, and the Parliament Square being cleared from end to end, he advanced alone, and gave the word to light the matches. The pause which ensued

* A mine is generally loaded with a box of powder, whereas, in a shot, the hole made by the jumper only is filled with powder.

was very remarkable; a deep silence marked, in the strongest manner, the doubt and anxiety which pervaded the minds of all the spectators. The first shot drove away a portion of the buttress, and threw up a cloud of smoke. This was followed almost instantly by the second explosion, which completely destroyed the support, and the whole of the vast pile was observed to be in motion. At first it seemed merely to tremble, but, in the next instant, it was seen to writhe to and fro, from top to bottom; next, a few loose stones fell; then the immense stalks of chimneys, and the tops of the walls, bowed their heads forwards;—the middle and lower parts now seemed all disjointed and powerless; and all these motions rapidly accelerating, the whole fabric came thundering to the ground, with a most prodigious crash, filling the air, to a great height, with a dense cloud of dust. See Plate V.

Nothing could be more completely successful:—not a single person was hurt, nor a single building injured, though some were situated at no more than a few feet from the ruins.

What is particularly remarkable is, that, in no case of the fall of these walls, did their effects extend to more than a few yards distance from their bases. This can only be accounted for, by supposing the stones completely disunited by the decomposition of the mortar, and the partial calcination of the stones by the heat, so that the instant the equilibrium was destroyed, all the parts were left to act independently, and being without any cohesion, fell straight to the ground *.

Art. XII.—*Memoir on the Milk of the Cow-Tree.* By Mariano de Rivero, and T. B. Boussingault †.

Mr Laet appears to be the first who has made known, in Europe, one of the most curious vegetable productions of the

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* The engravings (Plates IV. and V.), illustrative of the above description, are taken from a set of eight admirably executed representations of the ruins after the fire, published in Edinburgh for the benefit of the sufferers. They are said to be the work of Mr James Hall, a rising young advocate at the Scotch Bar.—Edit.

† Translated from the Spanish.

equinoctial regions,—a tree which gives a kind of milk entirely analogous to that of the cow, and which, for that reason, has been called Cow-Tree. This singular juice, on account of its similitude to the milk of animals, in the place of which, Mr Humboldt has seen it used for every domestic purpose on the farm of Barbula,—has been admired by every traveller. Mr Humboldt, in the description he has given of it, says, "I confess, that, among the great number of curious phenomena, I have observed in the course of my travels, there are few which have made a stronger impression on my mind than the cow-tree. All that has any connection with milk, all that relates to cereals, inspires us with an interest which is not simply that of the knowledge of causes, but which is connected with another series of ideas and feelings. We cannot, without difficulty, believe, that the human species can exist without farinaceous substances, nor without the nutritious milk contained in the bosom of a mother, which is intended for the long weakness of infancy. The starchy nature of grains,—an object of religious veneration among so many ancient and modern nations, is disseminated in the seeds, and deposited in the roots of vegetables; milk appears exclusively to be the production of animal organisation. Such are the impressions we have received in childhood, and such is the cause of the astonishment we feel at the sight of the tree we are going to describe. Here our emotion is not caused by the dark thick solitudes of woods, nor by the majestic courses of rivers, nor by those mountains covered with eternal snow; but a few drops of a vegetable juice, make us sensible of the power and fecundity of nature. On the barren declivities of a rock grows a tree, whose leaves are dry and coriaceous. Its thick ligneous roots scarcely enter the rock; for several months in the year rain scarcely waters its fan-shaped leaves. The branches appear dry and dead. But when an incision is made in the trunk, a sweet and nutritious milk flows from it. It is at the rising of the sun that the vegetable liquid runs most abundantly. Then the natives and Negroes are seen to come from all parts, provided with vessels, to receive the milk, which becomes yellow, and thickens at the surface. Some empty their vessels under the same tree; others carry them to their children. It is like a shepherd distributing to his family the milk of his flock.

—*Humboldt, Voyage aux Régions Equinoxiales du Nouveau Continent,* lib. 5. chap. xvi. page 263 et 264.

If those who possess these precious trees near their habitation, drink with so much pleasure their beneficent juice, with what delight will the traveller, who penetrates in these high mountains, appease with it his hunger and thirst? Thus we have seen, on the road from Patito to Puerto-Cabello, all these trees full of incisions, made by the travellers, who seek them with anxiety. It would be sufficient, it appears to us, that this milk could be used as an aliment, to value it, and invite to the cultivation of the trees which furnish it; but Nature has been pleased to make it still more precious and useful; for, besides containing so nutritious a constituent as fibrin, it also contains, in abundance, an exquisite kind of wax, which may be extracted with great facility.

Before we left Europe, Baron Humboldt recommended us particularly to make the analysis of this juice; and it is the result of our experiments we are going to detail.

The milk we have examined is given by the cow-tree, which, according to Mr Kunth, appears to belong to the family of Sapotæ *, and is found on the road from Ourmase to the NW. of Maracovy, on the northern declivities of the Andes. It appears, that this tree is not peculiar to the Andes on this side of Caracas; since we have been assured it grows as well in Choco. This vegetable milk possesses all the physical properties of the milk of animals; only it is a little thicker, and mixes easily with water. When boiled, it does not coagulate, but a thick yellow pellicle is formed on the surface. Acids do not form with this milk any coagulum, as with that of the cow. Ammonia gives

* *Galactodendrum,* ex familia Sapotearum. Arbor 6-7-orgyalis. *Ramuli* teretes, glabri, juniores angulati, tenuissime canescenti-puberati. *Gemmæ* terminales, subulatæ, convolutæ, sericeo-pubescentes. *Folia* alterna, petiolata, oblonga, utrinque rotundata, apice brevissime acuminata, integerrima, reticulato-venosa, venis primariis transversalibus paulo approximatis subparallelis nervoque subtus prominentibus, subcoriacea, glaberrima, exsiccata, supra viridia, subtus aureo-fusca, novem aut decem pollices longa, vix quatuor pollices lata. *Petioli* crassi, canaliculati, glabri, 8 aut 9 lineas longi. *Stipulæ* nullæ; *fructus* facie drupæ juglandis? fœtus, globosus, viridis, fœtus nucibus! aut monospermus.—*Kunth in Humboldt et Bonpland,* Nov. Gen. tom. iii. ined.

no precipitate, and makes it more liquid: this character indicates the total absence of catechu, since we have observed, that, in juices containing this ingredient, ammonia precipitates it; and that the precipitate washed and dried, possesses the properties of elastic gum. When left to the contact of air, it is altered, and acquires an unpleasant smell, similar to that of sour milk; a pellicle is formed at the surface, which, triturated with caustic potash, exhales ammonia. During this decomposition, carbonic acid is disengaged, and acetic acid is formed, which, very likely, combines with the ammonia. If some drops of an acid are added to this milk, it may be exposed to the air, for a long time, without any alteration. Kept in a bottle, with a crystal stopper, it does not decompose, but becomes only thicker; but, by adding a little water, it regains all its properties. In this manner, we preserve a small quantity of it we have brought from Maracay. Alcohol gives a slight precipitate; fresh milk reddens blue paper; it boils at the temperature of 100° centigrade. On the fire it presents the same phenomena as cow's milk; a pellicle is formed on the surface, which prevents the expansion of aqueous vapours: if the evaporation is carried on, for a long time, drops of oil are formed, which increase in proportion as the water evaporates, and terminate by forming an oily liquid; in which swims a fibrous substance, which dries and contracts with the increase of the temperature of the oily liquor; then it exhales a smell very similar to that of meat fried in oil.

By the action of fire the vegetable milk is separated into two parts; one fusible, on account of its greasy nature; the other fibrous and infusible. If evaporation is not carried on too fast, and if the greasy matter is not made to boil, it may be obtained without any alteration, and possessing the following properties.

This substance is yellowish-white, and translucent; and has all the appearance of refined wax of Spain. It is solid at the common temperature, and does not yield to the pressure of the finger even at the maximum of temperature in Maracay (31° cent). It begins to melt at 40° cent.; and when in complete fusion, the same thermometer indicates 60°. It is soluble in essential oil; in turpentine it is also soluble, at a high temperature; and, when cold, it separates in two parts, the interior with the appearance of grease, the other more liquid. Alcohol, at the temperature of 40° cent., dissolves it entirely; but it is precipitated when it becomes cold. It combines with caustic potash, and forms a soap; boiled with ammonia, it forms a soapy unguent. Nitric acid dissolves it when heated, with disengagement of nitrous gas; and a little oxalic acid is formed. This matter appears to us to have exactly the same properties as the refined wax of bees; and we believe it may be applied to the same uses. We have made with it wax-candles for our own use.

We also examined the fibrous matter which swam in the wax in fusion; and, by treating it with the essential oil of sassafras and turpentine, we freed it entirely of the wax. To get rid of the oil, we boiled it in water for a long time, with a view to volatilize the essential oil. The fibrous matter obtained by this process, retains still a little essential oil; it is of a dark grey colour, probably because it is altered by the action of the wax in fusion; it is insoluble in boiling water; it is fibrous, and without odour; placed upon a hot-iron, it melts, swells, is carbonised, and exhales the smell of burnt meat; put in contact with nitric acid and water, a gas is disengaged, which is not nitrous gas; and it is transformed into a yellowish greasy matter, as is the case when nitrous gas is prepared by the action of nitric acid upon flesh. Alcohol does not dissolve it; and we have used this liquid to prepare it purer.

By repeatedly boiling the vegetable milk with alcohol, and decocting the hot liquor, we obtained the fibrous substance. This white and flexible fibrous matter dissolves easily in diluted muriatic acid. From what precedes, it is obvious, that the substance which is separated from the wax, either by fusion, or the action of alcohol, possesses the same properties as fibrin; and though it may appear singular to meet, in a vegetable product, a substance which has usually been considered as peculiar to animal matter, we have not the least hesitation to consider it as fibrin, being persuaded it does not differ from it in any thing *. Consequently, in the milk of the cow-tree, wax is mixed with fibrin. It remains now to examine the

* We do not pretend that this substance is exactly identical with the fibrin extracted from animal matters; but it seems to have the same relation to it as ve-

liquor, in which are found the two principles already mentioned.

It is almost impossible to filtrate the milk: the liquor which passes is, however, sufficiently limpid. We have already said, that alcohol gives a slight precipitate, and then it may be filtrated.

The liquor has a dark colour; it slightly reddens blue paper; when concentrated, it does not, by cooling, deposit crystals; when evaporated to the consistence of jelly, and treated by alcohol at 40°, a little sugar is dissolved. The remaining mass has a bitter taste. Dissolved in water, the solution still reddens blue paper. Ammonia forms a precipitate sufficiently abundant. This character, added to the bitter taste, made us suspect the presence of a salt of magnesia. Our conjecture was verified, by putting a drop of this solution upon a plate of glass, with a little phosphate of ammonia, then mixing the two liquids with a glass-tube, and forming a letter, the character remained adhering to the glass in the most palpable manner. By this ingenious process, for which we are indebted to Dr Wollaston, the presence of one or two hundred parts of magnesia may be detected.

We had now to determine the nature of the acid combined with the magnesia. We thought it was acetic acid; but sulphuric acid did not disengage any odour of vinegar, and only carbonised the salt of magnesia. We are still ignorant of the nature of the acid, but we suppose it is not acetic acid.

The matter upon the filter, when dried, assumes the appearance of unrefined wax, and when heated, it exhales the smell of roasted milk: it is wax mixed with fibrin.

There results from the preceding experiments that the milk of the cow-tree contains,

1. Wax.
2. Fibrin.
3. A little sugar.
4. A salt of magnesia, not the acetate.
5. A colouring matter.

It contains no albumen, nor curd, nor catechu.

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getable albumen has to animal albumen. M. Vauquelin has detected, in the vegetable juice of the Carica papaya, a principle which has also a great similitude with animal fibrin, (Thomson, t. iv. ch. 1. of Fibrins, page 87). Recently we have examined the fresh juice of Carica papaya, and we have found in it the substance mentioned by the celebrated French chemist: it appears to be similar to that of the milk of the cow-tree.

Art. XIII.—*A Table, containing the Results of some Observations made by late Navigators on the Temperature of the Ocean, at various depths below its surface* *.

Position.		Temperature of the		Depth in Fathoms.	Temperature at the depth in preceding column.	Difference between the Temp. of Surface water and that sounded to.	Names of Observers.
Latitude.	Longitude.	Air.	Surface Water.				
80° 0′ N.	5° 0′ E.	40°.0	29°.7	120	36°.3	6°.6	Scoresby
79 4	5 4	34.0	29.0	13	31.0	2.0	Ditto
...	...	...	...	37	33.8	4.8	Ditto
...	...	...	...	57	34.5	5.5	Ditto
...	...	...	...	100	36.0	7.0	Ditto
...	...	...	...	400	36.0	7.0	Ditto
79 4	5 38	38.0	29.0	730	37.0	8.0	Ditto
78 2	0 10 W.	36.0	32.0	761	38.0	6.0	Ditto
78 0	—	40.5	—	118	31.0	—	Lord Mulgrave
77 4	2 30 E.	30.0	29.0	50	29.3	0.3	Scoresby
...	...	...	...	100	31.0	2.0	Ditto
77 15	8 10	16.0	29.3	20	29.3	0.0	Ditto
...	...	...	...	40	29.3	0.0	Ditto
...	...	...	...	60	30.0	0.7	Ditto
...	...	...	...	100	30.0	0.7	Ditto
76 34	10 50	25.0	30.0	20	31.0	1.0	Ditto
...	...	...	...	40	35.0	5.0	Ditto
...	...	...	...	60	34.0	4.0	Ditto
...	...	...	...	100	34.7	4.7	Ditto
76 16	10 50	16.0	28.3	20	28.9	0.3	Ditto
...	...	...	...	50	28.3	0.0	Ditto
...	...	...	...	123	30.0	1.7	Ditto
...	9 0	12.0	28.8	50	31.8		Ditto
...	...	...	...	123	33.8		Ditto
...	...	...	...	230	33.3		Ditto
75 28	60 36 W.	—	34.0	314	32.0	2.0	Ross
75 2	105 14	31.0	30.0	94	31.25	1.75	Parry
73 37	77 28	—	34.5	80	32.0	2.5	Ross
73 35	89 1	39.0	34.0	185	34.0	—	Parry
Winter	Harbour,	—16	+28.0	5	30.0	2.0	Ditto
72 7	19 11 W.	42.0	34.0	118	29.0	5.0	Ditto
72 5	76 0	31.0	30.5	110	30.25	0.25	Ditto
72 0	73 0	33.0	32.0	75	32.25	0.25	Ditto
71 24	71 0	38.0	35.0	88	33.0	2.0	Ditto
69 0	—	59.5	—	673	32.0	—	Lord Mulgrave
68 25	65 0	34.0	32.0	35	31.5	0.5	Parry
68 24	63 32	31.0	30.5	170	30.5	0.0	Ditto
...	63 8	29.0	30.0	318	30.0	—	Ditto
68 12	60 5	31.5	32.0	770	33.0	1.0	Ditto
68 19	66 5	34.0	32.0	146	34.0	2.0	Ditto
68 0	62 9	34.0	31.0	809	27.0	4.0	Ditto
...	60 0	30.0	34.5	200	33.25	1.25	Ditto
67 0	—	48.5	—	810	26.0	—	Lord Mulgrave
61 11	31 12	48.0	47.5	320	44.25	3.25	Parry
60 44	59 20	—	—	100	30.0	—	Ross

* This Table was drawn up with great care by a young friend.

Position.		Temperature of the		Depth in Fathoms.	Temperature at the depth in preceding column.	Difference between the Temp. of Surface water and that sounded to.	Names of Observers.
Latitude.	Longitude.	Air.	Surface Water.				
60° 44′ N.	59° 20′ W.	°	°	200	29.0 °	— °	Ross
...	...			400	28.0	—	Ditto
...	...			660	25.5	—	Ditto
59 40	47 46	35.0	37.0	260	39.0	2.0	Parry
58 52	48 12	38.5	38.5	290	38.75	0.25	Ditto
57 44	47 31	46.0	45.0	650	40.5	4.5	Capt. Franklin
57 39	13 31	50.0	49.5	140	47.8	1.7	Parry
57 26	25 11	49.9	49.0	130	48.0	1.0	Ditto
57 0	17 52	50.5	50.0	100	49.0	1.0	Ditto
56 59	24 33	49.0	48.5	1020	45.5	3.0	Ditto
39 4	13 8	72.5	69.1	138	56.0	13.1	Kotzebue
39 27	12 57	71.1	68.5	100	56.7	11.8	Ditto
37 3	199 17	63.0	61.0	10	59.5	1.5	Ditto
36 9	148 9	73.0	71.9	25	57.1	14.8	Ditto
...	...	...	...	100	52.8	19.1	Ditto
...	...	...	...	300	44.0	27.9	Ditto
36 0	15 0	72.5	75.0	95	74.7	1.7	Krusenstern
35 51	147 38	75.0	72.0	100	51.0	21.0	Kotzebue
29 24	199 26	75.0	74.0	100	62.0	12.0	Ditto
27 50	152 22	77.1	77.0	200	51.5	25.5	Ditto
23 3	181 56	—	78.0	25	75.0	3.0	Krusenstern
...	...	—	...	50	70.5	7.5	Ditto
...	...	—	...	125	61.5	6.5	Ditto
20 30	83 30	—	83.0	1000	45.5	37.5	Sabine
9 25	205 0	85.7	87.4	100	49.5	37.9	Kotzebue
9 21	204 44	84.0	83.0	250	77.0	6.0	Ditto
8 59	204 24	85.0	87.0	100	56.2	30.8	Ditto
2 55	—	81.0	81.0	10	81.0	0.0	Bladh
2 50	—	83.1	84.5	20	81.0	3.5	Ditto
0	—	75.5	74.0	85	66.0	8.0	Wales & Bayley
0	177 5	83.0	82.5	300	55.0	27.5	Kotzebue
0 56 S.	146 16	82.0	82.0	100	60.0	22.0	Krusenstern
3 26	7 59 E.	—	73.0	1000	42.0	31.0	Wauchope
15 26	133 42 W.	79.8	80.0	10	79.0	1.0	Kotzebue
18 17	124 56	79.2	78.5	125	68.5	10.0	Ditto
24 0	—	72.5	70.0	80	70.0	0.0	Wales & Bayley
30 39	345 33	68.0	67.0	35	49.5	17.5	Kotzebue
34 44	—	60.5	59.0	100	57.0	2.0	Wales & Bayley
55 40	—	47.0	40.5	110	51.5	11.0	Bladh
44 17	57 31	57.6	54.9	196	38.8	16.1	Kotzebue

Art. XIV.—*On the Laws of Electro-Magnetic Action, as depending on the Length and Dimensions of the conducting Wire, and on the question, Whether Electrical Phenomena are due to the transmission of a single or of a compound fluid?* By Peter Barlow, F. R. S.

The question or controversy relative to the two hypotheses on which electrical phenomena are explained, is well understood; but still there are such decided proofs advanced by the advocates on either side, in support of their particular doctrines, that it can hardly be said, although the balance seems to incline on the side of those who maintain for two distinct fluids, that the followers of Dr Franklin, who admit only one fluid, are decidedly in error.

The following experiments, although directed to another inquiry, may perhaps be found to throw some light on this subject, and therefore it will not be amiss, before entering upon a detail of them, to point out the views which led me to undertake them. In a very early stage of electro-magnetic experiments, it had been suggested, that an instantaneous telegraph might be established by means of conducting wires and compasses. The details of this contrivance are so obvious, and the principles on which it is founded so well understood, that there was only one question which could render the result doubtful, and this was, Is there any diminution of effect by lengthening the conducting wire? It had been said that the electric fluid, from a common electrical battery, had been transmitted through a wire four miles in length, without any sensible diminution of effect, and to every appearance instantaneously; and if this should be found to be the case with the galvanic circuit, then no question could be entertained of the practicability and utility of the suggestion above adverted to. I was, therefore, induced to make the trial, but I found such a sensible diminution with only 200 feet of wire, as at once to convince me of the impracticability of the scheme. It led me, however, to an inquiry as to the cause of this diminution, and the laws by which it is governed. This, again, drew my attention to the two hypotheses of electrical action adverted to above. For example, if the electric action were due to a current of a single fluid passing through the wire, and if none of it were dissipated in its course, then one could see no reason for any diminution at all, whatever might be the length of the wire; and, on the other hand, if the diminished action were due to such dissipation, then, at that part of the wire nearest to the positive pole of the battery, the action ought to be much stronger than at the other extremity, where a less quantity of the fluid would be returned to the battery than was issued at the positive pole. This has reference to the hypothesis of a single fluid, agreeably to Franklin's theory; but if we admit the two fluids issuing from both the extremities of the battery, and still attribute the diminished action to their dissipation, then at least the power exhibited by the centre of the wire ought to be much less than that shewn by those parts adjacent to the two poles of the battery. My object, therefore, thus became to examine, by means of compass needles, distributed at different distances along the wire, and with different lengths of the latter, the power thus exhibited, and to endeavour to determine the mathematical laws of its action, as depending on the length of the conducting circuit.

With this view, I procured about 840 feet of copper-wire, a little stouter than that used for bell-wire, and arranged it as shewn in Fig. 5. Plate III., where *abcd*, *a′b′c′d′* represent four upright props, framed in a square, and their ends driven into the ground, the circumference of each frame being exactly 10 feet. The wire was then brought from P, turned round an upright prop at G, whence it passed to the frame E, about which it was revolved in thirty-seven spiral volutions, from the bottom upwards, and then passed from *b* to *a′*, whence it was made to run from the top downwards, in 37 volutions about the frame F: it then proceeded from *d* to H, where it was turned round, as at G, to the other extremity N. The whole length of the wire was thus

PG	=	15½ feet.
G*c*	=	14½
37½ volutions, frame E,		375
b a	=	28
37½ volutions, frame F,		375
d H	=	14½
NH	=	15½
Total		838 feet.

The line *ab*, *a′b′*, as also GP, NH, were placed very exactly in the magnetic meridian, and G*c* and H*d* perpendicular to the same, or east and west. The three compasses on which the observations were made, were situated as shewn at B, C, D. At P and N were placed two cups of mercury, and from the battery K proceeded two stout conducting wires, which were immersed in the cups at P and N; and, by immersing also the extremities of the wires at P and N in the same cups, the circuit was carried through the whole wire. We thus began our observations on the whole length of 838 feet; then unwound two circumferences from each frame, thereby shortening the circuit 40 feet, or reducing it to 798 feet; we then unwound 40 feet more, and so on to the end, as detailed in the following tabulated results.

There still, however, remained to guard against the variable power of the battery while the experiments were in progress, which occupied several hours. This was as follows: Between N and P was situated another compass A, over which could be placed a short conducting wire, which, prior to each experiment, was made to unite the two cups N and P, and its effect on the compass was registered; immediately after which, the wires P and N were immersed, and the short conductor removed; by which means the relative power of the battery became known at each observation; for it is shewn in "Essay on Magnetic Attractions," &c. (art. 247.), that, all other things being the same, while the wire is placed in the magnetic meridian the power is directly as the tangent of the needle's deviation, or rather the latter is as the former. It is thus easy to compute what the several deviations would have been, had the power of the battery remained constant, as is done in Table II. It may be proper to state, that the apparatus employed was Dr Hare's calorimeter, and that it was raised out of the acid after each set of experiments: that is, as soon as the battery was immersed, the short conductor was placed in the cups, and the deviation on the compass A registered. This was now removed, the wires P and N inserted, and the deviations on the three compasses B, C, D, were registered by three observers, one at each. The distance of the conducting wire from the needle was only half an inch. These wires P, N were now removed, the battery remaining down, and the short wire again inserted, the compass A registered, and the observation on the other three compasses taken as before; thus obtaining two sets of observations at each immersion, corresponding to the distance of half an inch. Then, in the latter part of the series, the battery being still down, the wire at each compass was raised to 1½ inches above the needle, and a double set of observations obtained with this distance, precisely in the same manner, after which the battery was raised out of the fluid, while the wire was shortened and readjusted. This being premised, the following Table of results will be readily understood.

TABLE of Experimental Results, shewing the Deviation of Compass-Needles at different Distances, and with different Lengths of Conducting Wire.

Length of conducting Wire.	Deflection of Standard Compass A.	Deflection of the other Compasses.—Distance ½ Inch.			Deflection of Standard Compass A.	Deflection of the other Compasses.—Distance 1½ Inch.		
		Deflection Compass B.	Deflection Compass C.	Deflection Compass D.		Deflection Compass B.	Deflection Compass C.	Deflection Compass D.
Feet.								
838	21°	5°	5°	4½°				
	21	5	5	5				
798	25	6	6½	...				
	23	6½	6	6½				
758	25	8	9	7½				
	25	8	9	7¾				
718	25	9	10	8				
	25	8	10	8				
678	27	8	10½	9				
	25	8	10½	9				
638	25	10¼	11	11				
	26	10	10½	10½				
598	26	10½	10½	10				
	26	10	11	10				
558	26	10½	11½	10				
	26	10½	11½	9				
518	29	11½	13	11½				
	29	11½	13	12½				
478	30	13	14	12½				
	30	12½	14½	11½				
438	30	14	15½	13½				
	30	14	15	13				
398	31	14	15½	13½	31°	3½°	3½°	3°
	30½	14½	15½	13½	31	3½	3½	3
358	31	15	16	14½	31½	3	4	3½
	32	15	16	14½	31½	3¼	5	4
318	34	16	17	18	35	3	4½	4
	34	16	17	18	35	4	4½	4½
278	34	17	17½	17½	36	4	4	4½
	34	16½	17½	17½	36	4	5	5
238	35	18	18½	18	34	5½	5	5½
	35	19	18½	18	34	5	6	5
198	34	19	20	18½	34	5½	5½	6
	33½	19	19½	17½	34	5	5	5½
158	34½	22	21½	20½	36	6	6½	7
	34½	22	22	20½	34	6	7	7
118	34	24	23	22½	34	7	8	7½
	33	24	22	23	34	7½	8	7½
98	32½	24	25½	25	32	8	9	8½
	32	23	25	25½	32	8	9¼	8½

On examining these results, the first obvious inference is, that the diminution of effect due to a greater length of wire is not owing to an accidental dissipation of the fluid; the compass, which was more than 400 feet from either extremity of the wire, being equally affected by the galvanic action, as those which were only 7 feet distant. Indeed, the central compass appears, in many cases, to have been more deflected than the others; but this, I have little doubt, is due to errors in observation, or perhaps to the adjustment of the wire. It has been stated, that, in the greater series of experiments, the wire was only half an inch from the needle; and, consequently, any little error in adjusting it, or any slight inflection of the wire just above the needle, would make a difference fully equal to any of the differences exhibited in the tabulated results. Moreover, although the four compasses employed were all as nearly alike as it was possible to get them, yet there might be slight differences in their action, which would still farther contribute to increase the other sources of error. I shall therefore assume, that each of the three compasses employed in obtaining the results at B, C, D, were equally affected, and shall take the mean of the six observations made with each distinct length of wire for a mean result, and the mean of the two deflections shewn by the standard compass in each case, for the mean standard measure, as in the following Table; and then, assuming that the tangent of the mean angle of deflection is proportional to the tangent of the deflection shewn by the standard compass, I shall compute what the several mean deflections would have been, had the power of the battery remained constant as at first, using 21° as the standard in the larger series of experiments, and 31° in the smaller.

That is, let Δ and Δ' be two deflections shewn by the standard compass under different powers of the battery, and δ the mean deflection corresponding to the power Δ. Then, as

$$\tan\Delta : \tan\delta :: \tan\Delta' : \frac{\tan\Delta' \tan\delta}{\tan\Delta'} = \tan\delta,$$

the mean deflection that would be due to the power Δ'.

In this way the angles in the fourth and seventh columns have been computed; the former being all reduced to the power $= 21°$, and the latter $\Delta = 31°$.

Mean Deflection in the preceding Table, reduced to one Standard Power of the Battery, viz. $\Delta = 32°$.

Length of Wire.	Distance of Wire ½ Inch.			Distance of Wire 1½ Inch.		
	Observed Standard Power.	Mean observed Deflection.	Reduced to Standard $\Delta = 21°$.	Observed Standard Power.	Mean observed Deflection.	Reduced to Standard $\Delta = 31°$.
838	21°	4° 55′	4° 55′			
798	24	6 18	5 26			
758	25	8 12	6 46			
718	25	8 50	7 17			
678	26	9 10	7 4			
638	25½	10 32	8 31			
598	26	10 20	8 10			
558	26	10 30	8 17			
518	29	12 10	8 30			
478	30	13 0	8 44			
438	30	14 10	9 31			
398	30¾	14 25	9 25	31°	3° 20′	3° 20′
358	31½	15 10	9 38	31½	3 47	3 43
318	34	17 0	9 52	35	4 5	3 31
278	34	17 15	10 1	36	4 25	3 39
238	35	18 20	10 18	34	5 20	4 45
198	33¾	18 55	11 8	34	5 25	4 49
158	34½	21 25	12 21	35	6 35	4 30
118	33½	23 5	13 53	34	7 35	6 46
98	32¼	24 40	15 37	32	8 32	8 13

Although in these reduced results there are a few discrepancies, some of the numbers being less where they ought to be greater than the preceding; yet these, which may be attributed to errors and irregularities in the experiments, are not such as to leave any doubt, that, upon a general view of the question, there is a certain increase of effect as the wire shortens; and it only remains to ascertain according to what function of the length this increase takes place.

As the tangent of the angle of deflection is the measure of the electro-magnetic effect, it is natural to refer to this in preference to any other trigonometrical line; and, comparing these tangents with the lengths, the square root of the latter is the most simple function of it which seems to approach towards the required ratio, although perhaps the discrepancies are rather too great to enable us to say, with confidence, that such is the law in question. At the same time, the difficulty in reducing such observations to numerical results, arising from the variable power of the battery, and other circumstances, renders it necessary for us to admit errors which would not be admissible in other cases.

If the law we have supposed were the exact law in this case, then the tangent of each mean angle of deflection, multiplied by the square root of the length of the wire, would be a constant quantity; and therefore, conversely, this product or constant quantity in any one case, divided respectively by the square roots of the several lengths, ought to give the tangents of the angles of deflections due to these lengths; and in this way we are enabled to submit our law to the test of observation, as in the following Table; in which we have taken tan $15° 37' \times \sqrt{98} = 2{\cdot}7659$, for the constant quantity in the first series, and tan $8° 13' \times \sqrt{98} = 1{\cdot}4283$ in the second series.

Comparison of Computed and Observed Deflections.

Length of Wire.	Distance ½ Inch. Δ = 21°. Deflection deduced from Observation.	Computed Deflection $= \frac{\tan 15° 37' \sqrt{98}}{\sqrt{L}}$	Errors.	Distance 1½ Inch. Δ = 31°. Deflection deduced from Observation.	Computed Deflection $= \frac{\tan 8° 13' \sqrt{98}}{\sqrt{L}}$	Errors.
	° ′	° ′	° ′			
838	4 55	5 28	+0 33			
798	5 26	5 35	+0 7			
758	6 46	5 44	—1 2			
718	7 17	5 54	—1 23			
678	7 4	6 4	—1 0			
638	8 31	6 15	—2 16			
598	8 10	6 27	—1 43			
558	8 17	6 41	—1 36			
518	8 30	6 56	—1 34			
478	8 44	7 13	—1 31			
438	9 31	7 32	—1 59	° ′	° ′	° ′
398	9 25	8 1	—1 24	3 20	4 6	+0 46
358	9 38	8 19	—1 19	3 43	4 25	+0 42
318	9 52	8 49	—1 3	3 31	4 35	+1 4
278	10 1	9 25	—0 36	3 39	4 33	+1 14
238	10 18	10 10	—0 8	4 45	5 17	+0 32
198	11 8	11 7	—0 1	4 49	5 48	+0 59
158	12 21	12 25	+0 4	4 30	6 39	+1 59
118	13 53	14 17	+0 24	6 46	7 29	+0 43
98	15 37	15 37	0 0	8 13	8 13	0 0

The errors in the fourth and seventh columns are, as has been already observed, rather too considerable to enable us to decide with certainty respecting the accuracy of the law assumed; at the same time, they are too small to allow us to suppose that the approximation is altogether accidental. Indeed, there can be no doubt, that the exhibited effect is governed by some law very nearly the same as that proposed; and it will remain for those who insist upon electric phenomena being due to the actual transmission of material or imponderable fluids, to prove that their hypothesis is consistent with this law of action, or with one but slightly different from it.

Experiments to ascertain the Conducting Power of different Wires, as depending upon their Thicknesses or Diameters.

I here procured a number of copper and brass wires, each two feet long, and weighing from 40 grains to near 4000 grains. An inch at each end was bent at right angles, which inch, after being well cleaned, and rubbed with nitrate of silver, was immersed in the cups filled with mercury, at N and P, as explained in the preceding article, and the deflection produced on the compass was carefully registered; but in this case, as in the last, it was necessary to guard against the variable power of the battery. This was done by employing one fixed wire to ascertain the relative power before and after each experiment. The weight of this standard wire was 470 grains for the two feet in length. Being thus provided, the experiments commenced by immersing this standard in the cups above mentioned. The result being registered, the smallest specimen was immersed, and the standard removed; then the specimen was removed, and the standard again immersed,—the mean of the first and third experiment being assumed as the mean standard power of the battery due to the period when the specimen was in the cups; and, in this way, we proceeded from the smallest to the largest copper-wire, and then from the smallest to the largest brass-wire. The following are the results, in which the first and the second observations on the standard wire are placed in adjacent columns, for the convenience of having their mean value also in an adjacent column to the results of the different specimens; but it will be understood, that the specimen was always submitted to trial between the observations on the standard, which latter was brass, and weighed 470 grains to the two feet in length.

Experiments on the relative Electro-Magnetic Effect of different sized Copper-Wires.

Weight of the Specimen in Grains.	Deflection produced by Standard Wire 1st Trial.	Deflection produced by Standard Wire 2d Trial.	Mean Deflection by Standard.	Deflection produced by the Specimen.
17	39°	37°	38°	25°
49	35	33	34	31
59	33	31	32	28
70	31	28½	29¾	28
95	28½	27½	28	26
140	27½	26½	27	26
180	26½	24	25¼	25½
250	22½	23	22¾	23
290	23	21	22	22
580	20	21	20½	21
1350	21	20	20½	20
1590	20	19½	19¾	19½

Experiments on the relative Electro-Magnetic Effect of different sized Brass-Wires.

Weight of the Specimen in Grains.	Deflection produced by Standard Wire 1st Trial.	Deflection produced by Standard Wire 2d Trial.	Mean Deflection by Standard.	Deflection produced by the Specimen.
38	33°	30°	31½°	26½°
44	30	29	29½	24
80	29	28	28½	26
100	28	27	27½	23½
150	27	26	26½	25
250	26	25½	25¾	25½
470	25½	24	24¾	24
680	24	23½	23¾	23½
1330	23	22	22½	22
1580	22	21	21½	22
1890	21	21	21	22
3770	21	21	21	21½

On a comparison of these several results, it will be seen, that, while the conducting wire weighed less than about 180 grains to the two feet in length, its effect on the needle was in defect, in comparison with that of the standard, which weighed 470 grains; but that no power was either gained or lost after this, although wire was employed weighing nearly 4000 grains, which appears to be consistent with the deductions made by Professor Cumming, published in the Transactions of the Cambridge Philosophical Society for 1821.

Art. XV.—*Notice regarding the different Character of the Waves of the Western Ocean, and of the British Seas.*

According to the observations of a gentleman conversant in marine affairs, there is a remarkable difference in the appearance, and also in the destructive effects, of the waves of the British Seas, compared with those of the Western Ocean. We doubt not that many will be surprised to be told, that the waves of the Bay of Biscay do not seem to be so destructive, in proportion to their great extent and weight, as those of our own seas. This appears to be owing to the slow pace at which these oceanic billows roll along in majestic style; while the surges of the British seas are quick in their motion, and impinge upon an obstacle with violent impulse.

In evidence of the fact, it may be remarked, that the great platform of the Tour de Corduan, situate in the Bay of Biscay, at the entrance of the Garonne, is only about 18 feet above the level of the sunken rock on which this magnificent structure is erected; and that the top of the parapet, or wall of circumvallation, which includes the store-rooms and other offices of the lighthouse, does not exceed 12 feet above the platform. Now, although the Corduan Rock is of much greater extent than the Edystone or the Bell Rock, yet, judging from the appearance of things, as represented in the vignette to Mr Smeaton's Narrative of the Edystone Lighthouse, and the frontispiece to Mr Stevenson's Account of the Bell Rock Lighthouse, in both of which the seas are represented as running up the building to the height of near 100 feet, we are led to apprehend, that, under like circumstances, the platform at Corduan would often be completely deluged with water, and that the offices erected upon it would be rendered wholly untenantable. And such would certainly be the case, but for the less velocity of the waves of the Bay of Biscay: Occasional seas and sprays do pass over the parapet-wall in very stormy weather, but not with such violence as to occasion material inconvenience to the inhabitants of the Tour de Corduan.

To convey an idea of the astonishing rapidity and impetuosity of the surges of the German Ocean, we shall quote a letter addressed to the Engineer for the Lighthouse Board by Mr Alexander Macdonald, one of the superintending artificers, who was residing at the Bell Rock Lighthouse during the storms in the month of October last.

"The gale, at N.NE., which commenced about the 8th (October), has been fully more severe, and the storm of longer duration, than any I have hitherto met with while at the lighthouse. The water came upon the house, in an unbroken state, to the height of the kitchen-windows (64 feet above the Rock), and the green seas as high as the bed-room windows (76 feet). At times seas, for I cannot call them sprays, though of a whitish colour, came above the library-windows, and struck the cornice (90 feet high) with such force, that, on separating, they darted to the leeward of the house, which was left, if I may so express it, at one end of an avenue of water. Indeed the appearance, in all directions around us, was at times more dreadful and terrific than I have ever before seen it. I really think, upon the whole, the house feels more firm and entire than when I first knew it, shortly after it was finished. I cannot perhaps better express my meaning than by saying, that, when the seas struck it hard, the sensation now, more than formerly, resembled the tremulous motion of a perfectly sound substance. The lamp-glasses in the light-room, and the utensils in the kitchen, were frequently heard to make a tingling noise during the gale, owing to the vibrations of the tower."

The violent impetus of these German Ocean waves, which, according to the graphic and forcible description of Mr Macdonald, darted to leeward of the Bell Rock lighthouse, and left the building, as it were, "at one end of an avenue of water," forms a striking contrast to the solemn march of the wide-swelling billows of the Bay of Biscay, which exhaust themselves in comparative tranquillity around the Tour de Corduan.

We think Mr Macdonald's idea regarding the increased firmness and stability of a building so situate, is probably correct. It is evident, that, for a year or two after the erection of this edifice, the mortar could hardly have taken sufficient band, and that the fabric would in effect not possess that degree of unity and firmness which it may now be supposed to have acquired. It is also extremely probable, however, that the shaking or tremulous indications would make a deeper impression on the minds of the inmates of the lighthouse at first, than in later years. To a stranger such scenes as must be familiar to these people, perched upon a sunken rock in the middle of the ocean, with the waves often rising to the height of 60 and 70 feet upon their circumscribed dwelling, would be truly awful and terrific.

Art. XVI.—*Remarks on the Modern Strata.* By the Rev. John Fleming, D. D. F. R. S. E. and M. W. S., Minister of Flisk.

The history of the Earth, as determined by the documents of geognosy, gives indications of different epochs, each of which may be characterised by the peculiarities of the strata which were then deposited, and the organised beings with which the Earth was then peopled. The remains of the ancient animals and vegetables which are now found in these strata, have, in many cases, been preserved sufficiently entire to furnish the characters of the species, and enable an attentive observer to recognise the different individuals belonging to them, even when occupying different beds, and associated with other relics. In tracing, therefore, the history of any one *species*, we find the remains of the individuals belonging to it, dispersed through a *limited series of strata*, neither occurring in those of a more ancient, nor in those of a more modern date. The associates of this species, or the other species, the remains of which occur in the limited series of strata, are in like manner circumscribed in their geognostical distribution. If we now attend to the *position* occupied by the strata of this series, in reference to those of other or newer series,—their *mechanical* structure and *chemical* constitution; and, if we determine the *species* of organised beings, the relics of which are imbedded in the strata of this series, we may consider the history of the series or group as complete. The characters of several of such series have, to a considerable extent, been determined, thereby establishing so many important epochs in the Earth's history.

It seems to be determined that the organised species, if connected with one series, differs from the organised species of every other series, and that the inorganic materials of the series have likewise a co-existing peculiar character.

If we contemplate for a moment the *genera* of organised beings, we shall find that some of the species belong to the older, others to the newer *series* of strata, while some, still living, belong to the modern epoch of the Earth. It is of great importance to attend to this distinction. Many geologists of eminence reason respecting *genera* instead of *species*, and, consequently, fall short of that precision which seems so desirable in geological science. Some examples on this subject are given in the paper on the " *Testaceous Annelides* *."

In the paper " On the Influence of Society on the Distribution of British Animals," which appeared in the last number of this Journal, I entered upon several zoological details, serving to illustrate the characters of the species belonging to the *modern series* of strata, and to demonstrate the imperfection of that classification whereby these strata are divided into *diluvian* and *postdiluvian* groups. In the present paper, it is my intention to offer another arrangement, founded, not on considerations connected with the relics imbedded in these strata, but on the materials of which they consist, and the circumstances which have operated in producing them.

The surface of the Earth is, at present, in an *unnatural condition.* Mountains rise above the level of the sea, and hollows exist beneath its level. What those causes have been, so much in opposition to the known laws of gravitation, which have produced this unnatural state, we stop not here to inquire. But we shall be compelled, in prosecuting the object at present in view, to contemplate those causes which are operating in bringing the Earth into a *natural state*, by wearing down the projecting parts, filling up the hollows, placing the surface every where at right angles to the direction of gravity, and perfecting the form of the Earth as a spheroid of equilibrium. It is difficult to arrange the strata belonging to the modern epoch of the earth's history, into subordinate groups, because the different causes

* The publication of the paper here referred to, in the present number of the Journal, has been prevented by circumstances connected with the late destructive fire in the neighbourhood of Mr Neill's printing-office.—Ed.

operating in their production, act so frequently in concert, that it is not easy to assign to each its due share. All of them are subject to considerable irregularities, occasionally suspending their influence, or renewing their operations with redoubled violence. But the situations of these different strata, and the classes or orders into which they may be distributed, will be better understood by the following remarks.

1. *Soil.*—The varying conditions of the atmosphere, in reference to temperature and humidity, exercise a powerful influence on the inorganic substances exposed to their disintegrating and decomposing effects. A film of earth is produced fit for the support and the nourishment of vegetables, which speedily clothe the surface. The history of the soil (in reference to its composition and structure), now under the influence of vegetation, must be studied in connection with the physical and geographical distribution of plants. The increase of the quantity of carbonaceous matter, marks the number of plants which have flourished and perished. Extensive forests are established in certain districts, and for ages, by the annual falling of their leaves, increase the thickness of the stratum by which they are supported. But this addition to its thickness seems, in some cases, to impair its fertility. The trees decay, mosses and lichens multiply, and the soil, instead of supporting any longer a forest, receives an addition of a layer of peat. But, in some districts the peat has been formed, in the absence of a previously existing forest, by the growth of the mosses and lichens alone. In Zetland, I have observed peat ten feet in thickness, consisting of the relics of that common moss *Trichostomum lanuginosum*, which continues to flourish vigorously on the decaying remains of its progenitors, or of itself. There is one difference, however, prevailing between the *forest-peat* and the *moss-peat*, deserving of notice. The soil under the former is always of some thickness,—while under the latter it, in many cases, can scarcely be said to exist. Partial depositions of bog-iron ore and marl occur in this formation. The marl usually consists of fluviatile shells, or encrusted masses, and its origin may be traced to springs holding carbonate of lime in solution.

2. *Sand-drift.*—The products of the disintegration of inorganic matter, from whatever cause,—the action of the atmos-

phere, or the attrition of rivers or the sea,—are not all equally favourable for the growth of plants. When the rocks, which have been disintegrated, consist nearly of pure quartz, and the result is a siliceous sand, the soil is not only unfit for the growth of vegetables; but, from its want of cohesion, is not stationary. The wind regulates its condition. The strata of this division, in reference to their origin and position, may be divided into two groups. The first will comprehend the *inland sand-drifts*, forming *deserts*, striking examples of which occur in Africa and Asia. To the second, will belong the *shore sand-drifts*, forming *downs*, of which our own country presents several well marked illustrations. The materials, in the latter case, chiefly consist of sand, derived from granitic or sandstone rocks, and portions of comminuted shells. Shore sand-drift spreads over the soil, and destroys its vegetable cover. In some places, I have seen it forming a thick bed over forest and moss *peat*; the latter exhibiting unequivocal symptoms of rapid decomposition.

3. *Detritus.*—Were the elevated portions of the earth, in a natural state, in reference to gravity, the soil formed by decomposition and disintegration, would remain in its place, and protect the subjacent materials from farther changes. But the portions loosened, of whatever size, have a tendency to descend from their unnatural elevation; and they are aided in their progress by the action of rains, frost and snow. The accumulations which occur, flanking the acclivities of mountain-ranges, are of this description. The extent of their encroachment on the low land, and the peculiarities of their arrangement, have usually been effected by the agency of running water. The rivers, whether raging in fury during rains and thaws, or gently descending, during droughts, are still contributing to transport the disintegrated materials of the mountains towards the plains, carrying forward the larger masses to short distances; but the minuter portions to their lowest level, to form islands and banks at the estuary. The strata of detritus thus formed, are necessarily irregular in their composition and structure, and contain the relics of the animals or vegetables of the river district, or acclivity, in which they are situated. Detritus is subject to be covered with soil and sand-drifts; and, in many cases, repetitions of these strata have taken place.

4. *Silt.*—Wherever there are hollows filled with still-water, whether these support the character of inland-lakes, or of the sea, processes are going forward, which have a tendency to fill them up; and the matter deposited we here venture to term *Silt.*

The *Lacustrine Silt* is, in some instances, saline, arising from the evaporation which the waters experience during the summer season. Of these, however, we have no examples in this country. The more common lacustrine silt, consists of the fine particles of detritus, carried into the lake by rivers or temporary streams, and slowly deposited from its state of suspension. It is increased by the supply produced on the margin of the lake by the disintegration, decomposition, and attrition of the rocks which prevail. As the lake becomes shallower, plants and animals multiply, and contribute by their relics, to accelerate the process. In ordinary cases, this silt consists of an inferior bed of sand, with an incumbent bed of peat. In some cases there is an intervening bed of marl. The marl consists of the relics of those testaceous mollusca, which feed upon the plants of the lake, and the animalcula of its waters, including phytivorous and carnivorous, pulmoniferous and branchiferous species. The marl-bed likewise receives as the effect of subsidence, the skeletons of the animals which have been drowned, while feeding on the marshy borders of the lake, or have been conveyed into it by floods. The character of the lowest or earthy bed, depends on the character of the bed of the lake, and the materials of the surrounding hills. Sometimes it is a sandy-clay, or a clayey-sand; while, in other instances, it is a pure clay, consisting chiefly of aluminous earth, or a pure siliceous mud, usually termed *Kaolin.* When a lake of this kind, situate on a level with the sea, and near the coast, has been filled up, chiefly with earthy matter, the surface of which has passed into soil, fit for the support of trees, the seaward barrier may be broken down, drainage by the tide may take place, followed by subsidence; and that soil may be daily covered at flood, which formerly was out of its reach, and above its level. In a paper published some time ago in the Transactions of the Royal Society of Edinburgh, vol. ix. p. 419, I endeavoured to explain the formation of *submarine forests,* agreeably to the preceding views. Subsequently, another explanation of these phenomena has been offered by Mr Henslow, Professor of Mineralogy in the University of Cambridge *. He considers the deluge of Noah as having taken place by water "*at that time added* to the Earth;" and that, since that period, "*this extraneous supply of water*" has been absorbed, to a certain extent, by the solid portion of the Earth; but a portion still remains, covering with the sea those forests which were, in its antediluvian state, above its level. If these forests grew on rock, the explanation here offered might seem plausible; but they are supported by a stratum of lacustrine silt, and in this respect exhibit a common character. Of the nature of this supporting stratum, the learned Professor had not been aware, else it would have led him to assign to the forests a different origin.

The *Carses*, especially those of high level, of the Forth and the Tay, seem to consist of lacustrine silt, and to have been produced in a fresh-water lake, to which the sea, in its ordinary movements, did not extend. The proofs, in support of this opinion, will shortly be laid before the public.

In some cases, the different beds of lacustrine silt seem to have been repeated, and two or more series, each consisting of sand (or clay) marl, and peat, occur in the bed of the former lake. In such cases, the first or lowest layer of peat, may have been covered by detritus of sand during a flood, placing the lake in some measure in its original condition; or the peat itself may be regarded as detritus, brought from a higher level in the form of mud.

Marine Silt derives its origin from the detritus of rivers, and the washing operations taking place on the sea-shore. At the mouths of rivers, the matter deposited has many of the characters of detritus, united with those of marine silt. Farther off the shore, the marine silt is deposited under the influence of currents, forming shoals or banks, as the Dogger-bank, the Long-fortus and Jutland-reef in the German ocean. The marine-silt receives the remains of sea-animals, which, in some instances, contribute greatly to its increase, as the coral reefs abundantly testify. It must likewise, in the case of great floods, receive the relics of terrestrial animals. Mr Stevenson has published the

* Annals of Philosophy, Nov. 1823, p. 344.

results of some very curious and valuable observations on the marine silt of the German Ocean, in the Wernerian Memoirs, vol. iii. p. 314.

5. *Diluvium.*—Violent movements in the waters of the globe, both of lakes and of the sea, appear to have taken place at different intervals, and have introduced depositions among the modern strata of the most interesting kind. These deposits, from violent inundation, divide themselves into two kinds.

Lacustrine Diluvium.—This seems to have been produced by the sudden bursting of the barriers of alpine lakes, by which the waters flowing out in mass have carried before them all the detached fragments of rock, soil of every kind, detritus, and silt, and distributed them at the lowest level on the plain. Switzerland has frequently experienced the effects of such sudden inundations; and the horizontal shelves of the glens of Lochaber, in our own country, give unequivocal indications of similar occurrences.

The diluvium, in some cases, consists of *clay*, deposited in one unstratified mass, and the contained boulder-stones are as large at the top as at the bottom of the bed; circumstances indicating the violent action of the transporting cause. This diluvium is known in Scotland by the name of Till. The *sand* and *gravel* usually form small eminences, obviously influenced in their direction by the neighbouring hills or valleys, and occasionally containing deep cavities, the indications of the eddies in the torrent by which they were deposited.

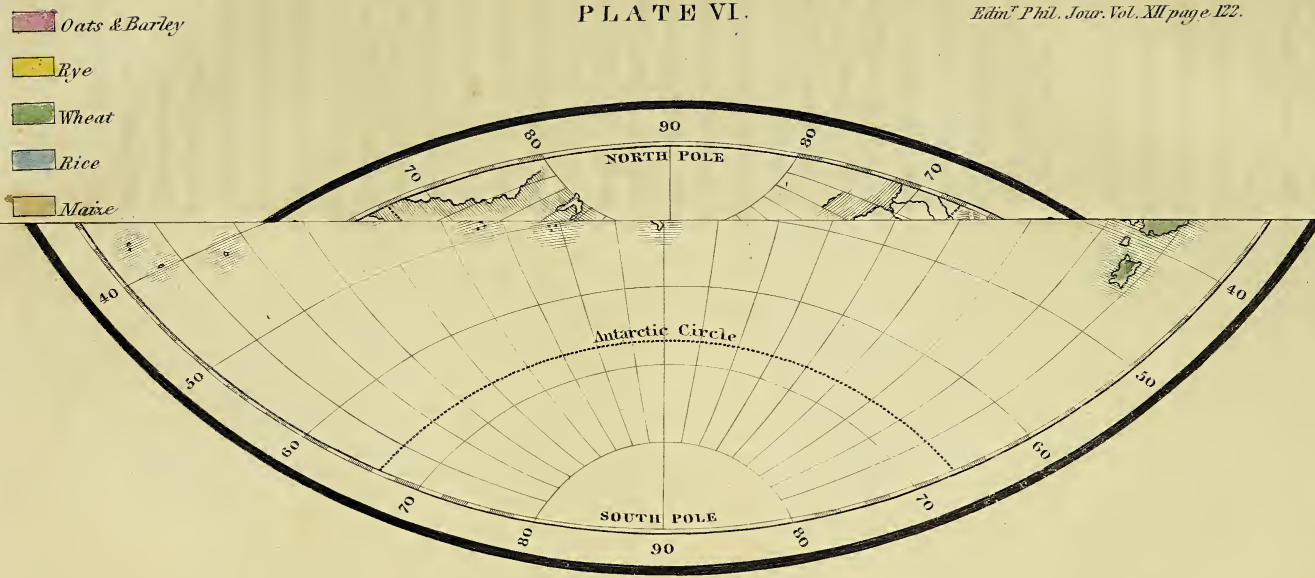
In some instances the diluvium consists chiefly of peat, as happened in the irruption of Solway moss, 16th December 1772, an interesting account of which was published by Dr Walker in the *Phil. Trans.* vol. lxii. p. 123.

These materials seem to have been derived from the strata of the *river district*. Hence, even in a comparatively limited space, the materials of the diluvium may exhibit very different characters. In the neighbourhood of my dwelling, where very extensive depositions of diluvium occur, the materials consist *exclusively* of the remains of primary, transition, and old red sandstone rocks. Ten miles to the south, they as unequivocally include the relics of the independent coal formation.

In speculating on these changes which have taken place, we

Edin^r Phil. Jour. Vol. XII page 122.

PLATE VI.



W.H. Lizars sc.

Published by A. Constable & C° Edin^r 1824.

Edinr Phil. Jour. Vol. XII page 122.

PLATE VI.

W.H.Lizars sc.

Published by A. Constable & Co Edinr 1824.

should bear in mind, that the aspect of the country is now widely different from that which it must anciently have presented. There are several facts which lead me to believe, that the German Ocean was once an inland lake, on the east side of our central chain of primitive rocks; and that the Minch was another, on the west side, having, as its barrier against the Atlantic, another primitive chain, the wreck of which now forms the Long Island.

The organic remains found in this lacustrine diluvium, include of course those of the animals and plants which occupied the districts through which the currents passed. In some cases they seem to be collected together in one spot; in other cases they have been found detached.

As in some measure connected with lacustrine diluvium, that which is produced by *waterspouts* deserves to be noticed. Many striking examples of this sort are on record. The effects are similar to the bursting of a lake, and the matter deposited exhibits nearly the same character.

Marine Diluvium.—The evidence proving the origin of this kind of diluvium, rests on the occurrence of the remains of *marine animals,* in such circumstances as to indicate that the sea had transported them to their present situations. Many sudden risings of the sea have taken place within the period of authentic history, by which shells, and sand, and gravel, have been placed in situations now considerably removed from the influence of the tide. Other inundations, of which neither history nor tradition preserve any memorial, have left their spoils in some cases far inland, and at higher levels.

In 1806, I examined a bed of sea-shells which occurs to the westward of Borrowstounness, on the Forth. At Craigenbuck, about two miles west from the town, I found it upwards of three feet in thickness, resting on a bed of small gravel, and elevated *thirty-three feet* above high-water mark. The shells belong to animals still existing in the Frith of Forth. The common oyster and mussel occur in greatest abundance; besides which were observed, *Patella vulgaris, Venus pullastra, Buccinum undatum* and *lapillus, Turbo littoreus,* and *Nerita littoralis* *. This

* See a description of this bed read before the Wernerian Society 30th November 1811, and published in the *Annals of Philosophy* for August 1814.

bed may be traced, nearly at the same elevation, several miles to the westward, on the south bank of the Forth; and at Alloa the same bed occurs, but the shells are in a more broken state, and occur at a much lower level *.

Two interesting facts have recently been made public, in all probability connected with the inundation of the sea, which deposited the shells now referred to. In July 1819, the skeleton of a whale was found imbedded in *Lacustrine silt*, at the marsh between the estate of Airthrey, belonging to Sir Robert Abercromby, Baronet, and the estate of Powis, the property of Edward Alexander, Esq., near Stirling. The skeleton was about 72 feet long, giving indication of its being a *Razor-back*, and was situate 20 *feet* above the rise of the highest tides in the Forth *. Another skeleton of a whale has been discovered, in similar circumstances, on the opposite side of the Forth, near Dunmore Park, the seat of the Right Honourable Lord Dunmore. It probably belonged likewise to a Razor-back, as it is stated to have measured from 85 to 90 feet in length. It was situate in the same lacustrine silt, and "between 23 *and* 24 *feet* higher than the highest tide of the Forth at present †." In the same bed of lacustrine silt, stags' horns are occasionally found. Disposed as we are to connect the bed of marine shells with the skeletons of the whales, and to consider that one inundation placed these remains of different marine animals in such peculiar situations; other relics of the inhabitants of the deep may yet be looked for on both banks of the Forth and its lateral valleys.

Indications of violent commotions in the German Ocean, occasioning inundations in the connected friths, likewise occur to the northward. In the Statistical Account of the Parish of Peterhead, by the Rev. Dr Moir (vol. xvi. p. 558.), it is stated, that "fossil shells are found in great quantities, 20 *or* 30 *feet* above the present level of the sea; and it is remarkable, that some of them are of a larger size than any that are now to be found on the coast." In the account of the Parish of Nig, Ross-

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* See Mr Bald's valuable paper on the Coal Formation of Clackmannanshire, *Wern. Mem.* i. 484.

* Mr Bald,—*Edin. Phil. Journ.* vol. i. p. 393.

† Mr Reddoch,—*Edin. Phil. Journ.* vol. xi. p. 415., (where, by mistake, the name is printed *Keddoch*).

shire, (vol. xiii. p. 21.), it is said, that "in the place of Ankerville, a part of the property of Mr Cockburn Ross of Shandwicke, in a bank removed at more than the distance of a mile from the sea, and raised *many feet* above its level, there is a stratum of oyster-shells of considerable extent, and above half a foot in depth; they lie about three feet below the surface of the ground, and, underneath them, there is a stratum of fine sand, like that on the sea-shore." In the *Transactions of the Royal Society of Edinburgh* (vol. x. p. 105.), there is a "Notice respecting the Vertebra of a Whale found in a bed of bluish clay near Dingwall," by Sir G. S. Mackenzie, Baronet. The bone was found in a bed of marine diluvium, consisting of a dark bluish clay, much mixed with sea-shells, three miles distant from high-water-mark, and 12 *feet* in height above the level of the sea. The occurrence of this bone and accompanying shells, when viewed in connection with the oyster-shells at Ankerville, in a different part of the Bay of Cromarty, give indications of an inundation of the sea in that quarter, similar to that which appears to have taken place in the Frith of Forth, and with which it was probably cotemporary.

On the west side of the country depositions of marine diluvium have likewise been noticed, corresponding in character with those on the eastern coast.

On cutting through a bed of sand and clay, which is about 40 *feet* above the level of the present bed of the Clyde, nearly four miles from Glasgow, and in the line of the Ardrossan Canal, a considerable accumulation of marine shells was met with. These consist of the common species at present inhabiting the Frith of Clyde, but at a distance of twenty miles from the spot where these relics are situate. The notice of this occurrence, by Captain Laskey, is inserted in the *Annals of Philosophy* for February 1814, vol. iii. p. 150., and *Wernerian Memoirs*, vol. iv. p. 568.

The marine deposits which occur on the banks of Loch Lomond, have been minutely described by Mr James Adamson, in *Wernerian Memoirs*, vol. iv. p. 334. These occur in three different places on the margin of the loch. In one place, the sea-shells are united with compact calc-tuff,—in the other they are imbedded in a brown clay. The species are similar to those noticed by Captain Laskey, and still common in the estuary of the Frith of Clyde. They are considered as occurring about 22 *feet* above the present level of the sea.

To these examples of marine diluvium others might be added, which have been observed in England, as in Essex, &c.—*Geol. Trans.* i. p. 330. And it is probable, that many more remain to be investigated. The shells which occur, being those of the present seas around the British Isles, furnish the means of distinguishing the modern marine diluvium from depositions of a similar character, which have taken place during earlier epochs, and in which the materials are yet in an unconsolidated state; as in the different formations above the chalk. The marine shells, however, in these last, do not belong to the present race of animals.

6. *Volcanic Deposits.*—These, whether of lava, ashes, or encrustations round the margin of hot-springs, may cover all the strata already enumerated, or be covered by them. Fortunately for this country, such deposits, with a single exception, are absent. On the 20th October 1755, a shower of *black dust* fell in Zetland. It resembled lamp-black, but smelled strongly of sulphur.—*Phil. Trans.* iv. p. 297. A similar dust fell on a ship belonging to Leith, on the 23d or 24th of October, when between Zetland and Iceland, and about 25 leagues distant from the former.—*Phil. Trans.* xlix. p. 510.

In viewing these different groups of modern strata, it is surprising to observe the various causes which may have been concerned in their production, and the intermixture of the individuals of the animal and vegetable kingdom, of fresh-water and terrestrial production, with those of the ocean. A most interesting question here presents itself, and one which involves some of the most important speculations in geology. Are we to consider the causes by which the different modern strata have been produced, as analogous to those which have contributed to the formation of the strata, belonging to the more ancient epochs of the Earth's history? If this question be answered in the affirmative, the occurrence of fresh and salt water deposits in the same hollow, and the remains of land and sea animals in the same bed, will cease to excite our surprise; and many of the irregularities, in thickness and extent, and arrangement, which the strata exhibit, will more easily be referred to their true cause. In such circumstances, the geologist will discover the importance of attending to the geognostical relations of the modern strata, and the laws which influence the physical and geographical distribution of the present races of organised beings; in order that, by proceeding from *the distinct to the obscure*, he may qualify himself for illustrating, with a greater chance of success, the various changes which the crust of this globe has undergone.

In examining the peculiar characters of the causes which operate in the production of the modern strata, we discover, in their results, three groups possessing very different features. In one we witness matter brought from an *unnatural state*, or from a high level above the sea, and deposited in a more natural condition, or nearer the level of the sea. Such are the depositions of detritus, lacustrine and marine silt, and lacustrine diluvium. In another, the causes in operation *prevent*, in some measure, the tendency of the wearing and lowering of the elevated parts of the Earth, and the products are soil and inland sand-drifts. In a third group, the matter deposited is brought from a natural condition, near the level of the sea, and elevated into an unnatural situation. Such are the products of shore-sand-drifts,—of marine inundations, and of volcanic eruptions. How far these may have mutually counterbalanced one another, in the great scale, and during the different epochs of the Earth, can scarcely be satisfactorily determined, in the present state of geological science *.

The preceding remarks, on the modern strata, when viewed in connection with the observations on the extinct and extirpated animals, published in the last number of the Journal, will, I hope, serve to throw some light on the modern epoch of the Earth's history, and the important geological phenomena which it embraces.

Manse of Flisk,
Dec. 3. 1824.

* In a future Number, a view of the Carses in the Forth, Tay, &c., as connected with the former configuration of the river districts of these rivers, &c., will be given.—*Edit.*

Art. XVII.—*On the Geographic Distribution of the Gramineæ; with Coloured Maps.* (Plates VI. and VII.) By Professor Schouw *.

THE grasses, both in respect of the economy of nature, and commercial intercourse, are of no small importance. In most countries, they form the principal part of the exterior covering of the earth. They materially affect the atmosphere, especially its quantity of moisture. They support a whole world of insects, and afford the chief nourishment of domestic animals. They are, on this account, of the utmost consideration in the breeding of cattle; and, since the most important of the cultivated plants belong to them, they constitute likewise the basis of agriculture. But the rearing of cattle and of corn is the main support of states, and determines the degree of culture, mode of life, and, to a certain extent also, the manner and customs of particular people. The geographical relations of the gramina must, therefore, be interesting, not merely to the botanist, but to those who occupy themselves with the sciences relating to man, and the policy of nations. In respect of ornament, this class plays a very prominent part in the arrangements of nature. The grasses impart to the plains and hills their lovely green; they border the blue waters of the lake; and, with them, the spring first puts forth its vegetation.

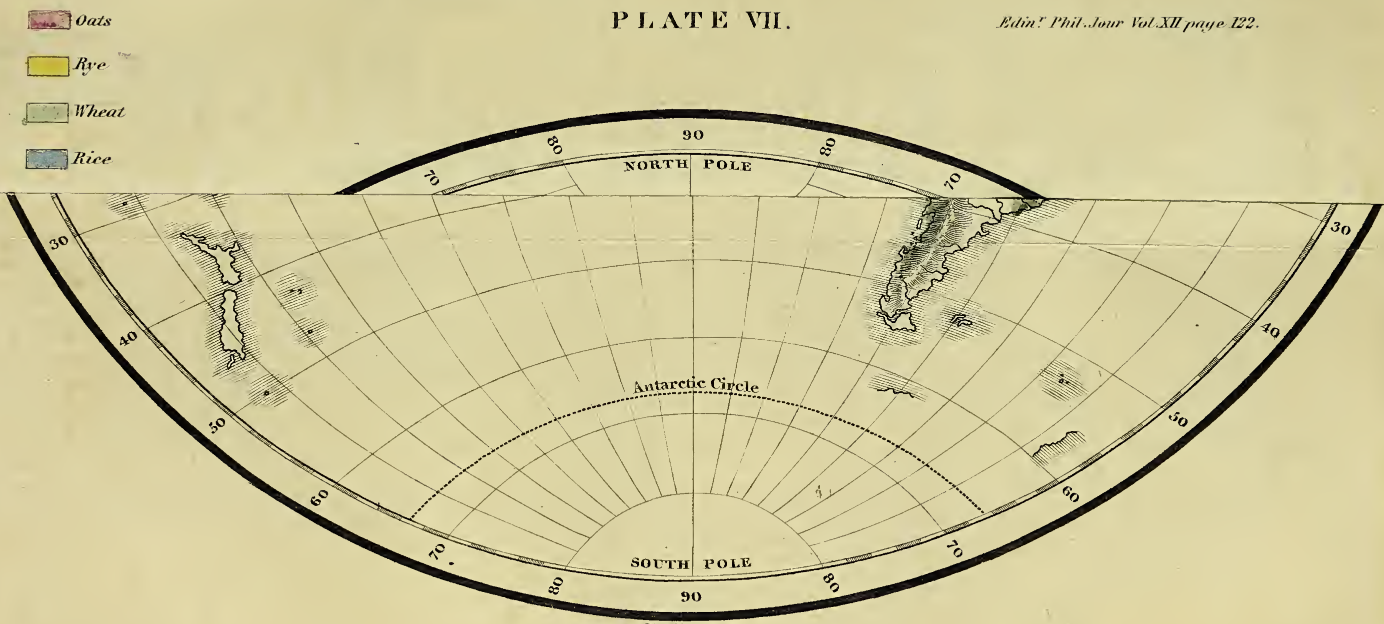
The Gramina are distinguished by such peculiar marks, that, even those who have no knowledge of botany easily recognize them, the Cyperaceæ alone having any resemblance to them; though, from them also, they are separated by a broad line of distinction not to be mistaken.

The family is very numerous. Persoon's Synopsis contains 812 species, composing $\frac{1}{26}$th part of all the plants therein enumerated. In the system of Ræmer and Schultes, there are 1800; and, since this work, were it now brought to a conclusion, would probably contain 40,000 in all, it may be assumed that the grasses form a twenty-second part. It is more than probable, however, that, in future, the grasses will increase in a larger ratio than the other phænerogamic plants, and that perhaps the just proportion will be as 1 to 20, or as 1 to 16. Greater

* Abridged from Schouw's Grundzüge einer Allgemeinen Pflanzen Geographie.

Edinr. Phil. Jour. Vol. XII page 122.

PLATE VII.



W. H. Lizars sc.

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Edinr. Phil. Jour. Vol. XII page 122.

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still will be their proportion to vegetation in general, when the number of individuals is taken into account; for, in this respect, the greater number, nay, perhaps, the whole of the other classes, are inferior.

With regard to the *locality* in such a large family, very little can be advanced. Among the grasses there are both land and water, but no marine, plants. They occur in every soil; in society with others, and alone: the last to such a degree as entirely to occupy considerable districts. Sand appears to be less favourable to this class; but even this has species nearly peculiar to itself.

The *diffusion* of this family has almost no other limits than those of the whole vegetable kingdom. Grasses occur under the Equator; and *Agrostis algida* was one of the few plants which Phipps met with on Spitzbergen. On the mountains of the south of Europe, *Poa disticha*, and other grasses, ascend almost to the snow-line; and, on the Andes, this is also the case with *Poa mulalensis*, and *Poa dactyloides*, *Deyeuxia rigida*, and *Festuca dasyantha*.

The *distribution* is of greater importance. As to the chief groups and species, their distribution will then first attain a real interest, when we shall be in possession of a perfect natural classification; for, in this respect we are still, in my opinion, far behind. The division of Beauvois appears to me too artificial; and, in that of Brown, the groups *Paniceæ* and *Poaceæ* are too large. The best perhaps is that of Kunth, according to which the grasses are arranged under ten groups. In respect of latitude, the relation of the grasses, in the system of Ræmer and Schultes, in the hot and temperate zone, is the following:

Grasses.	No. of Species.		Proportion of the Species to the whole of the Grasses.	
	Tor. Zone.	Temp. Zone.	Tor. Zone.	Temp. Zone.
Paniceæ, -	303	103	$\frac{1}{2}-\frac{1}{3}$	$\frac{1}{9}$
Stipaceæ, -	40	58	$\frac{1}{20}$	$\frac{1}{20}$
Agrostideæ, -	58	220	$\frac{1}{14}$	$\frac{1}{5}$
Bromeæ, -	133	554	$\frac{1}{6}$	$\frac{1}{2}$
Chlorideæ, -	78	30	$\frac{1}{10}$	$\frac{1}{40}$
Hordeaceæ, -	33	101	$\frac{1}{25}$	$\frac{1}{12}$
Saccharinæ, -	120	65	$\frac{1}{7}$	$\frac{1}{18}$
Oryzeæ, -	10	9	$\frac{1}{32}$	$\frac{1}{133}$
Olyreæ, -	18	4	$\frac{1}{46}$	$\frac{1}{300}$
Bambusaceæ,	6	3	$\frac{1}{137}$	$\frac{1}{400}$

Hence it follows, that not one of these groups belongs exclusively to either the one or the other zone; but that, on account of the proportionally greater number, the *Paniceæ*, *Chlorideæ*, *Saccharinæ*, *Oryzeæ*, *Olyreæ*, and *Bombusaceæ*, may be regarded as tropical, *Agrostideæ*, *Bromeæ*, and *Hordeaceæ*, as extra-tropical forms*; and that there is, consequently, a considerable contrast between the forms of these two zones On the contrary, the difference between the various continents and degrees of longitude is inconsiderable. Neither in the torrid nor temperate zone has any group in the Continent a perceptible preponderance over another. The result also appears to be the same, on comparing the two hemispheres. We know, however, too little of the Southern to state this precisely. In respect of elevation, the distribution, according to the degrees of latitude, is very similar; for, in the mountains of South America, the proportions of the larger groups are:

	0—200 Toises.	200—1100 Toises.	1100—1600 Toises.	Above 1600 Toises.
Paniceæ, -	39	33	12	1
Agrostideæ, -	6	10	23	2
Bromeæ, -	7	7	37	8
Saccharinæ,	16	20	20	2

Between the genera, the contrast is naturally greater, and manifests itself not only according to the latitude, but also the longitude. Thus in the torrid zone, the genus *Paspalus* has a decided preponderance in the new world. Most of the genera, however, especially the larger, for example, *Panicum*, *Andropogon*, *Chloris*, are every where nearly equal, those that are peculiar being generally not at all numerous. The generic difference between North America and the temperate regions of the European Continent, is very small. In North America, however, a greater number of tropical forms appears. Between the two temperate zones also, the distinction seems to be by no means considerable. Of 36 species from the Cape, 30 occur in the temperate zone of the Northern Hemisphere; while, in other families, Southern Africa has many peculiar to itself. In the extra-tropical part of New Holland, the greater number of genera are found also in the north (about ⅔ds); and this appears to be still more the case in the southern parts of South America, as well as New Zealand. One of the most extensively distributed genera is *Poa*. It is found almost over the whole earth ; and, although it reaches its maximum in the temperate, has also many species in the torrid zone.

A tendency to a wider distribution in the family of the grasses, is found, not only in the groups and genera, but also in the species. Among many examples, we particularize only *Lappago racemosa*, which occurs in the south of Europe, in Arabia, in both Indies, and in South America ; *Cenchrus echinatus*, *Festuca myurus*, *Poa megastachya*, *Andropogon Allionii*, *Holcus halepensis*, in the high lands of South America, and in Europe ; *Panicum Crus galli*, *P. glaucum*, *Cynodon Dactylon*, *Holcus gryllus*, *Arundo Phragmites*, and *Festuca fluitans*, in Europe and New Holland ; *Paspalus vaginatus*, in Tranquebar, Jamaica, and the Isle of France ; *P. filiformis* in India, Jamaica, North America ; *Rottbollia dimidiata*, in Guinea, at the Cape, and in Jamaica ; and *Imperata arundinacea* on the Mediterranean, in India and New Holland.

This family, then, is every where nearly the same, or it has a tendency to distribution in whole groups, genera, and species (distributio formis subordinatis conjunctis), to which, however, certain genera and species form exceptions. The individuals, also, of several species occur, not unfrequenty mixed (distributio speciebus mixtis) ; for meadows usually contain many species of the grasses.

What has been said of the decided influence of the degrees of latitude on groups and genera, holds also of the *habitus* of vegetation in general. The greatest differences between tropical and extra-tropical grasses appear to be the following :

1. The tropical grasses acquire a much greater height and occasionally assume the appearance of trees. Some species of *Bambusa* are from 50 to 60 feet high.

2. The leaves of the tropical grasses are broader, and approach more in form to those of the other families of plants. Of this the species Paspalus affords many examples.

3. Separate sexes are more frequent in the tropical grasses. *Zea*, *Sorghum*, *Andropogon*, *Olyra*, *Anthistiria*, *Ischæmum*, *Ægilops*, and many other genera, which only occur in the tor-

rid zone, and are there found in perfection, are monœcious, or polygamous. Holcus is perhaps the only extratropical genus with separate sexes.

4. The flowers are softer, more downy, and elegant.

5. The extra-tropical grasses, on the contrary, far surpass the tropical in respect of the number of individuals. The compact grassy turf, which, especially in the colder parts of the temperate zones, in spring and summer, composes the green meadows and pastures, is almost entirely awanting in the torrid zone. The grasses there do not grow crowded together, but, like other plants, more dispersed. Already in the southern parts of Europe, the assimilation to the warmer regions, in this respect, is by no means inconsiderable. *Arundo donax*, by its height, reminds us of the bamboo; *Saccharum Ravennæ*, *S. Teneriffæ*, *Imperata arundinacea*, *Lagurus ovatus*, *Lygeum spartum*, and the species of *Stipa*, by their soft, downy, elegant flowers, and the species of *Andropogon*, *Ægilops*, &c., by separate sexes, exhibit tropical qualities. The grasses are also less gregarious, and meadows seldomer occur, in the south than in the north of Europe.

As to what relates to the distribution of individuals, the generality of species are social plants.

Lastly, Do we wish to know how this family is distributed in respect of the number of species, and where they reach their maxima and minima, the following materials may supply, not indeed either a complete or faithful representation, because the grasses are not treated of by botanists or travellers in general, with the same care as the other families; but they will at least give some hints towards effecting that object. In Persoon's Synopsis, the grasses of the torrid zone form 1-25th, and those of the northern temperate zone 1-22d of the whole vegetation; but when it is considered that the grasses of the former have been less investigated than the European, the quotient would be nearly alike in both zones. In the systems of Ræmer and Schultes, the tropical are to the European grasses as 2 to 3; but this is, from a probable conjecture, also the proportion of all the tropical and extra-tropical plants. In Persoon's Synopsis it is as 1 to 2; and since the publication of that work, the knowledge of the tropical has been enlarged in a greater proportion than that of the extra-tropical plants. Although, however, the quotients in the torrid and temperate zones may be nearly equal upon the whole, when taken in subdivisions there will be an inequality. In the warm regions of South America, the grasses, under 200 toises elevation, form from 1-15th to 1-16th of the whole; in the West Indies 1-17th; on the river Esquibo, in Zugana, 1-12th to 1-15th; on the river Congo, 1-12th to 1-13th; in Guyana, 1-10th; (in the three last the local circumstances are particularly favourable for the grasses); in the East Indies, according to Brown, 1-12th; in Arabia, 1-15th; and in tropical New Holland, 1-10th to 1-11th. Now, attending to the circumstance, that the tropical are scarcely so well known as the other phænerogamic plants, it is not improbable that the true quotient for the torrid zone is 1-10th to 1-12th. In the warmer parts of the temperate zone, the grasses appear to form a smaller proportion of the vegetation; for, in the extra-tropical parts of New Holland they form 1-24th to 1-25th, at the Cape 1-35th, in Greece 1-15th to 1-16th, in the Canary Islands 1-12th to 1-13th, in the Crimea and Caucasus 1-14th to 1-15th, in Naples 1-11th to 1-12th, in France 1-13th, in Harberg 1-11th, and in Egypt (where, however, the circumstances are peculiarly favourable) 1-8th. Farther north, the relative numbers seem to rise somewhat higher; in Germany 1-13th, in Great Britain 1-11th to 1-12th, in Denmark 1-10th to 1-11th, in Scandinavia 1-10th to 1-11th, in Kamschatka 1-7th to 1-8th, Lapland 1-10th, Iceland 1-8th to 1-9th, Greenland 1-8th to 1-9th, and in North America, according to Pursh, 1-14th to 1-15th. We may assume, perhaps, as a medium for the warmer parts of the temperate zone, 1-12th to 1-14th; for the colder, together with the polar regions, 1-8th to 1-10th. That almost in every Flora, the quotient is considerably higher than in the works of Persoon, and of Ræmer and Schultes, affords another proof, that, in the rule, the distribution of the grasses is more extensive than that of the other phænerogamic plants.

In Southern Europe, the number of the grasses seems to diminish according to the elevation, for, in the Alpine Flora, they are only 1-18th. The distribution according to the elevation does not, therefore, accord with that according to the latitude; in South America the agreement is greater, for the relative numbers are, 0 to 200 toises, 1-15th to 1-16th; 200 to 1100 toises, 1-15th to 1-16th; 1100 to 1600 toises, 1-11th; above 1600 toises, 1-14th.

A detailed representation of the distribution of the cultivated gramina would certainly be very interesting. Here we must restrict ourselves to a short and general outline. We shall endeavour to specify those gramina which are the prevailing ones in the large Zones and Continents, mentioning, in passing, those plants of other families which either supply the place of, or are associated with, the different kinds of grain, as the chief article of food. This distribution is determined, not merely by climate, but depends on the civilization, industry, and traffic, of the people, and often on historical events.

Within the northern polar circle, agriculture is found only in a few places. In Siberia grain reaches at the utmost only to 60°, in the eastern part scarcely above 55°, and in Kamtschatka there is no agriculture even in the most southern parts (51°). The polar limit of agriculture, on the north-west coast of America, appears to be somewhat higher; for, in the more southern Russian possessions (57° to 58°) barley and rye come to maturity. On the east coast of America, it is scarcely above 50° to 52°. Only in Europe, namely, in Lapland, does the polar limit reach an unusually high latitude (70°). Beyond this, dried fish, and here and there potatoes, supply the place of grain.

The grains which extend farthest to the north in Europe are barley and oats. These, which in the milder climates are not used for bread, afford to the inhabitants of the northern parts of Norway and Sweden, of a part of Siberia and Scotland, their chief vegetable nourishment.

Rye is the next which become associated with these. This is the prevailing grain in a great part of the northern temperate zone, namely, in the south of Sweden and Norway, Denmark, and in all the lands bordering on the Baltic; the north of Germany, and part of Siberia. In the latter, another very nutritious grain, buckwheat, is very frequently cultivated. In the zone where rye prevails, wheat is also generally to be found; barley being here chiefly cultivated for the manufacture of beer; and oats supply food for the horses.

To these there follows a zone in Europe, and Western Asia, where rye disappears, and wheat almost exclusively furnishes bread. The middle or the south of France, England, part of Scotland, a part of Germany, Hungary, the Crimea and Caucasus, as also the lands of middle Asia, where agriculture is followed, belong to this zone. Here the vine is also found; wine supplants the use of beer; and barley is consequently less raised.

Next comes a district where wheat still abounds, but no longer exclusively furnishes bread; rice and maize becoming frequent. To this zone belong Portugal, Spain, part of France on the Mediterranean, Italy and Greece; further, the countries of the East, Persia, Northern India, Arabia, Egypt, Nubia, Barbary, and the Canary Islands: in these latter countries, however, the culture of maize or rice, towards the south, is always more considerable, and in some of them, several kinds of sorghum (Dura) and *Poa Abyssinica* come to be added. In both these regions of wheat, rye only occurs at a considerable elevation; oats, however, more seldom, and at last entirely disappear; barley affording food for horses and mules.

In the eastern parts of the Temperate Zone of the Old Continent, in China and Japan, our northern kinds of grain are very unfrequent; and rice is found to predominate. The cause of this difference between the east and the west of the Old Continent, appears to be in the manners and peculiarities of the people. In North America wheat and rye grow as in Europe, but more sparingly. Maize is more reared in the western than in the Old Continent, and rice predominates in the southern provinces of the United States.

In the Torrid Zone, maize predominates in America, rice in Asia, and both these grains in nearly equal quantity in Africa. The cause of this distribution is, without doubt, historical; for Asia is the native country of rice, and America of maize. In some situations, especially in the neighbourhood of the Tropics, wheat is also met with, but always subordinate to these other kinds of grain. Besides rice and maize, there are, in the Torrid Zone, several kinds of grain, as well as other plants, which supply the inhabitants with food, either used along with them, or entirely occupying their place. Such are, in the New Continent, yams (*Dioscorea alata*), the manihot (*Jatropha manihot*), and the batatas (*Convolvulus batatas*), the root of which, and the fruit of the pisang (Bananæ, Musæ, sp.), furnish universal articles of food. In the same zone, in Africa, doura (*sorghum*), pisang, manihot, yams and *Arachis hypogæa*. In the East Indies and on the Indian islands, *Eleusine coracana*, *E. stricta*, *Panicum frumentaceum*; several palms and cycadeæ, which produce the sago; pisang, yams, batatas, and the bread-fruit (*Artocarpus incisa*). In the Islands of the South Sea, grain of every kind disappears,—its place being supplied by the bread-fruit tree, the pisang, and *Jacca pinnatifida*. In the tropical parts of New Holland there is no agriculture,—the inhabitants living on the produce of the sago, of various palms, and some species of arum.

In the high lands of South America there is a distribution similar to that of the degrees of latitude. Maize, indeed, grows to the height of 7200 feet above the level of the sea, but only predominates between 3000 and 6000 of elevation. Below 3000 feet it is associated with the pisang, and the above-mentioned vegetables; while, from 6000 to 9260 feet, the European grains abound, wheat in the lower regions, and rye and barley in the higher; along with which *Chenopodium Quinoa*, as a nutritious plant, must also be enumerated. Potatoes alone are cultivated from 9260 to 12,300 feet.

To the south of the Tropic of Capricorn, wherever agriculture is practised, considerable resemblance with the northern Temperate Zone may be observed. In the southern parts of Brazil, in Buenos Ayres, Chili, at the Cape of Good Hope, and in the Temperate Zone of New Holland, wheat predominates; barley, however, and rye, make their appearance in the southernmost parts of these countries, and in Van Dieman's Land. In New Zealand the culture of wheat is said to have been tried with success; but the inhabitants avail themselves of the *Acrostichum furcatum*, as the main article of sustenance.

Hence, it appears, that, in respect of the predominating kinds of grain, the earth may be divided into five grand divisions or kingdoms: The kingdom of rice, of maize, wheat, rye; and, lastly, of barley and oats. The three first are the most extensive; the maize has the greatest range of temperature; but rice may be said to support the greatest number of the human race.

In Plates VI. and VII. these kingdoms are represented by different colours. That the limits in nature are not abrupt, as on the map, will be obvious to every one. Where, in any particular kingdom, besides the predominating grain, another is also found to abound, the circumstance is indicated by streaks of the colour, by which it is elsewhere represented *.

Art. XVIII.—*A Memoir on the Bag or Bladder occasionally protruded from the mouth of the Dromedary.* By Dr Paolo Savi, Professor of Natural History in the University of Pisa †.

Travellers and naturalists who treat of the Dromedary, mention, that this animal, in the rutting season, protrudes from its mouth a bladder (some say two) which contracts and disappears in the act of inspiration. It is singular that hitherto no one, as far at least as I am aware, has directed his attention to examine thoroughly and explain the fact, unless in a hypothetical manner.

Wherever he bites, says Tavernier, he carries off the piece, and from his mouth there issues a white foam, accompanied with two bladders, which are large and blown up like the bladder of a hog.—*Voyage de Tavernier*, tom. i. p. 161. And Buffon, who may be said to copy him, says, " It is then said, that they foam continually during the rutting season, and that one or two red vesicles, as large as a hog's bladder, issue from their mouths." —*Buffon*, vol. vi. p. 141.

" For forty days they scarcely eat any thing, and two large bladders are continually projected from their mouth, with a very disagreeable rattling."—*Menagerie du Museum National; par La Cepede et Cuvier*, p. 2.

" *Apronto sovente la bocca e caccian fueri una vesica membranosa rossa che vientra nella alto dell inspirazione.*"—*Rauzani, Elementi di Zoologia*, tom. ii., parte 3, p. 596.

The above is all I find written on the subject, and hence, I

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* In regard to the coloured maps, we have to notice, that, in some copies. the red colour is marked Oats, whereas it ought to be Oats and Barley; and also that the yellow colour occupies too great a space in Britain and Ireland.

† From Nuovo Giornale de Litterati, No. xiv. Pisa 1824.—Translated by our friend Thomas Stewart Traill, Esq.

should think myself inexcusable to naturalists, had I not procured materials for illustrating and explaining the fact, placed as I am, in a situation the most suited to note the habits, disposition and structure of this animal. There is, as is well known, near Pisa, a breed of camels pertaining to the Crown, in the district of San Rossore, in an extensive and beautiful plain, which, defended from the north winds by a mountain chain, always enjoys a mild temperature.

The soil of this district is chiefly sandy, and abounds in thickets of evergreen plants, of the species most agreeable to camels; hence these animals, there enjoying perfect liberty, suitable food, and living, in short, in circumstances almost similar to those of their native country, are perfectly accustomed to the climate, are in perfect health, and completely perform all their functions, which can never be the case with camels cooped up in the menageries of a colder climate, almost the only situations under which they have been attentively examined by naturalists. I therefore endeavoured to profit by these favourable circumstances as much as possible, especially as I frequently was among the camels in summer and in winter, both with the females while suckling their young, and with the males, either feeding at large in the woods, or led by the camel drivers in agricultural labours, and had every convenience for examining them attentively, and studying their natural history. And although the camel be an animal of which much has been written, yet I have found that some facts have escaped other observers, and that some things which have been stated respecting them require correction.

But before entering on the subject, it is necessary to ascertain to what species the camels of St Rossore belong. The best naturalists admit but two species of the genus *Camelus*, viz. the camel with two hunches, *Camelus Bactrianus;* and the camel with a single hump, *Camelus Dromedarius.* As our camel is furnished with but one hump, it belongs to the last species; and Professor Santi, in a memoir *Sur les Chameaux de Pise*, inserted in the 17th volume of the *Annales du Museum* of Paris, for 1811, has given it the name of *Camelus Dromedarius.* But Signior Luigi Porte, who published, in 1815, a memoir *Sul Camello Toscano*, is of the opinion of Valmont de Bomare, and of divers travellers, who incline to distinguish three species of camels; viz. 1*st*, The Bactrian Camel, with two humps; 2*d*, The Dromedary, with a single hump, a small head, slender legs and neck, a light body, and gifted with great fleetness; 3*d*, The common or Arabian Camel, also with a single hump, with stronger limbs, a thicker neck and body, and a slower pace; and to this species he would refer the Tuscan camel. Yet, it may be asked, are the distinctive marks between the common camel and the dromedary sufficient to constitute a species? Certainly not. No naturalist will attach to them so much consequence as to make them the diagnostics of a permanent variety, or a species; and Forskall himself considers the animals simple varieties of the same species, remarking that the dromedary, "*a camelo (vulgari) non specie sed propagatione differt.*" —Forskall, *Animalium Descriptiones*, &c. quæ in Itinere Orientali observavit. Havniæ, 1675, p. 4. Our camel, then, I place in the species *Dromedarius*, although I admit that the specific name may not be very suitable, because the name *dromedary* is thus not appropriated to a species distinguished for fleetness, but used generally to denote all camels with a single hump. Yet, as Linnæus, Buffon, Cuvier, and all the most approved naturalists, have adopted this denomination, it would be a difficult, as well as an useless task to correct this slight mistake. Professor Santi, however, does not err in naming the dromedary the *single hunched camel of St Rossore;* but wishing to determine to which of the two varieties of this species it belongs, I agree in saying with Signior Porte, that ours are the Arabian, or common, or true camels, and not *dromedaries*, since they at the first glance assimilate to the former in shape and habit.

But, it is now time to return to the guttural bladder of the dromedary, the original object of this memoir, from which I have digressed, to enlarge on a discussion, in my opinion, not without utility, there being many Tuscans still uncertain of the appropriate name of our camel, although the question has been for some time decided beyond the Alps.

From all I can collect in the various books I have consulted, the *Bactrian*, or the *two hunched camels*, never shew this sac, which so many have remarked in the dromedary: "*Ils n'ont point cette vessie, que les dromedaires font sortir de leur bouche* *à cette epoque.*"—La Cepede et Cuvier, *Menagerie du Museum*, Art. *Chameau*, p. 2. But it is found solely in the dromedary, and only among the males; and they exhibit it only during the rutting season, that is, in February and March. One of the most remarkable facts in the history of the camel, is, as we now know, the peculiar, and, if I may say, infuriated, state in which they are found at that season. They then eat very little, and consequently have little food in their immense paunches, which at other times are so distended; their belly is smaller, and more distant from the ground; they have as it were the paunch retracted, *paucia ritirata* as the camel drivers say. The discharge from the occipital gland * is more copious, so that the hair of the inferior part of the neck is soiled with it. The animal becomes thin, and ruminates more slowly, often moving the jaws on each other without having any thing between the teeth, by which a sort of disagreeable and sharp grinding is produced. They void their urine slowly, and receive the stream on their tail, with which they afterwards sprinkle their backs. They become restless, and frequently bestow bites and kicks on their companions, and occasionally on their keepers; and, lastly, they project from the sides of their mouth, a membranous body of a deep flesh-colour, which they generally inflate like a bladder.

Among the different authors who mention this fact, some, as we have seen, assert that *two* are observed at the same time, one on each side of the mouth; but this is not true. The dromedaries do not, and cannot, project more than a single bladder at any one time. The sight of a female, the very odour of her, the presence of another male in heat, are sufficient to produce the phenomenon of the bladder. At first a deep rattling † is heard, and then from one side, now from another side, of the mouth, is projected a red membrane, with variously ramified vessels, full of air, and sometimes much distended, but which is again quickly emptied, and reduced to a membranous body,

* This is a conglomerate gland of a reniform shape, about two inches long and three broad. It lies in the thickness of the skin, so that the rounded part points to the base of the neck, and its margin to the head. The lobules which compose it have each an excretory duct, which opens directly on the surface of the skin, among the hairs, without uniting with the ducts of the adjacent lobules.

† Gorgoglio.

pale, wrinkled and pendulous. When reduced to this state the animal retracts it within the mouth; and, to facilitate this operation, inclines the head back towards the trunk, at the same time bringing down the muzzle towards the neck.

The first time that I saw this singular body, it excited much astonishment; for I could not imagine whence it proceeded; and, as much as I tortured my imagination, I was unable to form a reasonable conjecture. I was therefore compelled, in order to satisfy my curiosity, to wait for an opportunity of dissecting a dromedary; and this happening at no great interval of time, what was my surprise to discover that this *guttural bladder* was nothing else but an extraordinary development of the *uvula;* an organ in the other mammalia of extremely small size, and scarcely touching the upper surface of the tongue. On examining the uvula and other parts of the mouth of the dromedary, I detected, with great ease, the mechanism by which this organ is projected from the mouth in the form of a bladder; and though such a mechanism be very complicated, those who have an opportunity of examining the head of an adult dromedary, will readily comprehend it, without having read this memoir. But to make it understood by words alone, through the medium of a simple description, without having the subject before the eyes, or without many designs, is not a thing easily to be done, at least by me; so complicated are the parts of the fauces of the dromedary, and so numerous are the circumstances which concur in forming the so-called bladder.

Therefore, through the medium of detailed descriptions, and by the assistance of a plate *, in which I have endeavoured to represent, in the most favourable point of view, the parts of which I speak, I shall endeavour to render the origin of the very curious guttural sac of the dromedary easily comprehended †.

(To be concluded in next Number.)

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* See Plate IX. of following Number.

† The Italian anatomists subdivide what is by the British denominated the arch of the palate into two parts, *pilastri* or crura of the arches, and *arcata* or crown of the arches.

Art. XIX.—*Geological distribution of the Fossil Organic Remains enumerated by* Baron Von Schlotheim, arranged by Dr Boue'.

As Baron Von Schlotheim has not arranged the fossils which he has described according to their geological relations, and has only promised to do so after the completion of his appendix; I have judged it expedient to present a classification of this kind, under the impression that it cannot but prove highly acceptable to geologists. Such an attempt may to some, at first sight, seem unnecessary, but I am persuaded, that this idea will vanish, when they are informed, that in the work of this celebrated naturalist, many of the localities and geological positions are erroneously indicated. These mistakes were, to a certain degree, unavoidable, as he had not visited all the places where the different species occur, but has often been obliged to trust to his correspondents, or even to the labels of some old collections purchased by him. Besides which, geological classification has been variously modified, and the secondary formations better defined, since the publication of his "Petrefactenkunde." To correct some of these errors, I have made use of the geological details regarding Germany which my own personal observation and the works of others have furnished me with. In the mean time, it must be gratifying to every German to be assured, that when Baron von Schlotheim's work shall be completed, or when he shall have figured all the species which he has described, his essay will be one of the finest of the kind, and will contain the fossils of every formation in Germany. In France and Italy the labours of the geological zoologists have been almost entirely confined to the fossils of the chalk and tertiary deposits; and in England, although the field of observation has been more extended, the expensiveness of the coloured engravings renders them, in a great measure, accessible only to the rich, which constitute the smallest portion of the scientific world. It is much to be wished, that some person would undertake the task of establishing a correct synonymy between the German, English, French, and Italian writers on this subject, for, at present, the science is but a mass of confusion, encumbered with double names to designate a single object; for example, *Grypæa aculeata*, Scloth. is *Productus aculeatus*, Sow.; *Gryphœa columba*, Bgt. is *Gryphœa spirata*, Schloth.; as well as *Gryphœa ratisbonensis* of the same author; *Gryphœa cymbium*, Schloth. is *Gryphœa arcuata*, Lam. This confusion has done much to retard the progress of geology in reference to the secondary formations, and has contributed so long to delay the acknowledgment of identity between the zechstein of Germany and the magnesian limestone of England, of the existence of greensand and chalk in Germany, the absence of muschelkalk in England, &c. Brongniart's visit to Baron von Schlotheim may perhaps hasten the gratification of our wishes in regard to this subject.

Geological Arrangement of Fossil Organic Remains.

Greywacke Formation.

Fishes similar to Esox Belone ?
Trilobites paradoxus, &c.
Orthoceratites
Cypræcites vulvarius
C. paradoxus
C. hystericus
Encrinites epithonius
Ammonites
Madreporites
Solenites
Mytulites
Tellinites
Impressions of Reeds and Palms.

Transition Limestone.

Trilobites cornigerus
T. paradoxus, &c.
Orthoceratites flexuosus
O. falcatus
O. vaginatus
O. regularis
O. undulatus
O. cochleatus
O. nodulosus
O. serratus
Lithuites convolvans
Ammonites primordialis
A. arietis ?
Nautilites bisiphites
Lenticulites ?
Serpulites torquatus.
Helicites delphinuloides
H. gualterianus
H. ellipticus
Helicites trochilinus
H. heliciniformis
Patellites primigenus
P. antiquus
Buccinites arcuatus
B. subcostatus
Muricites turbinatus
Trochilites priscus
T. delphinulatus
T. globosus
Turbinites duplicatus, var. α.
T. angulatus
Calceolites sandalinus
Radiolites, &c.
Pholadites caudatus
Venulites orbiculatus
Bucardites abbreviatus
B. hystericus
B. chamæformis
Anomites thecarius
A. anomalus
Terebratulites striatissimus
T. speciosus
T. intermedius
T. comprimatus
T. vastitus
T. striatulus
T. pecten
T. umbraculum
T. sarcinulatus
T. lævigatus
T. aperturatus
T. ostiolatus
T. gryphus
T. rostratus
T. priscus
T. asper
T. explanatus
Terebratulites dissimilis
T. suffarcinatus
T. helveticus
T. lacunosus
T. variabilis
T. reticulatus
T. vulgaris, var. β. latus
T. elongatus
T. laxus
T. curvatus.
T. dimidiatus
Poteriosinites crassus, &c.
Pentacrinites excavatus
P. caryophyllites
P. echinoides
P. e. var. α. major
P. e. var. β. minor
P. verrucosus
P. v. var. β. punctata
P. orthoceratoides
P. epithonius
P. tesseratus
P. loricatus
Escharites forniculosus
E. milleporatus
E. madreporatus
E. spongites
Fungites patellatus
F. piliatus
F. deformis
F. testudinarius
Porpites hemisphæricus
P. lenticulatus
Hippurites turbinatus
H. mitratus
H. comprimatus
Madreporites hippurinus
M. truncatus

Madreporites tenturatus
M. filatus
M. filatus, var. *α*.
M. hexagonatus
M. astroïtes
M. favosus
M. poriferus
M. stellatus
Milleporites cornigerus
M. cervicornis
M. polyporatus
M. celliporatus
Tubiporites catenarius
T. serpens
T. subulatus
T. nodosus
Spongites favus
Alcyonites texturatus
A. striatus
A. madreporatus
Tentaculites annulatus
T. scalaris ?
Cornulites serpularis.

Coal Formation.

Mytulites carbonarius
Palmacites lanceolatus
P. hexagonatus
P. oculatus
P. verrucosus
P. squamosus
P. quadrangulatus
P. affinis
P. variolatus
P. curvatus
P. incisus
P. sulcatus
P. verticillatus
Casuarinites equisetiformis
C. stellatus
C. rotundifolius
C. truncatus
C. capillaris
Calamites carinæformis
C. approximatus
C. remotus
C. interruptus
C. gibbosus
C. nodosus
C. decoratus
C. inermis
C. triquetrus
Filicites cyatheus
F. arborescens
F. affinis
F. giganteus
F. lanceolatus
F. aquilinus
F. tenuifolius
Filicites ptericinus
F. crispus
F. oreopteroidæus
F. fœminæformis
F. fragilis
F. adiantoides
F. bermudensiformis
F. muricatus
F. fruticosus
F. aspleniiformis
F. Pluckenetii
F. lonchiticus
F. linguarius
F. osmundæformis
F. acuminatus
F. vesicularis
Lycopodiolites arborescens
L. filiciformis
Poacites zeæformis
P. miliaris
P. gramineus
Carpolites ficiformis
C. alatus.

Coal.

Fishes
Clupea.

Red Secondary Sandstone or Todliegende.

Lithonylites
Lycopodiolites piniformis

First Secondary Limestone.

Fishes
Cyprinus, Clupea, Stromateus, &c. } In the undermost part.
Monitor and Insects, (Carabus, &c.)
Trilobites bituminosus
T. problematicus
T. tentaculatus
Trochilinus helicinus
Tellinites dubius
Pleuronectes pusillus
Chamites granulatus
Terebratulites alatus
T. pecten
T. cristatus
T. lacunosus
T. trigonellus
T. pelargonatus
T. communis, var. *b.* latus
Terebratulites sufflatus
T. elongatus
T. angustus
Gryphites Cymbium, var.
G. speluncarius
G. aculeatus
Mytulites ceratophagus
M. striatus
Pentacrinites ramosus
Ceratophyllites dubius
C. anceps
Escarites retiformis
Poacites phalaroides
Lycopodiolites funiculatus
Algacites orobiformis
A. frumentarius
Carpolites hemlocinus.

Variegated Sandstone.

Fishes, Bones } in fragments.
Nautilites, Pectinites } in the upper part.
Monocotyledones
Impressions of Ferns.

Second Secondary Limestone or Muschelkalk.

Bones of Amphibia or Cetacea, of Seadog, &c.
Bones and scales of Fishes
Ornithocephalus longirostris
Belemnites paxillosus
Orthoceratites eremita
O. flexuosus
O. vaginatus
O. regularis
Ammonites annulatus var. *α*. colubrinus vulgaris
A. amaltheus
A. a. gibbosus
A. nodosus
A. capricornus
A. dorsuosus
A. ornatus
A. papyraceus
Nautilites bidorsatus
Dentalites lævis
D. torquatus
Serpulites lithuus
Helicites arietinus
Neritites spiratus
N. paganus

Patellites discoides
P. mitratus
Buccinites obsoletus
B. labyrinthicus
B. gregarius
Muricites subcostatus
M. melanoides
M. aluciformis
Strombites denticulatus
Trochilites nodosus, var. β.
T. granosus
T. lævis
T. limbatus
T. acutus
T. solarius
T. cerithius
T. cingulatus
T. obeliscus
Lepadites curvirostris
Myacites ventricosus
M. musculoides
M. mactroides
Solenites mytiloides
Tellinites minutus
T. anceps
Donacites trigonellus
α. trigonellites pes-anseris
β. t. vulgaris
γ. t. simplex
δ. t. curvirostris
D. aratus
Venulites donacinus
Arcacites anomalus
A. corbularis
Chamites striatus
C. lineatus
C. ostracinus
C. glaberrimus
C. ventricosus
C. tellinarius
Pleuronectes lævigatus
P. discites
P. discus
P. decussatus
Pectinites reticulatus
P. salinarius
Ostracites spondyloides
O. anomius
O. crista-galli difformis
Craniolites Schræteri
Terebratulites fragilis
T. f. var. parasiticus
T. lacunosus
T. communis, var. β. latus
δ. annulatus
Gryphites cymbium
Gryphites suillus
Mytulites socialis
M. incertus
M. crenatus ?
M. costatus
M. eduliformis
Echinites pustulosus
Asteriacites ophiurus
Pentacrinites vulgaris
P. liliiformis
Fungites testudinarius
Hippurites mitratus
Bitubulites irregularis
B. problematicus
Isitolites
Confervæ ?

Quadersandstein.

Muricites
Strombites
Bullacites ovarius
Buccinites
Volutites mitroides
V. elongatus
Turbinites obvolutus
T. regensbergensis
Lepadites plicatus
Pholadites musculoides
Myacites musculoides
Venulites sinuatus
Bucardites cardissoides
Ostrea crista-galli
Terebratulites acutus
T. labiatus
Gryphites cymbium
Pinnites diluvianus
Musculites sablonatus
Mytilites
Donacites
Pectinites punctatus
P. radiatus
P. reticulatus
Pectinites longicollis
P. anomalus
Chamites transversim punctatus
Serpulites
Encrinites
Asteriacites lumbricalis
Echnites
Lithoxylites
Bibliolites
Lycopodiolites cæspitosus
Palmacites annulatus
P. canaliculatus
P. obsoletus
Carpolites malvæformis
C. secalis
Impressions of Ferns.

Lias or Gryphitic Limestone.

Monitor, &c.
Remains of Fishes
Pentacrinites subangularis
P. vulgaris
Encrinites Parkinsonii
Belemnites giganteus
B. paxillosus
B. canaliculatus
Ammonites annulatus
A. bifurcatus
A. ornatus
A. lævigatus
A. costatus
A. costulatus
A. coronatus
A. macrocephalus
A. noricus
A. angulatus
A. radians
A. natrix
A. divisus
A. collubratus
A. arietis
A. capricornis
A. amaltheus
A. hircinus
A. bipunctatus
A. lineatus
A. ammonius
A. serpentinus
A. capellinus
A. striatus
A. depressus } if not in the Lias, yet in the Jura Limestone.
Serpulites lumbricalis
S. gordialis
Muricites strombiformis
Turbinites trochiformis
Cerithium
Tellinites sanguinolarius
T. rhæticus
Donacites trigonius
D. costatus
D. hemicardius
Venulites islandicus
Buccardites hemicardiiformis
Pleuronectes discites
P. lævigatus
Pinnites diluvianus
Plagiostoma
Arca corbularia
Pectinites priscus
P. antiquus
P. textonius
Ostracites tabulatus

Ostræcites crista-galli	T. bicanaliculatus	G. suillus
O. complicatus	T. osteolatus	G. carinatus
O. pectiniformis	T. helveticus	Mytilites modiolatus
O. eduliformis	Gryphites gigas	Mytiloides (*Brong.*)
Terebratulites lacunosus	G. cymbium	Algacites granulatus
T. alatus	(syn. arcuata, *Lam.*	A. filicoides.
T. rostratus	incurva, *Sow.*)	

(To be continued.)

Art. XX.—*Geographical Expeditions.*— 1. *Captain Franklin and Dr Richardson's Arctic Expedition.* 2. *African Expedition under Denham and Clapperton.* 3. *Antarctic Voyage of Captain Weddel.* 4. *Russian Voyage along the Northern Shores of Siberia.* 5. *Captain Lyon's Voyage.*

I.—*Captain Franklin and Dr Richardson's Arctic Expedition.*

Captain Franklin, we are informed, has received most satisfactory letters from the wintering chief factors and traders at Hudson's Bay, expressing their earnest desire to forward his enterprise to the utmost of their power. Part of his expedition, consisting of three canoes with stores from Canada, under direction of a chief trader, was seen in good order, and far advanced on the way to Great Bear Lake, to build a house and lay in stores, and make other arrangements for his reception. Another part of his expedition, consisting of three light boats, manned by English seamen and Highlanders from the island of Isla, landed at York Factory, and proceeded into the interior, under the conduct of experienced guides, furnished by the Hudson's Bay Company. The crews of these boats will be employed, during the winter, in laying up provisions on Captain Franklin's line of route. They will move on in the spring; but the quicker movements of the commander of the expedition, and the more early opening of the navigation to the southward, will enable him to overtake them before they reach Great Slave Lake. The Fur Company has lately sent exploring parties into the northern ranges of the Rocky Mountains, and opened communications with the Nohanny Indians, of whom little was previously known; and the Esquimaux that frequent the mouth of Mackenzie's River, have intimated through a neighbouring tribe, their desire of opening a trade with the company, who, on their part, have pushed their advanced posts to within three days' march of the sea. These circumstances, combined with good accounts from the various districts, of the supply of provisions, augur well for the success of Captain Franklin's undertaking. The novel display of good feeling on the part of the Esquimaux of those quarters towards the white people, (so different from what is recorded in a former number of this Journal *,) may, perhaps, have originated in intelligence of Captain Parry's or Captain Franklin's visits having spread along the coast. We hope, that the influence of the European visitors in these quarters, will for ever terminate the exterminating warfare betwixt the Esquimaux and Indians. Captain Franklin and Dr Richardson leave England in February next, to proceed by the way of New-York to Mackenzie's River. Their course from New-York, will be by Lake Erie, Lake Huron, and Lake Superior to Fort-William; and thence by the usual river navigation pursued by the fur traders through the Lake of the Woods, Lake Winnipeg, Athapescou Lake, and Great Slave Lake to Mackenzie's River, which they hope to reach about the end of September, and to winter upon a tributary branch, which discharges the waters of Great Bear Lake. Much, we are confident, will be accomplished by these enterprising and distinguished travellers. We are also informed, that Captain Beechy has commissioned the Blossom, for the purpose of going out to meet Captains Parry and Franklin in Behring's Straits.

2.—*African Expedition under Denham and Clapperton.*

It is asserted in the public journals, that Dr Oudney's papers had reached London. This statement, we regret to say, is incorrect, as we are informed that not a single paper has as yet been received, but instructions have been sent to our Consul at Tropoli, to make every possible exertion to obtain them, and Lord Bathurst has ordered him to dispatch a courier to Bornou for the express purpose. Major Denham, with a carpenter from Malta dock-yard, an extremely useful man, proceeds to the eastward, along the lake which they discovered; and which, by

* Vol. viii. pages 78. and 79.

the way, making allowance for the uncertainty of English spelling and pronunciation of African names, is, most likely, the Wangara of Major Rennell.

Lieutenant Clapperton goes to the westward, to satisfy himself that the river which flows into the lake is actually the Niger, its diminished size having caused him to doubt. The information at present gained, tends to confirm Major Rennell's opinion of the waters of the Niger being expended by evaporation from the lakes into which they flow. The story told of the party having suffered from great cold, and from which the inference was drawn, that the country they had reached was greatly elevated, appears to be quite unfounded. If any cold was experienced, it probably originated in evaporation during the night, which often produces a great difference between the day and night, in the sandy deserts of tropical climates. It is incidentally mentioned in Major Denham's communication, that the body of water which lay before them, was a "great fresh-water lake."

3.—*Captain Weddel's Voyage towards the South Pole.*

An important and interesting voyage of investigation, to a high southern latitude, has been performed, during the years 1822, 1823, and 1824, by Mr James Weddel, master in the Royal Navy. An account of this voyage is now in the press, and will soon appear. Captain Weddel has had the goodness to favour us with a notice of his work, from which the following particulars are taken.

The vessels in which this voyage was performed, were the brig Jane, and cutter Beaufoy, of Leith and London; both under the orders of Captain Weddel, by whom the voyage was projected.

He sailed from England on the 17th of September 1822, and reached Bonavista, one of the Cape de Verdes, on the 15th of October following. In a few days, he proceeded thence to the southward; and on the 11th December, both vessels anchored at Port St Elena, on the east side of Patagonia. During the time that Captain Weddel remained at this anchorage, he made several useful observations, chiefly with regard to the harbour, of which he intends to give a plan. Leaving port St Elena on the 27th, he proceeded southward; and, on the 12th of January

1823, arrived in sight of a group of islands, to which Captain Weddel gave the name of South Orkney, in latitude 60° 45′ S., and 45° W. The vessels remained eleven days under sail, examining these islands, which Captain Weddel first fell in with when in search of land, during a former voyage, in the year 1821.

This group he thoroughly investigated, and denominated the eastern extremity Cape Dundas, in honour of the Noble Family of that name. Captain Weddel describes this country as the most sterile and uninviting of any southern land yet discovered. The tops of the islands, for the most part, terminate in craggy towering peaks, and look not unlike the mountain-tops of a sunken land. Professor Jameson has received specimens of the principal strata of which these islands are composed, which he has presented to the Museum of the University of Edinburgh *.

On the 23d of January, Captain Weddel proceeded southward, amongst innumerable ice-islands, till he reached the latitude of 65°. Perceiving no land in this direction, he returned to the latitude 58°; from which he again went south, into the latitude of 61° and then ran eastward, till within 100 miles of Sandwich Land.

On the 7th of February he steered to the southward, in expectation of still finding a range of land; which, since the discovery of South Shetland, has been supposed to lie behind these islands, a little within the Antarctic Circle. After passing through an extensive barrier of ice-islands, about fifty miles broad, commencing in the latitude of 68°; on the 20th of February, he actually reached the high latitude of *seventy-four degrees fifteen minutes South. Here, with very clear weather, he was astonished to find, that not a single piece of* field-ice, *and only four ice-islands, were in sight, even as far as the eye could reach from the mast-head.*

The state of the sea in this high southern latitude, must excite considerable wonder in the minds of men of geographical inquiry; who, since the unsuccessful attempt of Captain Cook, to advance beyond the 71st degree, have considered these regions as impenetrable. As this part of the ocean is not known to have been before visited, and has been considered hitherto as unnavi-

* These rocks, as will be described in Captain Weddel's Narrative, belong to the primitive and volcanic classes.

gable, Captain Weddel judged proper to confer upon it the name of *The Sea of George the Fourth,* in honour of our Gracious Sovereign. The variation of the compass, Captain Weddel states, to have fluctuated a great deal in these high latitudes; which he can account for only by that inactivity which the compass is found to exhibit in corresponding northern latitudes. The lateness of the season, and many concurrent circumstances, compelled Captain Weddel to take advantage of a strong southerly wind to return homewards. On the 15th, he arrived at the island of South Georgia, after a perilous navigation of 1200 miles, amongst ice-islands.

While lying at Georgia, he observed a tremulous motion in a mountain situated on the south side of the island. He discovered this by remarking, that the surface of the quicksilver in an artificial horizon was much agitated; although not the least breath of wind, nor any other ostensible cause of the phenomenon existed. After calling at the Falkland Islands, in October following, the vessel visited the coast of South Shetland, and found its harbours unapproachable, on account of ice.

On their way homewards they made a stay of nearly two months among the Islands of Terra del Fuego; during which Captain Weddel had many opportunities of acquiring accurate information regarding the character of the natives, as well as of ascertaining the conveniency which this coast affords for shipping. They arrived in England on the 7th of July 1824, after a hazardous voyage of nearly two years.

4.—*Russian Epedition along the Northern Shores of Siberia.*

The Russian Government had long formed the project of exploring the north coast of Siberia. M. de S. was sent out for this purpose; but his researches were extremely limited, and he only described a part of the coast, to a distance of about a hundred versts beyond the eastern part of the Kolyma. Toward the year 1822, it was resolved to send out a new expedition for exploring these countries. Three young officers, MM. Wrangel, Anjou, and Matuchkin, were charged with it: they were occupied four years in it, and justified the confidence of the Government, by the courage, prudence, and zeal, which they evinced in the discharge of this duty. They succeeded in making a description of the whole north coast of Siberia, in de-spite of numerous obstacles, the extreme rigour of the climate, and the dangers to which they were exposed; for the Tchouktchis had already destroyed two detachments sent out for the same purpose. M. Anjou has described the coast from the Uralian Chain, or from the river Ob to the Kolyma, the other two gentlemen from the Kolyma to the promontory of the Tchouktchis. Not content with exploring the coast, these travellers made an excursion also toward the north, over an extent of continuous ice, to the place where the sea is open, which forms nearly five hundred versts, of the coast of Behring's Straits. It was in this place, which faces the eastern part of the north coast, and is inhabited by the rein-deer Tchouktchis, that they perceived mountains at a distance of about a hundred versts. M. Wrangel conceived the project of getting to them. He was already pretty near, when the piece of ice on which he was placed became detached from the mass, and he was tossed about by the waves for five days in succession, with seven other persons, his dogs and equipage, until at length, after they had been several times upon the point of being swallowed up, the piece of ice was again united to the mass. There is a tradition among the Tchouktchis, that the strait which separates them from the opposite shore, towards the north, was not covered with ice, and that the inhabitants formerly traversed it in *baydars*, a sort of boat. They relate that a period, not very remote, (for all the inhabitants remember it still), some Tchouktchis, to the number of seven or eight, accompanied with a woman, crossed the ice to go toward these mountains to fish for morses, and that a long time after, the woman returned to the country by the way of the Kurile Isles, and brought the news that her companions had been all massacred. This woman was sold into another part of the country, and after having passed from hand to hand, was carried to Prince of Wales's Land, from whence she found means of returning to her own country. From this account, it is to be supposed, that the country which Wrangel had in view to visit, is nothing else than an island. The people who inhabit the islands nearest Siberia, make use of rein-deer, which renders it probable that they are only a colony of Tchouktchis, more especially as their languages are much allied. The Tchouktchis are in general large and well made; they have regular features, their nose is not flat, but their cheeks are very prominent. Our travellers also saw other islands which they named New Siberia. The rout which they took to get to them may be seen upon the chart of the famous pedestrian traveller Cochrane, where it is traced with great fidelity. They made very extensive excursions in all directions, but saw no land. In their land-journeys they rode upon horses or reindeer, but they preferred the former. With regard to sledge-travelling with reindeer, it is very convenient upon ice. They made use of a sort of large sledge called *narta*, drawn by twelve or thirteen dogs; these animals were always of great use to them, in defending them from the white and black bears, and wolves, as well as by their astonishing sagacity. Their instinct always led them to find the best road, and when the travellers thought themselves strayed, the dogs brought them back to the way. The sagacity of these animals was such, that after having made a number of turns, they took the shortest way to return. The travellers passed several weeks upon the ice, sometimes upon enormous pieces covered with grey snow, sometimes upon thinner layers, which frequently separate from the mass, so as to be carried along by the current, and tossed about by the waves. In these critical moments, the dogs rendered them innumerable services; in the places where the ice was thick, they ran with rapidity upon the snow, barked, bit one another, and appeared intractable; but as soon as the route became dangerous, they became gentle, circumspect and docile; they often walked upon pieces of ice, which were not more than half an inch thick with the greatest precaution, and seemed to advance only according to the order of the person carried in the sledge. MM. Wrangel and Matuchkin remained once for seventy days upon the ice, at a distance of several hundred versts from the shore. They were attended by several *nartas* laden with provisions; they buried these provisions under the snow and ice, and continued their journey, carrying with them what was absolutely necessary; and when their provisions were exhausted, they returned for what they had left. They did not fail to make astronomical observations wherever they could, but the fogs often prevented them. These fogs were so thick, that our travellers, drawn in their sledge, sometimes could not see the dogs which drew them. Frequently snow-storms overwhelmed the tents which served for their abode, and it was with much difficulty, when the storm abated, that they got themselves extricated. During the months of November, December, and January, when the intensity of the cold became insupportable, our travellers took refuge in felt cabins or tents, where the water froze upon the floor, and the ice rose to the height of upwards of two feet. A mass of ice, abont five inches thick, served them for a window. In this icy region, the earth produced only heath and a sort of plant peculiar to the country; in summer, the sun did not leave the horizon for two months, and in winter, it did not appear for the same period of time. The maximum heat, in the middle of summer, is above fifteen degrees of Reaumur's thermometer; it freezes at night or when the sun is upon the decline. The dazzling whiteness of the snow produced diseases of the eyes; the natives wear a sort of mask formed of the bark of trees, in which very narrow slits are made for the eyes. The Russian officers wore a piece of crape folded four times; at the beginning they neglected to avail themselves of this contrivance, and were rendered nearly blind; they learned, however, to cure this malady, by introducing tobacco oil into the eyes, a remedy which, although effectual, has the disadvantage of exciting acute pain. Their ordinary food consisted of fish, and reindeer, and bear's flesh; this last had the property of strengthening them, but it also produced violent agitation in the blood, and prevented them from sleeping. The natives are poor, do not practise any trade, and have no other occupation than that of fishing and hunting; yet there are Russian merchants who go to these countries for trade *.—*Revue Encyc.* Oct. 1824.

5.—*Captain Lyon's Voyage.*

Captain Lyon has been forced back to England by stress of weather, and the badness of his vessel. He found Sir Thomas Roe's Welcome much narrower than laid down in the charts, and full of shoals, but saw no ice in it. Southampton Island is broader than it was thought to be, or perhaps consists of several islands. Corrections have been made in the positions of some of the capes in Hudson's Straits. Captain Lyon's Narrative, in small octavo, with plates, comes out shortly: it will, we doubt not, like his former work, prove interesting.

Art. XXI.—*Remarks on the Strength of Materials, with an Account of several Experiments on the Transverse Strength of Wood and Iron.* By George Buchanan, Esq. Civil Engineer, Edinburgh.

The subject of the strength of materials forms a very interesting branch of mechanics, and the importance of which cannot be rated too highly, when we consider its numerous applications in the arts, and that, without a correct knowledge of it, no one could erect, with success, any structure, either of ornament or utility any work of strength, civil or military; any engine or machine, or, in short, any of those infinite diversities of form and combination, into which our materials are wrought, for the uses of a civilized community. These works cannot, any of them, be put together at random; they require contrivance, to enable them to withstand the various strains and shocks to which they are continually exposed; and without a knowledge of the principles which regulate the strength of different materials, and even of the same material under different circumstances, it would be impossible to construct them, so as to preserve, in every part, a strength and solidity proportioned to the strain which each has to bear.

The construction of our dwelling-houses, for example, illustrates the application of these principles; and the modern improvements, in the form of their walls, their floors, and their roofs, shews the importance of acting on them with judgment. Ignorant of the true measure of strength, our architects were formerly content to obtain security, by a lavish expenditure of materials, and, consequently, also of workmanship. We are now equally secure; but how greatly have we gained, in economy and convenience, by reducing the thickness of our walls, reducing the breadth, and adding rather to the depth of the joists for flooring; and by improving, in similar respects, the structure of our roofs. Nor does a heavy weight of matter, by any means, contribute to secure us from accidents; on the contrary, it often proves the very source of failure, by the undue strains which it occasions on the weaker parts of the structure; the strength of which often depends, not so much on the mere mass of its materials, as on their skilful disposition, and the due proportion of the different parts. In our furniture, also, and other articles of domestic use, the same sort of improvement has taken place; and here it is of consequence to attend to the principles of strength, not merely from economy and convenience, but as it may contribute to the neatness and tasteful design of the work. Consider, again, our wheel-carriages, and compare the unwieldy machines of former times, with the light and elegant vehicles of the present day. This improvement has also arisen from a judicious application of the principles of strength.

In public works we remark numerous instances to the same effect; and in these cases the matter becomes of still greater importance, from the large scale on which many of these works are conducted. The construction of bridges presents an eminent example; and here again we have a remarkable contrast between ancient and modern practice. Alarmed by the natural instability of the semicircular arch, our ancient builders appear to have sought security in the narrowness of their spans, and in the inordinate thickness of their piers. This plan, however, by obstructing the water-way of the river, led to a new evil, which frequently proved the destruction of the works; the rapid current of the waters, deepening their channel, undermining the piers of the arches, and thus sapping the foundations of the whole structure. The piers, therefore, were gradually reduced in size, and the spans of the arches enlarged, though with slow and cautious steps, as the principles of their equilibrium became better understood. A vast saving of material has been the consequence of these improvements, together with a lightness and boldness of design, which, in the more modern works, conduces greatly to the imposing effect of these noble structures. Much, however, remains still to be done, in following out the same principles; and when we compare the vast mass and solidity of many of these works, with their actual strength, and the strains which they have to sustain, it will appear that we are yet far from having attained that due proportion of strength to stress, which the nature and properties of the arch admit of; that exact accommodation of resistance to its corresponding pressure which marks the combined perfection of science and art. Cases of such magnitude, and involving such important interests, require, no doubt, extreme caution, and the most deliberate inquiry, as to every un-tried deviation from established rules: and, on this account, the progress of improvement must necessarily be slow, but there can be no doubt, that in this, as in other similar cases, principles, just in themselves, must, as heretofore, prevail in the end over our natural timidity, and be accommodated to practice; and nothing can tend to promote such an improvement as a just and accurate knowledge of the laws of equilibrium, and of strength. To this alone can we look for that more perfect state of human acquirements described and anticipated by Dr Young, where principle is authorised to guide the operations of the artificer, instead of "watching with servility the progress of his labours."

Throughout the various other public works, and the vast establishments for which this country is so distinguished, we find every where equal reason to admire the application of the principles of strength, as well as to look for still more striking improvements. But there is one department which merits particular attention, and presents indeed, in itself, a wide and inexhaustible field for the talents of the engineer, namely the construction of machinery, and of the various kinds of moving engines. Professor Robison, in his valuable paper in the *Encyclopædia Britannica*, and which has done more, perhaps, than any other work to promote the study of this subject, observes, there is nothing in which "ignorance of principle is so frequently observed, as in the injudicious proportions of the parts of machines, and other mechanical structures, proportions, and forms of parts, in which the strength and position are nowise regulated by the strains to which they are exposed, and where repeated failures have been the only lessons." Much has been done since the above remark was made, but much still remains for future attempts. The strains which occur in machinery, are often of a very complex nature, and require, therefore, considerable attention and skill, both to appreciate their amount, and to oppose them with true and proper effect. Here, also, every undue weight of material is to be avoided, not merely from motives of economy, but as it clogs the motions of the machine; and there are cases where this consideration becomes doubly important. In those locomotive engines, for example, which have been introduced on railways in the coal-districts round Newcastle, their great weight and cumbrous structure, forms in itself a heavy drag, which causes a very material deduction from the working power, so that, on this account, these machines have not yet been brought into general use. At present, indeed, they can only be viewed as the first rude attempt at the invention of the steam-carriage, which, sooner or later, (and, to all appearance, the period is not distant), must become the general vehicle of communication between different places. They resemble the huge and ponderous machines first introduced in this country as travelling carriages, and must speedily be superseded by an improved mechanism, more akin to the light, yet secure, vehicles now in use. The improvement of these machines involves another branch of the subject, which opens yet a new and extensive field for inquiry; namely, the construction of steam-boilers, in which strength is no doubt indispensable; but in which, also, lightness is in many cases an essential requisite. This object becomes of still greater moment, from the numerous failures which have taken place, and the dreadful consequences to which they have led. But these accidents have, in many cases, arisen, not so much from any deficiency of strength, or thickness of matter in the boiler, as from a want of that due and proper disposition of it, on which, as already remarked, strength often depends, as much as on mere material.

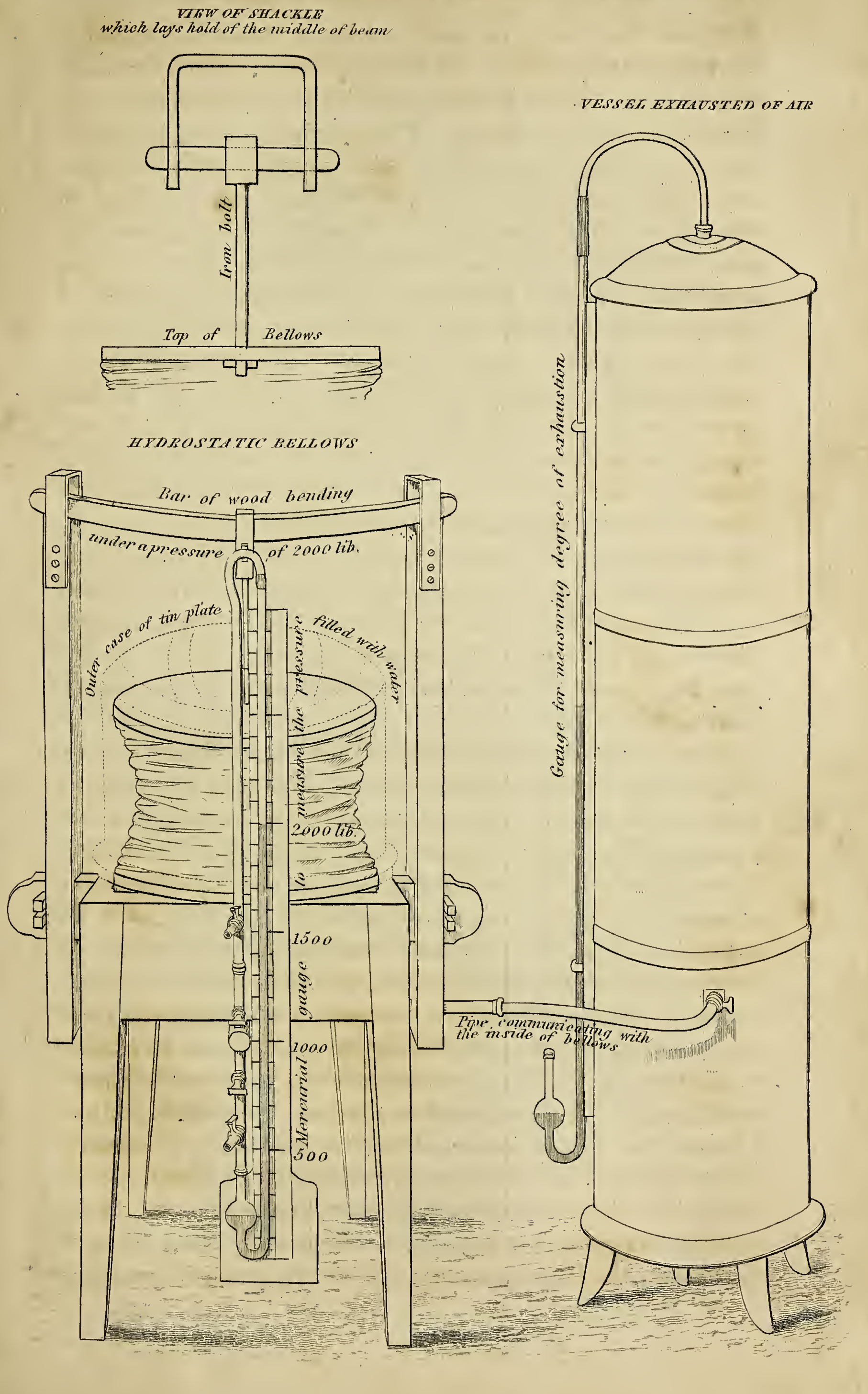
Numerous other examples of the same kind might be adduced of the importance of this subject; and into whatever department, indeed, of practical mechanices we look, we find such new and striking proofs of its utility, that it becomes an object, interesting not merely to the engineer and mechanic, but to the public at large: For, consider, even in point of economy, what an immense saving has arisen, in consequence of the improved knowledge on this subject which distinguishes the present age. Were our houses, our bridges, and the numerous other works of domestic and of public economy, which are required in this great community of industry and wealth,—were these to be all executed on the ancient models, what a waste of capital would not this occasion; and what a saving, on the other hand, may we not look for, by continuing to follow out the same principles, and to improve upon their application? Our buildings may be in many cases as expensive as before, but they are more convenient and luxurious, and this amounts obviously to a real increase of wealth. Political economists speak highly, and with justice, of the improvements occasioned by the use of a paper currency, which, in throwing a mass of specie out of circulation, adds it to the general stock of the country. In the same manner, the improvements which arise from an extended application of the principles of strength, are continually throwing dead stock into active circulation, by opening the resources formerly locked up in the rude and unformed materials of our consumption; and every discovery in this science, every new thought which can enable us to acquire strength, by a better disposition of materials, may be said, by its extensive application, and the prodigious mass of capital which it may relieve from employment, to add millions to the national resources.

Such being the important nature of this subject, it appears rather singular, that we should yet be ignorant as to various particulars regarding it; and, that it should only have been of late, indeed, that any very accurate notions were entertained of it at all. The principles have no doubt been pretty clearly laid down, although even here, there is room for improvement; but there is a want of accurate experiments to bring these principles to bear; and without which they remain as a dead letter in the various works which contain them. Here, as well as in various other instances, we observe, what is not a little remarkable in a country abounding both in science and in practical skill, a want of that proper combination which proves of such service to both. Philosophers have hitherto been in general rather refined in their notions, and often indeed push their theories to such an extreme, as to bring science itself into discredit; while, practical men, without leisure to inform themselves, are left each to the uncertain light of his own narrow experience. Fortunately, however, this evil is on the decline, and the advantages are becoming daily more apparent of conjoining practice with sound and accurate theory.

The illustrious Galileo was the first philosopher who studied with attention the laws of the strength of materials. The vast works which he observed going on in the dock-yards and arsenal of Venice, appear to have roused his acute and inquisitive genius, and, reflecting deeply on the subject, he succeeded in explaining the effects arising from direct and cross strains, and by a few simple considerations, arrived at those remarkable laws of strength, which not only throw light on the economy of nature; but still afford, with the aid of experiment, the safest rules for calculating the strength of materials in the various cases which occur in practice. While the direct strength of cohesion is proportional to the area of the section of fracture, Galileo shewed, that the transverse strength of any beam, must depend also on its length and depth, being impaired by the one, and strengthened by the other; and this single fact includes the whole theory of the transverse strain. His views regarding the internal mechanism of the bar, and the actions of the particles within the section of fracture are no doubt inaccurate, and succeeding philosophers have taken great pains to improve his theory in this respect. But this appears of little moment so long as the main fact remains uncontradicted, and is rather indeed demonstrated by all our experience. Admit this, and a few accurate experiments are only wanting to adapt it to practice,—experiments on beams of different materials, of different forms of section, and under any other circumstances which may affect the results. The internal process of fracture, may no doubt be an object well worthy of philosophic inquiry, and the results which have been obtained on this point, by Mr Barlow of Woolwich, in his valuable essay on the strength of timber, are highly interesting and instructive. His demonstrations are clear and conclusive, and in the true spirit of geometry; while his experiments are simple, and well adapted both to illustrate and confirm his views. Still, however, these speculations appear rather refined for practice. The internal structure of bodies is so various, that no general rule can be laid down. It is also so little known, and leads to such intricate considerations as tend greatly to embarrass the subject. It appears simpler, therefore, to throw this element entirely out of the calculation, and to content ourselves with the original law of Galileo, which has been since established by every succeeding observer. This brings the subject within a very small compass; and comprehends in one rule of admirable simplicity, all the diversified cases which can occur in practice. What is wanting to give effect to this law, is a series of experiments made on so large a scale, and with such full and accurate means of observation, as would leave no doubt of the results, to which we might then safely appeal as the standards of practice. It were much to be wished, therefore, that such experiments could be undertaken ; and the object is not unworthy of public support. The experiments, however, which have been already made are, so far as they go, highly valuable ; and ample information in regard to these, will be found in the work of Mr Barlow, already referred to, which contains, besides his own experiments, and those of several other observers, an abstract of those Buffon made on oak-timber, by order of the French Government, and which form by far the most extensive series, and the most satisfactory, yet performed ; an account of an interesting set of experiments, made by Mr Telford on the cohesion of iron with a hydrostatic press and of another important series made by Captain Brown, R. N., with a power of compound levers, similar to that of the weighing machine. Besides these, accurate experiments have been made by Mr George Rennie, on the strength of different materials, the results of which are contained in the Philosophical Transactions for the year 1818. Some observations have also been made b Mr Tredgold, on the deflection and transverse strength of cast-iron, the account of which was published in his useful work on that subject.

In another Number of the Journal, I shall endeavour, from these different sources of information, to lay down a few simple rules for calculation, and to illustrate their application by a few examples, referring, in the mean time, to Profes sor Leslie's Elements of Natural Philosophy. I may now also state the results of some experiments made at the School of Arts here, with an apparatus which I had constructed for that useful institution. It consists of a cylindrical hydrostatic bellows, seventeen inches in diameter, which exerts various pressures, according to the force of water or air within it, and which was found, could be carried to the extent of 2000lb., the pressure being measured by a mercurial gauge. This instrument may be used in various ways ; but I found it most convenient to obtain the pressure, by exhausting the air from within the bellows by means of an air-pump, and allowing the external atmosphere to act on the top and sides. Two upright bars being then erected, one on each side of the frame of the bellows, the bar whose strength was to be measured, was sup-

APPARATUS FOR EXPERIMENTS ON THE STRENGTH OF MATERIALS.



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ported between these, its extremities resting on the top of them; and being attached in the middle to the top of the bellows, by means of a bolt and shackle, was pulled down as the bellows descended, and was thus bent, or ultimately broken, by the pressure. As the air becomes exhausted in the bellows, the external air rushes in copiously through the pores of the leather, and would destroy the effect; to prevent which, it is necessary to inclose the instrument in a tin-case, about an inch wider all round, and this being filled with water, effectually excludes the air. (See Plate VIII.)

In order to exhaust the air with greater regularity, a large tin vessel was employed, which had already been constructed for the institution, to perform experiments in rarified air. This vessel being fully exhausted of its air, forms a sort of store of vacuity, by communicating with which, smaller vessels may be exhausted in a moment, and by opening, therefore, by means of a stop-cock, a communication between the vessel and the bellows, any desired pressure could be readily attained. The hydrostatic bellows is simple, and not much affected by friction, and although the sides pull downwards as well as the top, and with an effect somewhat varied according to the curve of their tension, this irregularity was corrected by a previous trial with a lever and heavy weight, by means of which the scale of weights on the gauge was formed, and I found, that, in this manner, the strain on the bar could be estimated to within 20 or 30 pounds. This may be sufficient for many practical purposes; and as it presented the readiest means in my power of trying the effects of the transverse strain, and shewing them to the students of the School of Arts, I took the opportunity of making with it the following experiments with care. A still more accurate apparatus, however, might be formed on a similar plan, by using a sort of gasometer and tank, in which friction would almost entirely disappear, and the pressure could be measured with great exactness by the rise of the water, as the gasometer became exhausted. Suppose, for example, we had a gasometer 4 feet diameter, and 6 feet deep, this might exert a pressure of nearly two tons, which, by a single lever, could easily be augmented to 20 or 30 tons. I mean shortly to try this experiment, and am persuaded it would form an extremely convenient and accurate measurer of such intense strains.

Experiments.—*On Bars of Memel fir, supported at each end, and loaded in the middle. Distance between the supports 5 feet.*

1. A bar 2 inches square, with 170 lb. bent half an inch, with 357 lb. bent 1 inch, and the pressure being removed, the bar rose again in the middle, and returned to a straight line, shewing that the strain had not been sufficient to give it any new set, and that it may therefore be applied to it safely for a short time; with 442 lb. the bar bent $1\frac{1}{2}$ inch, but in being relieved of this pressure, it only returned to $\frac{1}{8}$th of an inch of a straight line, shewing that it had now become overloaded, and was beginning to give way,—with 510 lb. it bent $1\frac{7}{10}$th inch, and with 595 lb. it broke.

2. Another bar, 2 inches square, with 170 lb. bent $\frac{1}{2}$ inch; with 344, bent 1 inch, and load being removed, rose to a straight line; with 450 lb. bent $1\frac{1}{2}$ inch, and with pressure removed, returned to $\frac{1}{8}$th inch of a straight line; with 510 broke.

3. A bar 3 inches broad, and 2 inches deep, laid on its side, with 255 lb. bent $\frac{1}{2}$ inch; with 527 lb. bent 1 inch; with 680 lb. began to crack or cripple on the under side; with 850 lb. broke.

4. Another bar, 3 inches by 2, but now laid on its edge, with 357 lb. bent $\frac{1}{2}$ inch; with 722 lb. bent 1 inch, and on pressure being removed, returned to a straight line; with 1045 lb. bent $1\frac{1}{2}$ inch, and pressure let off, rose to $\frac{1}{13}$th inch of a straight line; with 1190 lb. bent 2 inches, and broke.

5. Bar 4 inches by 2, with 340 lb. bent $\frac{1}{2}$ inch, with 654 lb. bent 1 inch; with 1037 lb. bent $1\frac{1}{2}$ inch, and broke.

6. Bar 2 inches by 3, with 1020 lb. broke.

On Bars of Cast Iron. Distance between supports 32 inches.

1. A bar 1 inch square, with 357 lb. bent $\frac{1}{4}$ inch; with 765 bent $\frac{1}{2}$ inch, and pressure being let off, returned to $\frac{1}{16}$th of an inch of a straight line; with 770 lb. broke.

8. A bar 2 inches by 1, laid on its side, with 714 lb. bent $\frac{1}{4}$th inch; with 1062 lb., bent 0.37 inches, and returned to $\frac{1}{13}$th inch; with 1530 lb. broke.

These experiments prove several important particulars relative to the strength of materials. They confirm the law of Galileo, that the transverse strength depends as well on the length and depth of the bar, as on its section of fracture being diminished in the simple proportion of the length, and increased in the simple proportion of the depth. They also shew, that the deflection of beams is exactly proportional to the pressure which they sustain ; at least until they become overloaded, when the deflection becomes irregular, in consequence of the beam beginning to give way. Lastly, they shew, that, in the case of Memel fir, it is always unsafe to load the beam with any more than one-half of what will break it.

The following is another series of experiments made in the succeeding year.

(To be continued.)

Art. XXII.—*On the Mines of Mexico.* Communicated by a Gentleman intimately connected with Mexico.

THE public attention has of late been directed in an unusual degree to the former possessions of Spain in the western world. It is now fully three centuries since both Mexico and Peru became known by report to Europeans, and it is natural for the public to inquire the causes of so long a period having elapsed, without a more direct acquaintance with these deposits of mineral treasure. The Government of Old Spain, bigotted equally in commerce and religion, forbade all intercourse between her colonies and the rest of Europe; and it happened, unfortunately, that England and Holland, the States best fitted to turn the wealth of these colonies to account, were long debarred from a connection with them, by a succession of untoward circumstances. If we go back to the seventeenth century, the era of the naval greatness of the Dutch, we find that their hostilities towards the subjects of the Spanish crown were confined in general to the East Indies. The naval power of England became conspicuous soon after, but, during the reign of the dreaded Louis XIV., it was directed wholly against France; and it was not until the war that began in 1740, that our countrymen made an attempt to wrest from Spain the fairest portion of her transatlantic possessions. Our enterprizes, however, were ill-conducted, and many valuable lives were lost at Carthagena, and other unhealthy districts on the coast. Still our arms could hardly have failed of success, had not the progress of the French in Germany and the Netherlands rendered it indispensable to suspend distant expeditions, and employ our resources at home.

In the war that began in 1756, and was so brilliantly conducted by Lord Chatham, Spain continued neutral until 1761, —after which there remained time for only one important expedition against her settlements, we mean that to the Havannah. Twelve years of peace ensued; and the war which next burst forth on the American Continent (that of 1775) was of a nature to check the ardour of this country in regard to colonial possessions. Lastly, In the grand military contest excited by the French Revolution, Spain was for some years in alliance with this country; and when, after 1796, her change of policy might have justified an attack on Mexico, the mortality among our troops in St Domingo, and, still more, the necessity of keeping our resources concentrated against France, prevented Ministers from giving effect to the tempting projects submitted to them by General Miranda, and other Spanish Americans. At last, in the year 1808, circumstances seemed to have become favourable for such an attempt, when the insurrection of the inhabitants of Old Spain against the usurpation of Bonaparte, induced Government to consider every scheme for the employment of our forces as secondary to that of resistance to the French in the Peninsula.

The colonists, however, had different views, and could not always be expected to remain in subservience to the mother-country. In 1810, they took up arms, and commenced those insurrections, which, varied in their success, and interrupted by frequent periods of pacification, have prevailed more or less during the last fourteen years. These were attended with incalculable injury to the mining districts; buildings being overturned, machinery destroyed, and the income of the proprietors reduced to a degree which, in a country thinly peopled, and bare of capital, could not for many years be recovered. Hence an accumulation of water in the mines, and an inability in the owners to defray the costs of the machinery and labour required to extract it. The consequence was, that Mexico, which formerly supplied four or five millions sterling of silver a-year, has not, since 1811, averaged more than half that quantity. The aid of foreigners was thus strongly called for; but there existed throughout all Spanish America a regulation of serious import to English capitalists, we mean the prohibition of any foreigner, except a Spaniard, holding mines in property, either separately or in partnership. It was only in the last and present year that the Mexican Congress rendered it lawful for foreigners to hold property in mines. This may be regarded as the commencement of a new era; for no two countries can render each other more substantial service than England and Mexico, the one abounding in mineral treasure, the other possessing the means of extracting it from the bowels of the earth, and applying capital, science and machinery, to the requisite processes in every stage.

This view of the relative situation of the two countries has already been taken by the persons most competent to form an opinion. Mr John Taylor of London is well known as an engineer particularly conversant with mining business, and, from the remarks prefixed to his lately published "Selections from Humboldt," we find that he has long been struck "with the richness of the Mexican mines, with the breadth of their lodes or metallic veins, the great productiveness of certain portions of these veins, and, in particular, with the amount of profit obtained from them under management of the rudest and most expensive kind." A beginning in the application of English machinery in Spanish America was made several years ago, steam-engines having been sent out to the mines of Potosi and Peru, and found to answer extremely well, until their operation was suspended by the political disorders of the country. At present there are in London no less than three associations formed, "for aiding in working the mines of Mexico." One of these originated in a proposal of Don Lucas Alaman, a well-known public character in Mexico, who having, when in Europe, resided chiefly at Paris, was desirous that the first proposal for a mining company should be issued in the French capital. But our southern neighbours, whatever may be their prowess in the field, or their fame in theory, discover very little enterprize in mercantile speculation. The attempt having failed at Paris, was renewed under better auspices in London, and a capital of L. 240,000 was speedily subscribed, the company taking the name of "The United Mexican Association."

Posterior in point of time, but nearly equal in amount of capital, is the Company called Real del Monte, from the district containing their mines, which is situated about sixty miles north of the city of Mexico. This Company is composed chiefly of proprietors of English mines, and is less open to the public at large, than the third and greatest of the three, the Anglo-Mexican, whose capital is a Million Sterling. Most of the mines taken up by this Company are in Guanaxuato, a district of great metallic wealth, but of which the name was hardly known in Europe, until the appearance, fourteen years ago, of Humboldt's well known work. Contracts of partnership, in several of the mines in that district, were made in Mexico by individuals, and transferred in London to this Association.

On hearing of several associations formed for a common object, it is natural to suspect the existence of rivalship or jealousy among them. But all who have had experience in mining business are aware, that any feeling of this nature would be misplaced: the market for the produce of mines is unbounded; and if, in a district so narrow as that of the Cornish mines, jealousy has totally ceased, much more ought it to disappear in Mexico, where the field is so wide, and the number of mines, great and small, is computed at no less than 3000. Besides, the uncertainty, inseparable from mining, and the unforeseen difficulties occurring in a new country, are powerful reasons for a cordial cooperation with each other; and we learn with satisfaction, that they are considered in that light by the different associations.

Objections are frequently made to the probability of their success, from the unsettled state of Mexico, in a political sense. While we readily allow, that the Mexicans may be termed *très nouveaux dans tout ce qui regarde l'administration*, and that the sway of a Washington, during the ensuing twenty years, would be to them the greatest of boons; we must, on the other hand, maintain, that political dissensions are not likely to oppose any serious obstacle to the success of speculations which, tending directly to benefit both the public and individuals, have a claim to the favour of all parties. A public depredator could gain little by the seizure of machinery, or of ore; and if specie, in a refined state, present a more tempting prize, it is apparent, first, that the quantity kept on hand needs not, at any time, be large; and, next, that so long as a government can at all stand its ground, it will extend protection to property in bullion as readily as to property in land, houses or merchandise. "Our ores," it is said in an official report to the Mexican Congress, in November 1823, "require for their manufacture a great stock of machinery, and a large quantity of what are called "mining stores." The owner of mines distributes capital, employs labourers and artisans; in short, the prosperity of many classes in the community depends on the impulse given to them, by activity at the mines: hence the expediency of the late reduction of duty on our bullion, and of encouraging the exportation of machinery from Europe." To this we may add, that the letters lately received from our countrymen, in the different mining districts in Mexico, express great satisfaction at the friendly disposition of the inhabitants.

On the protection of the Government, our countrymen may, we believe, confidently depend: their real difficulties in mining operations lie, in our opinion, in expence, in particular, in the length of land-carriage and the cost of fuel. How far can means be devised for lessening these heavy charges? The country has few navigable rivers, and the formation of canals is probably remote; but the roads may soon be improved by the application of British capital. Next, as to fuel; Mexico, different from the uncultivated provinces of the United States, being in general bare of timber, how, it may be asked, can steam be called in to aid the labours of the miner? Is the geological structure of the mining districts such as to afford a hope of finding peat, coal, or any mineral combustible? Failing these, is the climate such as to favour the growth of particular kinds of wood, which, when cultivated with an almost unlimited command of territorial surface, might supply the requisite fuel? On these points information is, we understand, at present, very anxiously expected. Of wood, the stock is, in some parts, abundant, in others scanty; but, supposing the application of steam-machinery to be at present only partial, a great point will be gained by merely bringing British capital in aid of the mine-owners, whom the late war, and the disorders that followed, had so completely impoverished.

The next and almost equally important question, will be the mode of dressing and refining the ores. The process of separating the ore from the dross in its earliest stage, is termed *dressing;* and, like other branches connected with mining, has, in this country, experienced great improvement in the course of the present age. This has been effected by the application of improved machinery; such as, stamping mills and crushing rollers. After this first process, the ore is farther refined by smelting, as practised in England, or by amalgamating, as is frequent in Germany; the former taking place by the aid of fuel, the latter by the application of quicksilver.

The Mexicans have, in general, refined their ore by amalgamation; but long as has been their experience in this branch, they are greatly behind the refiners of Saxony, and incur both an unnecessary waste of quicksilver, and a miserable sacrifice of time. Are our countrymen likely to continue the practice of amalgamation, introducing the improved method of the Germans; or will they substitute for it the process of smelting, as practised in Sheffield, and other parts of England? The latter seems more probable, since several of the mining districts in Mexico promise an abundant supply of lead-ore, an ingredient of the first importance in smelting.

We propose, at an early opportunity, to resume this subject, continuing our observations on the Mines of Mexico, and laying before our readers some remarks on those of Columbia, which have been so lately brought before the public.

In regard to the probable success of these undertakings, we decline drawing any inference from the favour they have lately experienced on the Stock Exchange; and shall merely remark, that if, under a system, which, whether we look to the raising of the ore to the surface, or the subsequent process of dressing and refining, was extremely awkward and expensive, these mines proved profitable to the owners, much more are they likely to be so, when wrought with all the aid of capital and science.

Art. XXIII.—*On the Illuminating Power of Coal-Gas.* By Adam Anderson, Esq. A. M. F. R. S. E Rector of the Academy, Perth.

THERE is no subject, perhaps, capable of being investigated in a rigid and scientific manner, with respect to which there seems to be so great a diversity of opinion, as that relating to the comparative illuminating power of oil and coal gas. Though the gaseous products concerning which we have so many discordant statements, are publicly and daily exhibited in almost every quarter of the empire, and though the properties of both have attracted from men of science more than a due share of attention, it is not a little singular, that, amidst the multiplicity of facts which have been laid before the public, none has yet been adduced of a nature sufficiently decisive to fix, beyond dispute, the relative values of the rival gases. In such circumstances, I cannot imagine that any thing which I may communicate on the subject will set the matter at rest; but as I have some practical knowledge, not only of the manipulations by which the gases are produced and purified, but also of their chemical constitution and mechanical properties, it would be an affectation of modesty were I not to claim some degree of authority for the facts which I am about to state.

The gas which was the subject of the experiments I have to describe, was manufactured, in the ordinary way, at the Perth Coal-Gas Work,—an establishment that was planned and executed under my directions, and respecting which, it may be proper to mention, that the whole of the arrangements for the production of the gas, (the separation of the tar, and the other purifying processes), are essentially different from those of any other gas-work in the kingdom. In this brief notice, it is not my design to enter upon details, but merely to request your permission to lay before the public, through the medium of the *Edinburgh Philosophical Journal*, a few general results, that may contribute something, at least, to the stock of information which is already in their possession. For this purpose, it will be sufficient to state, that the whole number of retorts at present in constant operation at the Perth Gas Work is only three; while the number of lamps, of various kinds, to which these retorts are found to afford an abundant supply of gas, is 650, including, however, nearly 100 which are only lighted on Sundays in churches. The lamps are of the following descriptions:

1 Jet, - -	52
2 do. - -	94
3 do. - -	80
5 and 7 Cockspurs, -	7
Batwings, - -	22
Argands, 10 holes, -	221
Do. 14 do. -	125
Do. 18 do. -	24
Do. 22 do. -	26
	651

From this statement it appears, that a single retort at the Perth Gas Manufactory, is capable of affording an ample supply of gas to about 200 lamps, the greater number of which are Argands, and many of them batwings, burning upwards of twelve hours daily. This result, so very different from the number of burners supplied by a single retort in other places *, I ascribe to two causes: In the first place, to a more thorough decomposition of the coal, arising from the peculiar manner in which the retorts are set; and, in the second place, to a more effectual separation of the tar and other noxious products than has hitherto been effected by the modes of purification usually employed.

With regard to the gas itself, I shall avail myself of your indulgence to give the result of a considerable number of experiments, which I performed with a great deal of care, in order to determine its illuminating power, in reference to that of a Kensington candle of the description termed "short sixes." The 1st column shews the kind of burner; the 2d the number of cubic inches of gas consumed per hour; the 3d the number of candles to which the light was equal, as determined by the method of shadows; and the 4th the number of inches per hour which corresponded to the light of one candle.

* One retort supplies gas to about 100 burners in Edinburgh; to 45 in London; to 31 in Berwick, &c.

Burners.	No. Cubic inches consumed per Hour.	No. of Candles giving an equal Light.	No. Cubic Inches giving a Light equal to Candle.
3 Jet, -	2074	6	346
Argand 5 holes,	2592	8	324
Do. 10 do.	3798	12	316½
Do. 14 do.	5940	19¼	308
Do. 18 do.	6804	21	324

The mean of these results is, that 323½ cubic inches of the Perth coal-gas afford a light equal to that of a candle for an hour. Now, according to Mr Milne's enquiries at different oil gas manufactories, taken in connection with his own experiments, it appears, that a burner consuming 1 cubic foot of oil gas per hour, yields a light equal to that of 8 candles; or, which is the same thing, 216 cubic inches of oil-gas afford, during the same time, a light equal to one candle. From these data, it follows, that the volume of oil-gas, is to that of the Perth coal gas, giving an equal degree of light, as 216 to 323½, or in the ratio of 1 to 1½.

This conclusion, though agreeing in substance with the results obtained by Mr Leslie and Dr Fyfe, must not be extended, however, to every species of coal-gas; as it cannot be doubted that the quality of carburetted hydrogen, obtained from pit-coal, must be greatly affected, not only by the nature of the coal from which it is procured, but, in no small degree, by the purifying processes to which it is subjected. It is to these circumstances, that we must ascribe the very opposite statements, respecting the comparative illuminating powers of oil and coal gas, which are now pressed upon the public attention, with an anxiety which betrays more of the monopolizing jealousy of commerce, than of the spirit of a liberal and enlightened philosophy.

To Professor JAMESON.

PERTH,
Dec. 15. 1824.

Dec. 15. 1824.

Art. XXIV.—*List of Rare Plants which have Flowered in the Royal Botanic Garden, Edinburgh, during the last three months.* Communicated by Professor Graham.

Acacia Houstoni.
Anthocercis littorea.
Bæobotrys indica.
Bromelia pallida.
Cactus truncatus.
Canarina campanula.
Canna edulis.
Carissa spinarum.
Ceropegia dichotoma.
Cuscuta americana.
Cuscuta verrucosa.

I can scarcely doubt that this is the C. verrucosa of Sweet's British Flower Garden, though, in some respects, the description and figure in that work differ. It is said that the corolla in that specimen was urceolate, and the teeth blunt, (though this last scarcely accords with the figure). The figure represents the teeth of the corolla as scarcely reflected, and the calyx of deep green. In every one of the numerous plants in the Edinburgh Botanic Garden, the corolla is clavato-funnel-shaped, the teeth pointed, and completely turned back, the calyx almost colourless. The flowers are much larger than those represented in the British Flower Garden. In all other respects, however, the plants seem alike; and these differences may perhaps have originated in situation, ours having been raised in the stove or green-house, that figured by Sweet on ivy in the open air. I shall be glad if ours prove as hardy as his is represented to be. It has formed abundance of seed in the stove, but none has yet ripened. The species certainly approaches very nearly the C. reflexa of Roxburgh, figured in his Plants of Coromandel, t. 104. In it, however, the flowers are small, and no warts are noticed in the description, or represented in the plate. The temperature which these species affect is probably similar. The C. reflexa is produced in the cold season, and this flowers freely in our green-house. The seeds were given to me by Dr Short last year, and were obtained from Madras. A figure will speedily be given in Hooker's Exotic Flora.

Cymbidium sinense.
Cypripedium venustum.
Hedychium coronarium.
Hedychium gardnerianum.
Hedychium thyrsiformis.
Hedysarum nutans.

Brought under this name from the Calcutta Garden in 1823 by Dr Macwhirter.

Passiflora alata α.
Passiflora alata β, acuminata.
Passiflora alata γ, insignis.

These varieties are perfectly distinct, and of different degrees of beauty. α, The plant commonly cultivated, is by much the least ornamental, the colours of the other two being greatly more brilliant: β differs from α and γ, in the leaf being pointed. It was sent to this garden some years ago, from the neighbourhood of Southampton. γ, Has a leaf very similar to α, but the flowers are even more rich in colour than β, and should certainly supersede both for general cultivation. It was brought to this Garden from the Brazils in 1821, by Captain Stewart of Binny, Hon. E. I. C. service; and, though propagated freely from hence, is not generally known.

Passiflora quadrangularis.
Salvia splendens.

A remarkably fine specimen of this magnificent plant, nearly ten feet high, and spreading in proportion, has been kept in a house, without any heat, during the season, and stood without injury in full flower, when the thermometer fell to 25°, but suffered greatly during one night in the early part of December, when the temperature sunk to 16°.

Scævola Taccada.
Tulbagia alliacea.

Art. XXV.—*Celestial Phenomena from January* 1. *to April* 1. 1825, *calculated for the Meridian of Edinburgh, Mean Time.* By Mr George Innes, Aberdeen.

The times are inserted according to the Civil reckoning, the day beginning at midnight.—The Conjunctions of the Moon with the Stars are given in *Right Ascension.*

January.

D.	H	′	″	
1.	19	56	46	Im. IV. sat. ♃
1.	20	4	16	Im. I. sat. ♃
1.	21	26	0	☌ ☽ ♄
2.	0	26	39	Em. IV. sat. ♃
4.	0	51	30	☌ ☽ η ♊
4.	4	0	30	☌ ☽ μ ♊
4.	20	15	15	☌ ☽ ζ ♊
4.	23	31	50	○ Full Moon.
5.	0	23	11	Im. III. sat. ♃
5.	3	55	20	Em. III. sat. ♃
6.	12	53	9	☌ ☉ ♅
6.	18	59	30	☌ ☽ ♃
7.	0	34	32	Im. II. sat. ♃
7.	3	29	24	Im. I. sat. ♃
8.	21	57	48	Im. I. sat. ♃
11.	15	48	38	☾ Last Quarter.
12.	4	21	48	Im. III. sat. ♃
14.	3	11	0	Im. II. sat. ♃
14.	5	23	0	Im. I. sat. ♃
15.	23	14	46	☌ ☽ δ Oph.
15.	23	51	27	Im. I. sat. ♃
16.	20	9	0	Inf. ☌ ☉ ☿
17.	15	20	34	☌ ☽ 1 ν ♐
17.	18	19	51	Im. I. sat. ♃
17.	20	6	12	☌ ☽ ο ♐
18.	3	47	10	☌ ☽ ♅
18.	18	17	43	☌ ☽ ☿
18.	18	28	57	Em. IV. sat. ♃
19.	3	41	49	● New Moon.
20.	6	24	36	☉ enters ♒
21.	5	47	40	Em. II. sat. ♃
21.	21	24	8	☌ ☽ ♂
22.	22	40	10	☌ ☽ ♀
23.	1	45	11	Im. I. sat. ♃
24.	19	6	37	Im. II. sat. ♃
24.	20	13	38	Im. I. sat. ♃
27.	8	24	40	☽ First Quarter.
28.	19	12	0	☍ ☉ ♃
30.	5	54	10	Em. I. sat. ♃
31.	11	35	2	☌ ☽ η ♊
31.	14	46	2	☌ ☽ μ ♊

February.

D	H	′	″	
1.	0	22	38	Em. I. sat. ♃
1.	0	36	25	Em. II. sat. ♃
1.	7	6	45	☌ ☽ ζ ♊
2.	18	51	9	Em. I. sat. ♃
2.	19	49	19	Em. III. sat. ♃
3.	0	45	25	☌ ☽ ♃
3.	11	16	32	○ Full Moon.
8.	2	16	41	Em. I. sat. ♃
8.	3	13	33	Em. II. sat. ♃
9.	20	15	9	Im. III. sat. ♃
9.	20	45	12	Em. I. sat. ♃
9.	23	47	59	Em. III. sat. ♃
10.	1	57	40	☾ Last Quarter.
10.				☿ greatest elong.
12.	4	43	15	☌ ☽ δ Oph.
13.	21	13	0	☌ ☽ 1 ν ♐
14.	2	2	10	☌ ☽ ο ♐
14.	12	43	0	☌ ☽ ♅
15.	4	10	52	Em. I. sat. ♃
15.	14	56	34	☌ ☽ ☿
16.	22	39	24	Em. I. sat. ♃
17.	0	14	34	Im. III. sat. ♃
17.	3	47	31	Em. III. sat. ♃
17.	22	6	43	● New Moon.
18.	15	2	20	♀ near ε ♓
18.	19	8	50	Em. II. sat. ♃
18.	21	8	24	☉ enters ♓
20.	1	23	0	☌ ☽ ♐
21.	1	57	36	Im. IV. sat. ♃
22.	2	42	30	☌ ☽ ♀
24.	0	33	43	Em. I. sat. ♃
24.	4	13	36	Im. III. sat. ♃
25.	14	18	20	☌ ☽ A ♉
25.	14	42	40	☌ ☽ ♄
25.	19	2	20	Em. I. sat. ♃
25.	21	46	8	Em. II. sat. ♃
26.	1	42	31	☽ First Quarter.
27.	21	17	35	☌ ☿ η ♊
28.	0	35	0	☌ ☽ μ ♊
28.	17	26	0	☌ ☽ ζ ♊

March.

D	H	′	″	
2.	7	0	20	☌ ☽ ♃
3.	2	28	9	Em. I. sat. ♃
4.	20	56	47	Em. I. sat. ♃
4.	21	20	46	○ Full Moon.
5.	0	23	29	Em. II. sat. ♃
8.				♀ greatest elong.
9.	19	58	55	Im. IV. sat. ♃
10.	0	38	26	Em. IV. sat. ♃
11.	14	23	22	☾ Last Quarter.
11.	22	51	21	Em. I. sat. ♃
12.	3	0	52	Em. II. sat. ♃
13.	2	58	3	☌ ☽ 1 υ ♐
13.	7	46	23	☌ ☽ ο ♐
13.	20	40	16	☌ ☽ ♅
17.	19	44	6	Em. III. sat. ♃
18.	22	41	40	☌ ☽ ☿
19.	0	46	1	Em. I. sat. ♃
19.	16	17	20	● New Moon.
20.	19	14	41	Em. I. sat. ♃
20.	21	13	31	☉ enters ♈
21.	4	25	53	☌ ☽ ♂
22.	18	57	23	Em. II. sat. ♃
23.	19	5	30	☌ ☽ ♀
24.	20	10	1	Im. III. sat. ♃
24.	20	24	24	☌ ☽ A ♉
24.	23	43	17	Em. III. sat. ♃
25.	0	31	7	☌ ☽ ♄
26.	2	40	46	Em. I. sat. ♃
27.	4	43	12	☌ ☽ ν ♊
27.	6	56	0	Sup. ☌ ☉ ☿
27.	8	7	0	☌ ☽ μ ♊
27.	15	12	35	☽ First Quarter.
27.	21	9	27	Em. I. sat. ♃
28.	1	32	3	☌ ☽ ζ ♊
29.	14	11	17	☌ ☽ ♃
29.	21	34	41	Em. II. sat. ♃

Times of the Planets passing the Meridian.

January.

D.	Mercury. H. ′	Venus. H. ′	Mars. H. ′	Jupiter. H. ′	Saturn. H. ′	Georgian. H. ′
1	13 27	14 44	14 30	2 15	21 15	12 24
5	13 22	14 47	14 27	1 56	20 59	12 8
10	13 0	14 50	14 23	1 37	20 38	11 52
15	12 20	14 53	14 18	1 15	20 18	11 33
20	11 35	14 56	14 13	0 53	19 57	11 14
25	11 0	14 58	14 9	0 31	19 38	10 55

February.

D.	Mercury. H. ′	Venus. H. ′	Mars. H. ′	Jupiter. H. ′	Saturn. H. ′	Georgian. H. ′
1	10 34	14 59	14 2	23 55	19 10	10 30
5	10 29	15 0	13 57	23 37	18 54	10 15
10	10 29	15 0	13 52	23 15	18 35	9 57
15	10 35	15 0	13 47	22 52	18 15	9 37
20	10 41	15 1	13 41	22 27	17 56	9 22
25	10 50	15 0	13 35	22 9	17 37	9 6

March.

D.	Mercury. H. ′	Venus. H. ′	Mars. H. ′	Jupiter. H. ′	Saturn. H. ′	Georgian. H. ′
1	10 59	14 59	13 32	21 51	17 23	8 47
5	11 7	14 59	13 27	21 35	17 8	8 30
10	11 20	15 0	13 21	21 14	16 49	8 15
15	11 32	14 58	13 15	20 53	16 31	7 53
20	11 47	14 57	13 9	20 33	16 13	7 34
25	12 2	14 53	13 3	20 12	15 55	7 14

Art. XXVI.—*Proceedings of the Royal Society of Edinburgh.* (Continued from Vol. XI. p. 209.)

Nov. 15. 1824.—A paper was read *On the Determination of the Idea of Species in Mineralogy*, according to the principles of Professor Mohs, by W. Haidinger, Esq.

Nov. 22.—At a General Meeting of the Society, the following gentlemen were elected Office-bearers and Counsellors for the ensuing year:

Sir Walter Scott, Bart. President.

Vice-Presidents.

Right Hon. Lord Chief-Baron, Lord Glenlee,
Dr T. C. Hope, Professor Russell.

Dr Brewster, General Secretary.
Thomas Allan, Esq. Treasurer.
James Skene, Esq. Curator of Museum.

PHYSICAL CLASS.

Alexander Irving, Esq. President. John Robison, Esq. Secretary.

Counsellors from the Physical Class.

Rev. Dr Macknight. James Jardine, Esq.
Robert Stevenson, Esq. Sir William Forbes, Bart.
Sir William Arbuthnot, Bart. Dr Home.

LITERARY CLASS.

Henry Mackenzie, Esq. President. P. F. Tytler, Esq. Secretary.

Counsellors from the Literary Class.

Lord Meadowbank. Rev. Dr Lee.
Professor Wilson. Lord Advocate.
Sir William Hamilton, Bart. Henry Jardine, Esq.

Dec. 6.—There was read a notice respecting two ancient Graves or Tombs discovered at North Charlton, parish of Ellingham, Northumberland, in January 1823, by John Cay, Esq.

Specimens of ancient warlike instruments were exhibited.

At the same meeting, Dr Brewster read a paper *On the Vision of Impressions on the Retina*, in reference to certain supposed discoveries respecting vision announced by Mr C. Bell.

Art. XXVII.—*Proceedings of the Wernerian Natural History Society.* (Continued from Vol. XI. p. 403.)

1824, *Nov.* 13.—AT this meeting the Secretary read, 1. A notice of the incarceration of a live toad (*Rana verrucosa*), in the wall of Fort-William Barracks, Calcutta, for the long period of fifty-four years; communicated by Major-General Hardwick. 2. Account of the monocotyledonous and dicotyledonous plants found between the 4th and 11th degrees of north latitude, on the western coast of Africa; communicated by Mr George Don. 3. Notice of a viviparous variety of *Juncus lampocarpus*, with specimens; by Mr F. C. Parry.

Dec. 4. The Secretary read two communications relative to the discovery of the bones of a grampus or small whale, in the carse-clay lying over black peat-moss, on the estate of Blair-Drummond; the one communication from Henry Home Drummond, Esq. M. P., and the other from Mr A. Blackadder, surveyor.

There were likewise laid before the meeting Meteorological Observations made at Guayaquil, from January to June 1824, by William Jameson, Esq. surgeon; and Barometrical Observations made between the Pacific Ocean and Mendoza in the year 1821, by Dr Gillies.

Dr Barclay presented a letter from Dr Mease of Philadelphia, accompanying a specimen of the *Syren lacertina*, for the Society's collection.

At this meeting the following gentlemen were elected office-bearers for the year 1825:

Robert Jameson, Esq. President.

Vice-Presidents:

Dr R. K. Greville.	Robert Bald, Esq.
Rev. James Grierson, M. D.	Sir William Jardine, Bart.
Secretary, P. Neill, Esq.	Librarian, James Wilson, Esq.
Treasurer, A. G. Ellis, Esq.	Painter, P. Syme, Esq.

Council:

Professor R. Graham.	Dr Robert Knox.
Alexander Adie, Esq.	G. A. W. Arnott, Esq.
William Drysdale, Esq.	Rev. Dr Alexander Brunton.
Gilbert Innes, Esq.	Dr Andrew Coventry.

Art. XXVIII.—SCIENTIFIC INTELLIGENCE.

GEOGRAPHY.

1. *Heights of the principal Parts of Ætna.*

	Feet.		Feet.
The Summit, -	10,874	The Goat's Cavern, -	5362
Foot of the Cone, -	9760	Angelo the Herdman's Cottage, - -	4205
The English House,	9592	Nicolori Convent, -	2449
Philosopher's Tower,	9467	Lingua-grossa, -	1725
Bishop's Snow Stores,	7410	Caltabiano Station, -	371
Highest part of the woody region, - -	6279	Catania Station, -	47

Smyth's Memoir.

2. *Bellinghausen's Voyage.*—The Russian voyage of discovery towards the South Pole, did not reach so high a latitude as Captain Weddel, whose voyage is noticed at page 146.; for the chief of the expedition, Captain Bellinghausen, says, "We continued our cruise to the south-east, sailing between large masses of ice; but, notwithstanding all our efforts, we never could pass the 70° of south latitude, and this only in one place. In all others, we could only advance $69\frac{1}{2}$°".

GEOLOGY.

3. *Remains of Fossil Quadrupeds in Chalk and Jura Limestone.*—The discovery by Dr Boué of bones of the mastodon in the chalk formation, and the previously known fact of the occurrence of bones of didelphi in the Stonesfield oolite of England, which is equivalent with the Jura limestone, increase the range of distribution of fossil mammiferous animals.

4. *Humboldt's New Geological Work.*—Humboldt has nearly ready for the press a large geological work, in two volumes, with numerous plates.

5. *Buch's Geological Maps of Palma and of the Lake of Laach.*—Baron Von Buch has published a most magnificent map of the Island of Palma. He has also published a geological map of the remarkable country around the Lake of Laach on the Rhine.

6. *M. Brongniart junior's Fossil Botany.*—This active and intelligent young naturalist has collected a vast store of materials for a work on fossil plants. It will appear during the course of next year, and will contain descriptions of about 1000 *species.*

7. *Cordier's Geology.*—Cordier has just finished the composition of an extensive work on geology, with a mineralogical classification of rocks.

8. *Arrangement of Rocks at Predazzo.*—The following, according to Dr Boué, is the arrangement of rocks at Predazzo. The upper rock is trap-amygdaloid; below it fine granular dolerite; next dolerite with mica; to this succeeds felspathose dolerite, granitic dolerite, that is with felspar and mica; and, lastly, at the foot of the hill, granite with quartz, and a dike of trap, with coccolite, and large crystals of felspar. On the opposite side of the river is true coarse granular granite, with schorl. We have here an instance of tertiary dolerite passing into granitose rock, and perhaps even into granite. The whole series rests upon chalk.

9. *Supposed cause of the Heat of Hot Springs and Volcanoes.*—It is known that the density, and consequently the heat of the atmosphere, increases as we descend into the interior of the earth. This being the case, it is probable that the heat of springs and volcanoes may be derived from currents of hot and dense air, in the deeper regions of the solid mass of the globe.

MINERALOGY.

10. *Strontites in Yorkshire.*—Most of the native combinations of strontites have of late been found by Dr Peter Murray in the West Riding of the county of York, in the vicinity of Knaresborough and Pately Bridge.—The *carbonate* has, for the first time in England, been observed at the lead-mine of Merryfield, near Pately, in veins and nests, associated with galena and sulphate of barytes in calcareous grit. Two varieties have been met with: one compact, semitransparent, and of the most splendent white colour, resembling some kinds of arragonite, and contains in the 100 parts, 55 of Strontian, 4 Carbonate of Lime, 2 of Alumina, Sulphate of Barytes 1, Water and Carbonic

Acid 32; the other is beautifully crystallised in prisms, of a greyish-white colour, and in many specimens impressing calcareous spar, and, when analysed, has been found to contain in 100 parts, 1 of Water, 33 of Carbonic Acid, 6 of Lime, and 60 of Strontian.—Of the *sulphate*, three varieties have been noticed upon the banks of the Nidd, near Knaresborough. The *foliated sulphat* of Professor Jameson finely crystallised, of a delicate blue colour, and well meriting the name of Celestine, in magnesian limestone, resting upon the new red sandstone, and containing a small percentage of carbonate of lime, varying in different specimens. The *compact sulphate*, of a snowy white, occurs with the former in spheroidal or reniform pieces, containing 7 per cent. of carbonate of lime.—The *radiated sulphat*, of a yellowish or reddish-white colour, is found at Bilton, upon the opposite bank of the river, in the new red sandstone formation, accompanied by several varieties of gypsum. This sandstone greatly varies within very narrow limits, extremely compact and hard where inclosing the strontites, and then becoming almost amygdaloidal, with nodules of quartz, on one hand; and on the other passing into a soft red marl, containing gypsum.

11. *Mr Heuland's Mineralogical Collection.*—The most extensive, splendid, and useful collection of minerals in the world, is that belonging to Mr Heuland of London. Those parts of this cabinet which have been occasionally shewn to mineralogists, have not failed to excite their wonder and admiration, as well as an ardent desire to see the whole of this splendid display of the riches and magnificence of the mineral kingdom. It is therefore with great pleasure we inform the mineralogical world, that such arrangements are now making by Mr Heuland, as will enable him to display the whole collection some time during the course of next spring.

12. *Mineralogical Collections.*—Mr Heuland, from the vast collection of the finest and most characteristic minerals in his possession, and from having lately added to his stores the splendid cabinet of M. de Dreé, and the well known and admirable cabinet of a foreign nobleman, will be enabled to supply public institutions, or private collections, in a style hitherto unknown in

this country. But he will not engage to furnish any collections under L. 300, nor above L. 500, having already pledged his word to several London collectors, to suit them by the choice of single specimens. Any orders he obtains, and these, we doubt not, will be numerous, now that scientific societies, and private collections are rising every where, will be executed under the condition, that he is to bear every expence, to and from, should the collection not agree with the expectation of the receiver.

BOTANY.

13. *Gum Animi as connected with the origin of Amber.*—"We saw in the woods many of the trees from which the gum animi is obtained (Hymenœa Courbaril, L.) *. They are here called Satabá or Jatar. Between the bark and the wood of this tree, which in its growth resembles the elm, there are, in proportion, but a few interstices filled with fluid gum; the far greater part of it is found under the principal roots, when they are bared of the earth, which, in general, cannot be done, without felling the tree. Under old trees, pale yellow round cakes, weighing from six to eight pounds, are sometimes found, which have been formed by the gradual filtering of the liquid gum. The purity and colour of this substance, principally depends on the nature of the earth in which these cakes are found, for the brown mould or moor soil, imparts to them certain ingredients, which are not found in the dry, clayey, or sandy soil. The finest part of the gum, however, is that which, exuding from the bark chiefly in the dry season, in the months of September and October, is collected by the inhabitants in the form of drops, and melted over the fire. The formation of these large masses of gum between the roots, seem to throw some light on the origin of amber, as it is very conceivable, that this vegetable substance may have been partly accumulated in the ground, in a similar manner, under the trees which produced it, before it was received and rounded by the sea. Insects, too, particularly ants, are also found in the pieces of the Jatar gum, as in amber. The Iayapos, and other Indian tribes on the Rio Grande, on the banks of which the Hymenœa forms extensive woods, form

* We met with several kinds of hymenœa, all of which produce gum.

this gum into ornaments, shaped like a club or a spindle, which they wear in holes, bored in the nose and underlip. Of the thick bark of the tree they make small canoes, which, on account of their lightness, are peculiarly adapted for land carriage from one river to another. Many lofty crotons also grow on the banks of the Sapucahy. A red resinous matter is obtained from them, which the inhabitants call dragon's-blood, and use for dying."—*Spix and Martius's Travels.*

14. *Sterility of Hybrid Plants.*—The phenomenon of hybridism is perhaps of more frequent occurrence than is imagined in common plants, or in such as belong to genera numerous in species. It has only, however, been confirmed in a satisfactory manner by a small number of observations. That which forms the subject of the present note, is confirmative of another nearly similar one, made by MM. Guillemin and Dumas upon the Gentians, and which they have inserted in the first part of the "Memoires de la Societé d'Histoire Naturelle." MM. Aug. de St Hilaire, and De Salvert, while herbarizing in the Lower Auvergne, made the discovery of a Digitalis, which they took at first for the Digitalis fuscata of Persoon. Paying afterwards more attention to the circumstances in which it was found, they concluded that it was a hybrid of Digitalis purpurea and D. lutea. In consequence, M. de Salvert published its description in the Journal de Bòtanique, and named it D. hybrida. M. de St Hilaire adds here, that, during six years, the same plant has been found in the same valley, and in the midst of the two parent species; that its capsules were constantly shrivelled, and did not contain any seeds capable of germination; lastly, that the ovaries resembled a fine and light powder. This fact must be added to those which have already been recorded, as in favour of the sterility of hybrids. M. de St Hilaire, as well as MM. de Candolle, Guillemin, and Dumas, do not pretend to assert, that this incapability of generation is common to all the individuals originating in this way.—*Bulletin Universel.*

15. *Disengagement of Ammoniacal Gas during the Vegetation of the Chenopodium vulvaria.*—There is not a more singular phenomenon in vegetable physiology, than the well known fact of the continual motions of certain aëriform fluids in the interior

of the organs of plants. An observation of much interest has been added by M. Chevallier, to those which we already possess upon this subject. He had announced, in conjunction with M. Lassaigne, the existence of sub-carbonate of ammonia, ready formed in the leaves of *Chenopodium vulvaria;* and this assertion was scarcely credited. However, he has reason to congratulate himself upon the issue of the controversy to which this has led, since it has conducted M. Chevallier to the discovery of a fact equally curious with the former, though in a different way. It is now no longer an ammoniacal salt, forming part of the leaves, like so many other saline matters, but a continual exhalation of free ammonia, which may take place during the whole life of the plant. Certainly this first fact, which has not hitherto been noticed, opens a mine rich in important results, and we cannot help comparing it to the ingenious ideas of M. Robiquet regarding the aroma. We would also observe, that it is for the first time that the exhalation of a gas, containing azote, has been observed in vegetables; and the facility with which the ammonia leaves this principle, may perhaps contribute to a better understanding of the formation of the azotic productions of the vegetable kingdom, the source of which has hitherto been more sought for in the atmospheric air, and in the nitrates or nitrites, which might occur in the soil. We transcribe M. Chevallier's observation verbally. "Wishing to obtain the volatile alkali from the vulvaria, without employing the action of fire, and thus to prevent the objections which might be raised, I placed, in a large flower-pot, a lump of earth containing two stalks of Chenopodium. When I was assured that this transportation had not injured the vitality of the plant, I placed a glass funnel upon the pot, and luted the whole in such a manner, that the vapour, which was continually disengaged from the vulvaria, was obliged to pass through the upper part of the funnel. I adapted to this upper part, a tube which passed into a flask containing hydrochloric acid, diluted with water. All communication with the external air was besides interrupted by a second tube dipping into water. Scarcely was the ammoniacal exhalation in contact with the hydrochloric acid, when white vapours were perceived, which diffused themselves over the surface of the liquid, where they disappeared. This disengagement being very strong, on the evening of the same day, I made an analysis of the liquid, and I found it to contain hydrochlorate of ammonia. I repeated the same experiment several days successively, and always obtained the same results.—From this experiment, I find reason to be convinced that the Chenopodium vulvaria spontaneously disengages free ammonia during the act of vegetation. I have also been aware, for several years, in conjunction with M. Boullay, that a great number of flowers, even of those whose smell is very agreeable, spontaneously emit ammoniacal gas. We cannot hesitate to recommend this observation to the attention of those who occupy themselves with vegetable physiology: and, since M. Chevallier has been so fortunate as to discover this important phenomenon, it were very desirable that he should push his researches farther, and direct them toward the influence which the solar rays may exert upon this disengagement, taking special care to exclude the vegetable earth, the presence of which might interfere with the results.—*Annales des Sciences Naturelles*, tom. iv. Avril 1824.

16. *Contributions to the Flora of Scotland.*—In our list of plants found in the Highlands last summer, we omitted to mention that *Hypnum alpestre* had been discovered by Drs Greville and Townsend, in Breadalbane. Since our last publication, Mr Drummond, nurseryman at Forfar, has found the *Weissia latifolia* of Schwægrichen. This was derived from that inexhaustible source of botanical riches, the Mountains of Clova, and is, we believe, confined, both on the Continent and in this country, to a micaceous soil. It is not a little remarkable, that it grew intermixed with two of the rarest plants of Great Britain, *Oxytropus campestris* and *Didymodon glaucescens.* Dr Greville has already figured it in his Cryptogamic Flora, at p. 149. *Daltonia heteromalla*, a moss only recently ascertained to be a native of Scotland, has been found on the banks of the North Esk, opposite Preston Holme, by Mr M. Stark. Professor Graham, and Mr Macnab, have examined a *Senecio*, observed by the gardener at Woodhall, and found it to be *S. tenuifolia*, and new to the Scottish Flora. It grows abundantly in clay pastures around Woodhall.

17. *Carrodori on the contractibility of Vegetables.*—This

observer, in the Transactions of the Academy of Sciences of Modena, has a memoir on the contractibility of vegetables. He communicates some experiments, from which he infers, that the phenomenon of contractibility observed in different parts of plants, and which Tournefort considered as a mechanical effect of elasticity, must be viewed as a consequence of vitality. Thus the contraction of the valves in the seed-vessels of balsams, when the seeds are ripe, may be considered as an example of this power. If such capsules are immersed in laurel water, which kills their vitality, they lose their contractile power, while, if put into cold water, their contractile power remains unchanged.

ZOOLOGY.

18. *Note regarding the Spider whose Web is employed in Medicine, by N. M. Hentz.*—It has lately been discovered, that the web of a species of spider, common in caves in Pennsylvania, possesses a narcotic power; and it has been administered with success in the treatment of certain fevers. This spider, of which M. Hentz has figured a large female, with a description of the parts of the mouth, and the disposition of the eyes, belongs to the genus *Tegenaria* of M. Walckenaër, or to that of *Aranea*, properly so called, of M. Latreille. M. Hentz proposes to give it the specific name of *T. medicinalis.* It is black, tinged with blue, and its abdomen presents about ten pale and livid spots, as well as a line, toward its anterior extremity. In some individuals, the legs are marked with black spots. The author is of opinion that the webs of all the species of the same genus in America are equally narcotic. It would be interesting to make some experiments upon those of the European spiders, with the view of determining whether they possess the same property.—*Journal Acad. Nat. Sciences of Philadelphia*, vol. ii.

19. *Notice regarding the Breeding of the Peacock Parrot of South America.*—The author of this notice having put together, at Paris, in the month of April 1822, two peacock parrots, male and female, obtained an egg on the 18th May following; three days after a second; then a third and a fourth, with the same interval as that observed between the laying of the first and second. Two of these eggs were found to be clear; and the other two, when broken by M. Gabriac, after an incubation of

twenty-five days, presented two dead fœtuses, one of which might have been of about six days and the other twelve. He attributed the failure to the great quantity of electricity diffused through the atmosphere during the month of June of this year. M. de Gabriac allowed his parrots to rest for ten days, and put them together again on the 1st July. On the 14th, the female again laid an egg, which, as at first, was accompanied with three others, on the 17th, 20th, and 23d. It was always at six or seven in the evening that they were laid. On the 6th August, the first egg was hatched, and the rest on every succeeding third day; that is to say, on the 9th, 12th, and 15th, all in the evening, about the time at which they had been laid. The observations of M. de Gabriac prove, that, in this species of parrot, the period of incubation is twenty-three days. When first excluded, the young are covered with a grey down. At the time when M. de Gabriac published his notice, his young parrots were already two months old. This is the second instance of parrots breeding in France. M. Lamouroux, Professor of Natural History at Caen, read to the Linnean Society of Paris, a memoir upon *Blue Aras* (Psittacus Ararauna) *bred in France.* The parent birds belonged to M. Esnault, also of Caen, to whom they laid, from the month of March 1818, to the month of August 1823, 62 eggs in all, at nineteen different times. Several trials of the same kind have been made within these few years, and the results have been satisfactory. Every thing leads us to hope that we may one day be able to multiply in our aviaries the greater part of the numerous species which compose the beautiful family of parrots.—*Bulletin Universel.*

20. *Splendid Luminosity of Sea Animals, observed by Kuhl, in Lat.* 24° *S., Long.* 12°, *in Oct.* 1820.—" M. de Humboldt has observed, that galvanic electricity is without visible influence upon the medusæ. The same can be said of the Pyrosomata, although there is a vestige of nervous system in them. The Biphora also, as well as the pyrosomata, when preserved in a bottle, make the temperature of the water rise nearly one centigrade degree. The *Pyrosoma atlanticum*, the only species hitherto observed by us, diffuses, while swimming beneath the surface of the sea, a light of a foot and a half in diameter. Only imagine the superb spectacle which we enjoyed some days ago,

when, in the evening, from seven to eleven o'clock, a continuous band of these living globes of fire passed near our vessel. With the light which they diffused, we could distinguish, at a depth of fifteen feet, the individuals of *Thynnus pelamys*, and *Sarda*, which have followed us these several weeks, notwithstanding the great celerity with which we have sailed."

21. *Notice regarding Two Eggs contained one within the other, and without Yolks, by M. Defrance.*—If it sometimes happens that eggs contain two yolks, we also find that others contain none. The hen which had the crop torn, and of which mention is made in the *Bulletin General*, and which lived without a cock, has laid thirty-seven eggs from the 6th February last, to the 26th March. On the 28th, it laid one which was a little smaller and more elongated than the others. This egg having been opened, was found to contain only albumen ; and, in the place of the yolk was found a small egg, very well formed, of the same size as this latter. The shell was soft, and contained itself nothing but albumen.—*Bulletin Universel.*

22. *Musical Thrush of Brazil.*—" We first observed in these woods the notes of a greyish-brown bird, probably a thrush, which frequents the bushes and ground in damp low woods, and sings with numerous repetitions through the musical scale, from H^1 to A^2 (of the German scale), so regularly, that not a single note is wanting. It commonly sings each note four or five times over, and then proceeds imperceptibly to the following quarter tone. It is usual to deny to the songsters of the American forests all melody and expression, and to allow them no pre-eminence but splendour of plumage. But if, in general, the pretty natives of the torrid zone are more distinguished by the beauty of their colours than by fulness and power of note, and seem inferior to our nightingale in clearness and melodiousness of tone, yet this little bird, among others, is a proof that they are at least not destitute of the principles of melody. How far the musical improvement of man has already had an influence on the notes of birds, remains an interesting subject for physiological investigation. It is at least inconceivable, that when the almost inarticulate tones of a degenerate race of men no longer resounds in the woods of Brazil, many of the feathered song-

sters will also produce more refined melodies."—*Spix and Martius's Travels in Brazil.*

PHYSIOLOGY.

23. *On Asphyxia by Strangulation.*—M. Segalas has established, by a considerable number of experiments, which he communicated to the Philomathic Society, in the month of August last, 1. That the death which succeeds the mechanical obstruction of the trachea is more or less protracted, according to the temperature of the atmosphere in which it is produced, the species of animal strangled, and especially its age; a young animal resisting it longer than an older: 2. That, in these different circumstances, the obstruction of the trachea in mammifera is followed by a more protracted death, when, after having produced it, the thorax of the animal is opened in such a manner as to admit the air into contact with the external surface of the lungs: 3. That every operation which, without hurting the central organs of sensation and of circulation, and without allowing a great part of the blood to escape, damages a great number of capillary bloodvessels, equally retards death following obstruction of the trachea; that, for example, on skinning guinea-pigs, small cats, small dogs, &c. as also on laying bare the abdominal viscera by a crucial incision, the symptoms of life are prolonged in these animals.—From these facts M. Segalas has drawn the following conclusions: The lungs in mammifera are not the exclusive seat of respiration; the oxygenation of the blood appears, as is also demonstrated with regard to the transpiration and disengagement of carbonic acid, to be the joint production of all the cutaneous and mucous surfaces which are in contact with the air, and which are not removed from its action by too thick an epidermis, or by too dense a pile. Consequently M. Segalas is not disinclined to believe, that the prerogative which man possesses of surviving prolonged asphyxia, depends, at least in part, upon the naked state of the skin, the thinness of the epidermis, and the great number of capillary bloodvessels which are found in this envelope.

24. *On the Uses of the Mustachial Bristles of Animals, by Vrolick of Amsterdam.*—Being convinced (says Vrolick) that

the mustaches of several mammifera, such as the seal and cats, are peculiar organs of touch, I made choice of the rabbit for trying some experiments upon the subject. This animal passing the greater part of its life in warrens, where the light cannot penetrate, this circumstance seemed to me to render it better adapted for the object of the inquiries which I had proposed to myself, its mustaches being also long and pretty numerous. I found in this animal the same division and distribution of the nervous filaments in the bulbs of the mustaches as in seals and cats in general, a circumstance which removed all my doubts with regard to the use of these parts. However, not contented with this proof, derived from analogy of structure, I wished to make some direct experiments, of which the following are the results. I arranged upon the floor of a large room a quantity of books, in such a manner as to form a sort of labyrinth, through which an animal of moderate size could with difficulty find a passage. I placed a rabbit in the middle of this labyrinth, having previously taken care to produce such a degree of darkness, as to render it impossible to distinguish any object whatever. On admitting the light a few moments after, I found the animal escaped from its prison, after finding a passage through the whole of these books, without having overturned or displaced one of them, although they were placed so near to one another that the smallest shock would have been sufficient to make them fall. In order to determine whether its sight had enabled the animal to escape from its prison, I tied up its eyes first with a piece of linen, which I tightened well, and made several folds of, and afterwards with a piece of crape folded double, and bound down, to prevent all mistakes, by means of a crucial bandage. In both cases the animal walked with great ease among the books, without knocking against any thing, even when forced to accelerate its progress. I was very curious to observe, during this experiment, the motion of the head by which the animal seemed to have in view to measure the distance of objects; when it approached them, it touched them with the extremity of its mustaches. In order to remove all doubt from my mind, I cut the mustaches situated at the side of the head, and those placed around the eyes. The animal was bound up again as it had been before, but now it seemed afraid to move; it knocked against the books, overturned several of them, and could only escape by sliding along, as a blind man would do who directed himself by a wall.

25. *Experiments made upon six decapitated Robbers, by Professor* Bartels.—On the 14th October 1811, six highway robbers were beheaded near Marburg; one of them was sixty years of age, the other five from twenty to thirty. At the instant when the head of the first fell, the trunk got up again as if the individual had been about to rise upon his feet, while the bodies of the others fell down flat at the very moment. When a little after the heads were thrown at the foot of the scaffold, we saw all the muscles of the face of the last executed completely relax, while those of the old man presented a general contraction, which lasted for a considerable time. These opposite effects took place without the occurrence of any difference in the mode of decapitation to which they could be attributed: with respect to this, it will not be useless to remark, that there remained at least two vertebræ attached to each of the heads. It was observed, that, at the moment of decapitation, the muscles of the face of the greater number of the heads contracted in a convulsive manner. As the head of the first decapitated had not been brought with the rest, no other observations were made with regard to it. The second, which fell ten minutes after it, was observed without loss of time. It was tried at first to excite a contraction of the iris, by pricking that organ, but no apparent motion was obtained. The same operation having been made upon the iris of the third head, the pupil dilated a little, and again quickly contracted; while, at the same time, the pupil of the other eye (which had not been pricked) contracted, and again immediately dilated; an effect which Professor Trenderoth, as well as Messrs Bunger and Herold, who were also present, saw in the most evident manner. Some minutes after decapitation, the bodies were opened, the heart contracted and dilated alternately with much force, in such a manner as to produce regular pulsations. At the end of ten minutes, these motions had, it is true, abated a little; but they were always incessant, and the alternate contraction and dilatation preserved their regularity. Five minutes later, these mo-

tions had become unequal and very weak; they revived, however, when the heart was irritated by pinching it. A mechanical irritation made upon a branch of the great sympathetic, accelerated a little the motion of the heart, but only for a minute at most; the motion itself, however, continued for a long time, only decreasing in intensity. A puncture made in the transverse muscle of the abdomen of the same body occasioned strong convulsions, especially in the lower extremities, and yet the nerves had not been immediately irritated. A mechanical irritation made at the lower part of the spinal marrow caused violent contractions in the muscles of the trunk, as well as in those of the neck, particularly those of the upper part, at the place of the section (which had already been frequently remarked). On irritating the upper part of the spinal marrow of another head, convulsive motions were produced in the muscles of the face, and there resulted a movement of the tongue and surrounding muscles. In the third body, a motion was remarked in the lower part of the trachea which remained attached to the trunk: this motion was accompanied with a sort of hissing, an effect caused, without doubt, by the convulsive contractions of the muscles which had been cut. Similar motions took place in all the others. The head of the last decapitated was transported to the theatre, which, on account of the distance, occasioned the loss of an hour. Here, our first care was to try the duration of the galvanic irritation upon the different muscles of the head. The elevator-muscle of the upper eyelid, and the superior oblique muscle no longer contracted; but the frontal muscles, the orbicularis palpebrarum, masseter, digastric, &c. still continued to contract. The contractions ceased first in the masseter muscle; they were prolonged in the buccinator. Two hours after execution, it had entirely ceased in all the muscles, and it could not be excited on moistening them anew. In another head, cut off twenty minutes at least before the preceding, the galvanic irritation caused the depressor commissuræ labiarum, the orbicularis palpebrarum, and masseter, to contract; this latter always much longer than the others. Two hours and three quarters after decapitation, the muscles of this head appeared to have lost all irritability. Before concluding our experiments upon the head of the last decapitated, we exposed the pectoralis major and minor of a body which was brought in. The large pectoral muscle alone contracted under the influence of the galvanic fluid, the muscles of the abdomen no longer contracted; contraction took place only in the right triceps muscle and in the sartorius; they ceased always in the latter half an hour sooner than in the other. Irritation applied to the transverse muscle of this body no longer produced contraction, which we attributed to the circumstance that the body had been opened at the place of execution, after the first experiment. In another body which had been opened at the same time, the application of galvanism also produced some motions, as well as a feeble contraction, which was not renewed: mechanical irritation produced none. An hour and a half after execution, the natural motion of the heart had ceased in the bodies already carried to the theatre. We were still, however, in hopes to produce contraction by means of irritation, not being able to get at the heart of the body which had been first opened, we proceeded to that of a body which had been newly opened. This last had also retained its heat, principally in the internal parts; the heart still contained a little blood, of a deep colour, in the left ventricle, which was partly fluid and partly coagulated; but we could not, either mechanically, or by means of galvanism, excite any contraction of the muscular fibres of the heart. —*Schriften der Gesell der Gesammt Naturwiss zu Marburg*, vol. i. 1823.

ANTHROPOLOGY.

26. *Hereditary supernumerary Fingers.*—Dr Willigins of Kirchberg, gives the following curious history: A man had born to him by his wife children, most of which had six fingers on each hand; and the same was the case with most of the children he had by a second wife. A daughter by the first wife married, and bore two children with six fingers on each hand.

ARTS.

27. *Spiritous Liquors derived from trees, or from fruits of trees.*—Among the trees of India, we observe the *Mowah* or *Bossia butyracea.* It attains the height of an English oak; the

beauty of the foliage and flowers, make it a great ornament of the plains; and its wood is precious, inasmuch as it is not exposed, like other wood, to destruction from the attacks of the white ants. The flowers of the mowah are dried, and are used for acidulating "les mets," and especially for the distillation of arrack. They give a great degree of strength to this liquor, and arrack made with these flowers, is distinguished by the name of *mowali arrack.* In a favourable season, a good mowah produces from two to three hundred pounds of flowers. A thick oil-like butter is obtained from the fruit, and used for domestic purposes.—The *barb* or *pamyra* grows upon the banks of the Nerbudda and other rivers of the Guzerat. A good tree of this species furnishes daily 43 quarts of tars or palm wine, from which a pound of *gaggaria* or coarse sugar may be got. The sugar-cane is cultivated in several places of this country, but in place of manufacturing sugar from it, they are contented with selling daily in the market the canes with the juice, of which the Hindoos are very fond.—The celebrated Danish chemist, M. Oersted shows, that of all the fruits which grow in Denmark, the apple is that which, together with a great quantity of sugar, produces the drink which approaches nearest to wine. Cherries, gooseberries, and other fruits, from which it has beentried to extract vinous drinks, are by no means proper for that purpose. He hopes, in the course of a few years, to be able to manufacture very good wine with the juice of the apple and sugar.—The sap of the trunk of the birch, is of all vegetable substances that which furnishes the best means of imitating Champaigne, which is adulterated in London and Hamburgh, in the manufactories, with different sorts of berries, and especially whortles.—*Bulletin Universel.*

28. *Brown's Gas Vacuum Machine.*—This machine having excited considerable attention both here and in England, we consider it right to state our opinion in regard to it. We shall feel happy, both on account of the patentee and the public, to find that we have been mistaken in the view we are now to lay before our readers. In this period of boundless speculation too much caution cannot be used. The object of this engine, as its name implies, is to obtain power by means of the vacuum cre-

ated by the combustion of inflammable gas. It is well known in mechanics, that a vacuum, in whatever way it is produced, forms the source of great mechanical power. It was by means of a vacuum, produced by the condensation of steam, that Captain Savery contrived to raise water in his steam-engine. It was also remarked by the celebrated mechanic Dr Hook, in regard to some plan which had been proposed for working by means of a piston, "If," said he, "a speedy vacuum could be made under your piston, your work is done." It was accordingly, by forming this vacuum under the piston by means of the condensation of steam, that Newcomen succeeded in his improved steam-engine; and this continues, indeed, to be still the great principle of the engines of the present day, namely, the creation of a vacuum under or above the piston. Mr Brown then proposes to create this speedy vacuum by means of the combustion, for example, of coal or oil gas, a gas-burner being lighted within the cylinder, and allowed to consume the internal air, part of which it condenses into water. Now, admitting that this plan is practicable, and that the machinery which Mr Brown has described could be made to work with effect, let us see what would be the expence of this power. Coal-gas sells in Edinburgh at 12s., oil-gas at 40s.: take the coal-gas, then, and suppose that every cubic foot of this gas is capable of creating an equal space of vacuum,—a circumstance which is by no means proved even to half the extent; but let this advantage be set against the raising of its water of condensation, and other impediments which the steam-engine may have to encounter; and suppose that a steam-engine consumes 20 feet of steam per minute for every horse-power, which will be found near the truth; then, by the same rule, a gas-engine would consume the same quantity, which is equal to 12,000 feet per day, and would cost therefore £7, 4s. per horse-power, for gas alone. Such a sum, however, would maintain at least 30 horses, and this consideration alone is sufficient to prove that the engine has no chance of success, let its mechanism and operations be ever so perfect; unless, indeed, it can be shewn, that every cubic foot of gas is capable of creating 30 cubic feet of vacuity, instead of only half a foot, the usual estimate of chemists. Where the gas has to be made on purpose for the engine, its application appears still more dubious, as gas-making forms a business abundantly nice and complex of itself, and quite incompatible with that simplicity which every mechanical power should possess.

POLITICAL ECONOMY.

29. *Friendly Societies.*—In a former Number, we noticed the Results of the Highland Society's Inquiry into the rate of Sickness and Mortality among the members of Friendly Societies in Scotland. From the able and perspicuous Report drawn up by a Committee of that body, we were led to anticipate, that those laudable and highly useful institutions would immediately perceive the erroneous principles upon which they had hitherto very generally proceeded, and take speedy measures for placing themselves on a more secure footing. We are now happy to state, that our expectations have been realised, and that numerous Societies have already begun to revise their laws, and to regulate their contributions and allowances according to rules deduced from experience and distinctly laid down in the Report. By many Societies, recourse has been had to professional accountants for assistance; and we know that The Edinburgh Compositors' Society has already in the press a very judicious set of Laws, with Remarks on the Constitution and prevailing Errors of Friendly Societies. These Remarks we have seen. They are written in a clear and popular style, and contain an interesting statement on the subject by James Skirving, Esq. accountant, a gentleman who assisted in framing the Tables in the Highland Society's Report. These Remarks and Laws, are, we believe, to be immediately published; and we would strongly recommend a perusal of them, to all those who take an interest in securing the stability and success of Benefit Societies.

ART. XXIX.—*List of Patents granted in Scotland from 13th August to 2d December* 1824.

55. TO JOSEPH FOOT of Church Street, Spittalfields, in the county of Middlesex, silk-manufacturer, for "An improved umbrella." Sealed at Edinburgh 1st September 1824.

56. To Robert Lloyd of the Strand, county of Middlesex, hatter, and James Rowbotham of Great Surrey Street, Blackfriars Road, county of Surrey, hatmaker, for "hats upon a new construction." Sealed at Edinburgh 30th August 1824.

57. To William Harwood Horrocks of Stockport, county of Chester, cotton-manufacturer, for "a new apparatus for giving tension to the warp in looms." Sealed at Edinburgh 31st August 1824.

58. To John George Bodmer of No. 50. Oxford Street, in Charlton Row, parish of Manchester, county of Lancaster, civil engineer, for "certain improvements in the machinery for cleaning, carding, drawing, roving, and spinning of cotton and wool." Sealed at Edinburgh 21st September 1824.

59. To John Leigh Bradbury of Manchester, county palatine of Lancaster, gentleman, for "a new mode of twisting, spinning, or throwing silk, cotton, wool, linen, or other threads or fibrous substances." Sealed at Edinburgh 23d September 1824.

60. To Josiah Parkes of Manchester, county palatine of Lancaster, civil engineer, for "a certain method of manufacturing salt." Sealed at Edinburgh 25th September 1824.

61. To John Heathcoat of Tiverton, county of Devon, lace-manufacturer, for "certain improvements in the method of preparing and manufacturing silk for weaving, and other purposes." Sealed at Edinburgh 29th September 1824.

62. To Philip Chel of Earl's Court, Kensington, county of Middlesex, engineer, for "improvements on machinery for drawing, roving, and spinning flax, wool, waste silk, or other fibrous substances." Sealed at Edinburgh 25th October 1824.

63. To Simeon Broadmeadow of the town of Abergavenny, in the county of Monmouth, civil engineer, for "a new and improved method of manufacturing and purifying inflammable gases, by the admission and admixture of atmospheric air." Sealed at Edinburgh 29th October 1824.

64. To James Tetlow of Manchester, in the county palatine of Lancaster, weaver, for "certain improvements in power-

looms, for weaving various articles." Sealed at Edinburgh 29th October 1824.

65. To Junius Smith of Old Street, city of London, merchant, for "improvements on a machine for washing, cleansing, and whitening cotton, linen, silk, and woolen garments, or piece goods." Sealed at Edinburgh 6th November 1824.

66. To Thomas Richard Guppy of Bristol, gentleman, for "certain improvements in masting vessels." Sealed at Edinburgh 6th November 1824.

67. To Samuel Hall of Basford, county of Nottingham, cotton-manufacturer, for "an improved steam-engine." Sealed at Edinburgh 6th November 1824.

68. To Herman Schroder of Hackney, county of Middlesex, broker, for "a new filter." Sealed at Edinburgh 30th November 1824.

69. To John Head of Banbury, county of Oxford, hosier, one of the people called Quakers, for "certain improvements in machinery for making cord or platt for boot and stay laces." Sealed at Edinburgh 2d December 1824.

TO CORRESPONDENTS.

Owing to the great confusion and loss occasioned by the late dreadful fires all around the printing-office of this Journal, and also the press of matter, the Editor has been forced to delay publishing in this Number many interesting communications: in particular, those intrusted to his care by Mr Anderson of Perth, Professor Barlow, Dr Boué, Mr Buchanan, Mr Don, Dr Greville, Dr Fleming, and Dr Traill.

P. Neill, Printer, Edinburgh.

THE

EDINBURGH

PHILOSOPHICAL JOURNAL.

Art. I.—*Remarks on the Climate and Vegetable Productions of the Hudson's Bay Countries.* By John Richardson, M. D., Member of the Wernerian Society. Communicated by the Author *.

The following observations have been thrown together, and the subjoined tables drawn up, principally with the view of making public the few facts collected during Captain Franklin's late expedition through the Hudson Bay territories, that relate to the inquiry so ably prosecuted by Baron Humboldt, into the *geographical distribution of vegetable forms*, and on which so much light has been thrown by the observations of our learned countryman Mr Brown. Occasion has also been taken, in the course of the paper, to insert as many circumstances relative to the *climate* of these northern countries as were known to us.

The expedition landed at York Factory, Hudson's Bay, in Lat. 57° Long. 92°, (a few miles to the westward of the line of no variation of the magnetic needle, and nearly in the longitude assigned by Dr Brewster to *one of the poles of cold*, but 23° to the southward of it), and travelling on a W.S.W. direction, reached Carlton House, on the Saskatchawan, distant in a direct line, about 430 geographical miles. This place is in Lat. 53° Long. 106° W., and lies nearly midway between the Pacific and

* Read before the Wernerian Natural History Society, 8th and 22d January 1825.

Hudson's Bay; the Continent here being about 33° of long., or 1000 miles wide. From Carlton House, the course, for 1000 miles, was north, inclining to the west, to the mouth of the Coppermine River, in Lat. 67° 47′ N. Long. 115°½ W.

All the plants collected up to this point, amounting, *Agamæ* inclusive, to nearly 700 species, and to at least 5000 specimens, were brought home, and form the ground-work of the subjoined tables of natural families. About 500 miles of sea-coast, including the circumnavigation of the bays and inlets, were visited to the eastward of the Coppermine River, and the latitude of 68° 18′ N. attained at Point Turn-again; but the whole of the plants collected during this part of the voyage were left behind, owing to the hardships encountered in the subsequent return across the barren grounds. This loss has been supplied, as far as regards the purpose of the present paper, by the collections made during Captain Parry's second voyage in the same parallels of latitude, and at no great distance to the eastward.

In making a few desultory remarks upon the circumstances which are likely to influence the vegetation of the districts, I shall begin with their altitude above the sea; and it is almost superfluous to remark, that we have few precise data on this subject, and must for the present be content with rude approximations. The line of country travelled through is destitute of lofty mountains, table-lands, or great plains; except that Carlton House may be said to stand on the northern boundary of a sandy plain, which opening to the south, and extending to the confines of Mexico, is favourable to the migration of plants to the northward; but our stay in that quarter being confined to ten days at the commencement of spring, during which only thirty species of plants were gathered, few of these southern plants find a place in our list. Few hills were seen during the whole voyage, rising beyond 300 or 400 feet above the level of the surrounding country, and none exceeding 800, except on one part of the Coppermine River, where a range was observed to rise, on a rough estimation, to 1200 or 1500 feet; but even this was free from snow in the beginning of July.

Indeed, our route being by the great rivers, and almost uninterrupted water communications of the districts, was necessarily through the lower part of the country. Our barometer was rendered useless soon after leaving York Factory; so that I can only state in general terms, that, from the shores of Hudson's Bay to the Rocky Mountains, (a continuation of the Andes), the ascent appears to be gentle, most rapid, however, about fifty miles from Hudson's Bay, where the rivers, in crossing a ridge of primitive mountains, form a quick succession of cascades and rapids.

Carlton House, the south-west limit of our journey, I estimate to be 1000 feet above the sea of Hudson's Bay. From this spot, our route to the north lay nearly parallel to the Rocky Mountain chain.

The summit of Portage La Loche or Methy Portage, which lies in 56° 43′ N. Lat., and 109° 52′ W. Long., and is about 250 miles from Carlton House, I estimated at 1500 feet. Methy Lake, the commencement on the south of this portage, of the water communication with Hudson's Bay, at 1000 feet, and Clearwater River, which flows from the north side of the portage uninterruptedly to the Arctic Sea, under the names of Athabasca, Slave River and Lake, and Mackenzie's River, at 800 feet. Slave Lake at 400 feet above the Arctic Sea. The height of land to the north of Fort Enterprize, from whence the descent of the Coppermine River to the Arctic Sea, is gradual, at 900 feet. The data from which these altitudes have been deduced are not precise enough to be worthy of detail; but the results, imperfect as they are, may be sufficient to shew that the elevation alone of these districts is not great enough to give a decided character to their vegetation.

The peculiarities of the Hudson's Bay climate, which have a more marked influence on the vegetable productions, may be, in some measure, collected from the following tables, and the remarks appended to them. The tables are formed on the model of those given by Humboldt, and the deeply interesting memoir of that illustrious man on the *Distribution of Heat*, published in the *Mémoires d'Arcueil*, or its translation in the 3d, 4th, and 5th volumes of the Edinburgh Philosophical Journal, may be referred to, for the original views which prompted the formation of such tables, and the many interesting deductions that may be made from them.

TABLE I. *Exhibiting the Mean Temperatures in various Latitudes.*

Months.	Mean Temperature of the Air in the Shade.				
	Cumberland House, Lat. 54° Long. 102¼′ W.	Near Fort Enterprize, Lat. 64° Long. 113° 6′ W.	Winter Island, Lat. 66¼° Long.	Igloolik, Lat. 69⅓° Long.	Melville Island, Lat. 74¾° N. Long.
	1819—20.	1820—21.	1821—22.	1822—23.	1819—20.
	°	°	°	°	°
September, -	+ 49.20	+ 34.30	+ 29.06	+ 22.45	+ 22.54
October, -	+ 36.68	+ 23.94	+ 10.21	+ 10.29	— 6.96
November, -	+ 14.60	— 0.23	+ 4.75	— 23.37	— 25.60
December, -	+ 2.14	— 29.12	— 16.94	— 32.80	— 26.79
January, -	— 14.19	— 15.08	— 27.96	— 22.07	— 35.09
February, -	— 1.82	— 24.80	— 29.97	— 25.41	— 37.19
March, - -	+ 11.09	— 11.07	— 15.64	— 24.75	— 23.10
April, - -	+ 33.97	+ 5.11	+ 2.51	— 4.68	— 11.87
May, - -	+ 49.05	+ 32.11	+ 21.09	+ 22.85	+ 14.16
June, - -	+ 59.88	+ 46.62	+ 31.97	+ 30.16	+ 34.24
July, - -	+ 69.80	+ 53.20	+ 36.34	+ 40.04	+ 42.41
August, - -	+ 73.73	+ 55.36	+ 36.68	+ 33.68	+ 32.68
Annual Means,	+ 32.01	+ 14.19	+ 6.84	+ 2.20	— 1.71

Remarks upon Table I.

The temperatures for Lats. 54° and 64°, were deduced from Captain Franklin's observations; those in the three remaining columns are copied from Captain Parry's journals, with the modifications noticed below.

Cumberland House is situated in Lat. 53° 57′ N., Long. 102° 17′ W., in a flat limestone country, covered with wood, and abounding in swamps and lakes. The month of September was occupied in travelling from Lat. 57° to 54°, for which an allowance has been made in the table at the rate of 1°.8 of temperature for each degree of latitude, by which the place of observation exceeded 54°; and the same addition was made to the recorded temperatures for June, July, and August 1820, during which months we travelled from Cumberland House to Lat. 64½° N. The allowance of 1°.8 here used, is greater than that which Humboldt specifies for the same parallel of latitude; but it was obtained from a comparison of the mean annual temperatures of Cumberland House and Fort Enterprize, which are $10\frac{1}{2}$ degrees of latitude apart. The observations for the other months in the Cumberland House column, were made within the stockade of the fort, and a deduction of 1° has been made from each recorded observation, to compensate for the radiation from the neighbouring buildings, an allowance which corresponded with the few observations we made upon the subject. The means for some of the months were deduced from three or more observations each day, taking into account the length of the intervals. In the rest of the months, the means of the extremes have been used, which differ only in a fraction of a degree from the more correct mode of taking the intervals into account.

The temperatures in the column for Lat. 64° were (except those for the latter end of June, the month of July, and the beginning of August,) taken at Fort Enterprize, in a shaded situation, on a northerly exposure, and not subject to any material radiation from warm buildings, and an addition of 0°.5 has been made to the registered temperatures, as a reduction to Lat. 64°; Fort Enterprize being actually 28 miles north of that latitude. The temperatures for July, and the early part of August, in this column, having been observed during the journey from the parallel of $55\frac{1}{2}$°, an allowance of from 1°.5 to to 1°.8 has been deducted for each degree of latitude, according to the situations of the places of observation. The temperatures for June, after the 10th, were taken in Lat. 65°, and have therefore been corrected for Lat. 64° by an addition of 1°.5 Fahr.

With regard to the temperatures in the three remaining columns, Captain Parry observes, "that the thermometer, when placed on the shore, or on the ice, at a distance from the ship, invariably stood from 3° to 4° or 5°, and on some occasions 7° lower than the temperature registered on board;" and he in consequence deducts 3° from the mean temperature for the year. In the above table an attempt has been made to proportion the compensation for the warm atmosphere of the ships, amongst the months, so that the greater allowance is made when the difference of temperature between the atmosphere and ship was greatest, or, in other words, in the coldest months. Thus, in July and August, when the radiation of the earth is supposed to be nearly equal to that of the ship, the registered temperatures are used without alteration. In the other months, a deduction has been made, increasing from 2° to 5°, as their mean temperatures decreased. The annual means thus obtained are nearly the same with Captain Parry's corrected temperatures; but the differences betwixt the summers and winters a little exceed those given by his tables.

The means were obtained by Captain Parry from the twelve daily observations, made at intervals of two hours, or from 4380 observations in the year, and thus possess a degree of accuracy which is very rarely attained.

TABLE II. *Shewing the Distribution of Heat in the different Seasons, in various Latitudes.*

SEASONS.	*Mean Temperature of the Air in the Shade.*				
	Cumberland House, Lat. 54°.	Near Fort Enterprize, Lat. 66°.	Winter Island, Lat. 64¼°.	Igloolik, Lat. 69⅓°.	Melville Island, Lat. 74¾°.
Six Summer Months, April—September,	+ 55°.97	+ 37°.78	+ 26°.28	+ 24°.08	+ 22°.36
Six Winter Months, October—March,	+ 8.12	— 9.39	— 12.59	— 19.68	— 25.79
Spring,—March, April, May,	+ 31.37	+ 8.72	+ 2.65	— 2.19	— 6.94
Summer,—June, July, August,	+ 67.80	+ 51.71	+ 35.00	+ 34.63	+ 36.44
Autumn,—September, Oct. Nov.	+ 33.49	+ 19.34	+ 14.67	+ 3.12	— 3.34
Winter,—December, Jan. Feb.	— 4.62	— 23.03	— 24.96	— 26.76	— 33.02
Mean Annual Temperatures, ...	+ 32°.01	+ 14°.19	+ 6°.84	+ 2°.20	— 1°.71

Table III.

Places.	Position. Lat. N.	Position. Long. W.	Height in Feet.	Mean Annual Temperature.	Distribution of Heat in Seasons. Mean Temp. of Spring.	Mean Temp. of Summer.	Mean Temp. of Autumn.	Mean Temp. of Winter.	Mean Temp. of warmest month.	Mean Temp. of coldest month.	Diff. betwixt 3 summer and 3 winter months.	Diff. betwixt hottest and coldest months.	Highest Temp. observed.	Lowest Temp. observed.	Diff. or extreme annual range.
Cumberland House,	53° 57′	102° 17′	800	+32°.01	+31°.37	+67°.80	+33°.49	—4°.62	+73°.73	—14°.19	72°.42	87°.92	+87°	—44°	131°
Near Fort Enterprize,	54 0	113 6	850	+14.19	+8.72	+51.71	+19.34	—23.03	+55.36	—29.12	74.74	84.48	+78	—57	135
Winter Island, -	66 11	83 30	0	+6.84	+2.65	+35.00	+14.67	—24.96	+36.68	—29.97	59.96	66.65	+54	—42½	96½
Igloolik, - -	69 19	82 30	0	+2.20	—2.19	+34.63	+3.12	—26.76	+40.04	—32.80	61.39	72.84	+50	—50	100
Melville Island, -	74 45	11 0	0	—1.71	—6.94	+36.44	—3.34	—33.02	+42.41	—37.19	69.46	79.60	+60	—55	115
From Humboldt:															
Transatlantic region,	...	58 to 72	0	32	...	+55.40	...	+1.40	...	...	54.00				
Labrador, -	53 0	57 40	0			+51.80	...	+3.20	...	...	48.00	63·00			
Labrador, Nain,	57 08	61 20	0	+26.42	+23.90	+48.38	+33.44	—0.60	+51.80	—11.20	48.98				
Churchill, Huds. Bay,	59 02		0	+25.03		+52.20		—6.80			59.00				
Europe:															
Enontekies, -	68 30	20 47	1356	+26.96	+24.98	+54.86	+27.32	+0.68	+59.54	—0.58	54.18	60.12			
Hospice de St Gothard,	46 30	8 23	6390	+30.38	+26.42	+44.96	+31.82	+18.32	+46.22	+15.08	26.64	31.14			
North Cape, -	71 0	25 50	0	+32.00	+29.66	+43.34	+32.08	+23.72	+46.58	+22.10	19.62	24.48			
Umeo, - -	65 50	20 16	0	+33.26	+33.80	+54.86	+33.44	+12.92	+62.60	+11.48	41.94	51.12			
Uleo, - -	65 3	25 26	0	+35.08	+27.14	+57.74	+35.96	+11.84	+61.52	+7.50	45.90	54.02			

TABLE IV. *Shewing the Increase of Vernal Temperature.*

NAMES OF PLACES.	Latitude.	March.	April.	May.	June.	Difference of the Temperatures of the Four Months.			Mean Temp. of the year.
Continental Climate:									
Umeo, - -	63° 50′	+ 23°.0	+ 34°.2	+ 43°.7	+ 55°.0	11°.2	9°.5	11°.3	33°.3
Uleo, - -	65 0	+ 14.0	+ 26.2	+ 41.0	+ 55.0	12.2	14.8	14.0	33.1
Enontekies,	68 30	+ 11.5	+ 26.6	+ 36.5	+ 49.5	15.1	9.9	13.0	27.0
Cumberland House,	53 57	+ 11.1	+ 34.0	+ 49.1	+ 59.9	23.0	15.1	10.8	32.0
Fort Enterprize,	64 0	— 11.1	+ 5.1	+ 32.1	+ 46.6	16.2	27.0	14.5	14.2
Climate of Coast:									
Winter Island,	66 11	— 15.6	+ 2.5	+ 21.1	+ 32.0	18.1	18.6	11.0	6.8
Igloolik, -	69 19	— 24.7	— 4.7	+ 22.0	+ 30.2	20.0	26.7	10.0	2.2
Melville Island,	74 45	— 23.1	— 11.9	+ 14.2	+ 34.2	11.2	26.1	20.0	— 1.7
North Cape,	71 0	+ 25.0	+ 30.0	+ 34.0	+ 40.0	5.2	4.0	6.1	+ 32.0

TABLE V. *Comparing the number of days that reach temperature 51°.8, and the Warmest Months of various Latitudes, and Isothermal Lines (Lines of equal Annual Temperature).*

Isother. Lines of	NAMES OF PLACES.	Lat.	Mean Temp. of the year.	Sum of the Temperatures of the Months that reach 51°.8.	Number of those Months.	Mean Temp. of days which reach 51°.8.	Mean Temp. of warmest months.	OBSERVATIONS.
32°	Umeo -	59° 56′	38°.8	236	4	59°.0	65°.7	East of Europe.
		53 50	33.3	118	2	59.0	62.6	Gulf of Bothnia, east coast.
	North Cape,	71 0	32.0	0	0	0	46.6	Interior climate.
	Enontekies,	68 30	27.0	116	2	58.1	59.5	Continental climate.
	Cumberland House,	53 57	32.0	213	3	66.5	73.7	Continental climate.
59	Nismes,	43 50	60.3	593	9	65.8	78.3	Basin of Mediterranean.
53.6	Philadelphia,	39 56	53.4	463	7	66.2	77.0	
50	Buda, -	47 29	51.1	323	5	64.6	72.0	Interior climate.
41	Upsal, -	59 51	41.9	229	4	57.2	61.9	
10	Fort Enterprize,	64 28	13.7	108	2	uncertain	54.6	Continental climate.
	Winter Island,	61 11	6.8	0	0	0	36.7	Coast.
Zero,	Igloolik,	69 19	2.2	0	0	51.8 1 day	40.0	Coast.
	Melville Isl.,	74 45	— 1.7	0	0	51.1 1 day	42.4	Partly interior climate.

Remarks on the preceding Tables, principally with a reference to the Climate of Cumberland House.

Humboldt informs us, that "in all places whose mean temperature is below 62°.6, the revival of nature takes place in spring, in that month whose mean temperature reaches 42°.8 or 46°.4. When a month rises to

41°.9, the peach-tree *(Amygdalus Persica)* blossoms;
46 .8, the plum-tree *(Prunus domestica)* blossoms;
51 .8, the birch-tree *(Betula alba)* pushes out leaves.

"Barley, in order to be cultivated to advantage, requires during ninety days, a mean temperature of from 47°.3 to 48°.2.

"In reference to the culture of useful vegetables, we must discuss three things for each climate; the mean temperature of the entire summer, that of the warmest month, and that of the coldest month.

"By adding the mean temperatures of the months that rise above 51°.8, that is the temperature of the months in which trees with deciduous leaves vegetate, we shall have a sufficiently exact measure of the strength and continuance of vegetation."

Wahlenberg has also remarked in his *Flora Lapponica*, that "the air must acquire a mean temperature of 4° centigrade, or 39°.20 Fahr., before the frozen rivers break completely up."

The River Saskatchawan, which flows about two miles an hour at Cumberland House, broke up on the 28th April 1820, the mean temperature of the ten preceding days having reached only 36°; but it is to be noticed, that one of the principal branches of this river rises in a more southerly latitude.

The narrow but deep streams which flow from Pine Island Lake, on which Cumberland House stands, into the Saskatchawan, did not freeze at any time during the winter; a circumstance to be attributed to their receiving a constant supply of warm water from the bottom of the lake. The lake itself was covered with ice about three feet thick.

The phenomena of spring, however, are perhaps most readily exhibited in a tabular form.

TABLE VI.—*Tabular View of the Phenomena marking the Progress of Spring at Cumberland House, Lat.* 58° 57′, *Long.* 102° 17′ *W.*

Date.	*Means for the Month and 10 days preceding the respective Phenomena.* Mean Temp. of preceding month.	Mean Temp. of preceding 10 days.	Means of Maxima for 10 days.	Means of Minima for 10 days.	Highest Temperature observed within 10 preceding days.	PHENOMENA.
1820. Mar. 8.	...	...	...	...	...	The snow covering the ground to the depth of 3 feet, was first observed to moisten in the sun, the temperature in the shade having risen to +27° Fahr.
10.	...	+1°.0	+11°.0	—9°.0	+27°	
12.	...	...	...	...	...	Temp. in the shade rose to 30°, and the melting snow began to drop from the eaves of the houses.
20.	...	+18.0	+27.6	+7.6	+39½	
21.	...	...	...	...	...	The temp. this day rose in the shade to 40°, patches of earth became visible from the wasting of the snow, and the River Saskatchawan broke up partially.
22.	...	...	..	...	...	On the 22d the highest temperature of the air was +26°; but the surface of the snow, which was moist in the sun, was observed to assume a bluish hue, from myriads of minute hemipterous insects, which made their way through it with great rapidity, and were, without injury to their vital powers, frozen up with the snow after sunset.
24.	...	...	...	...	...	A white-headed eagle seen. Temp. 50°.
28.	...	...	...	...	...	Temp. in the shade 29°. Many grasses and bents *(Carices)* were observed shedding their seeds, which had withstood the winter firmly grasped in their glumes. This circumstance, and the sap still remaining in the culms, renders the hay or grass of the swamps nutritious to cattle in the winter of these climates.
31.	+11.1	+15.2	+24.2	+6.3	+50	
April 2.	...	...	...	...	...	The temperature sunk yesterday to —14°, and did not rise to-day above +20°. The River Saskatchawan is again frozen up.

TABLE VI.—*Continued.*

Date.	Mean for the Month and 10 days preceding the respective Phenomena. Mean Temp. of preceding month.	Mean Temp. of preceding 10 days.	Means of Maxima for 10 days.	Means of Minima for 10 days.	Highest Temperature observed within 10 preceding days.	PHENOMENA.
1820.						
April 7.	...	...	...	...	...	Rooks seen to-day.
9.	...	...	...	...	...	A merganser seen.
10.	...	+ 25 0	+ 35.0	+ 15.0	+ 49	Willow catkins beginning to burst.
12.	...	...	...	...	...	Geese and swans seen. Temp. in shade + 51°. Wind SE.
13.	...	...	...	...	...	Poplar catkins bursting. Temp. + 54°.
14.	...	...	...	...	...	Duck killed. Temp. in shade + 62°.
17.	...	...	...	...	...	Plovers, grackles, and orioles seen. Temp. in shade + 75°.
18.	...	...	...	...	...	Canadian jays and flycatchers seen. Highest temp. to-day + 38°, and at midnight on the 19th the thermometer sunk to + 21°.
20.	...	+ 50.6	+ 60.5	+ 40.9	+ 75	Tussilago flowering. Highest temperature to-day + 34°.
26.	...	...	...	...	...	Alder *(Alnus glutinosa)* flowering. Temp. + 46°.
28.	...	...	...	...	...	River Saskatchawan completely broken up.
30.	+ 34°.0	+ 35.5	+ 43.0	+ 28.0	+ 54	
May 1.	...	...	...	...	...	*Anemone Ludoviciana* flowering, its leaves not yet evolved. Mosquitoes first seen, and in a few days afterwards severely felt.—Sugar harvest commenced about 20th of April, and lasted till the 10th of May, shewing the period during which the sap flowed freely in the sugar maple *(Negundo fraxinifolium,* DeC.) The mean temperature of these two decades was + 36½° Fahr.; but it is to be remarked, that the sugar boilers observe the flow of sap not to be so immediately influenced by a high mean temperature, as by the power of the direct rays of the sun. Most sap is collected when a smart frost during night is succeeded by a warm sun-shining day.
10.	...	+ 38.0	+ 46.2	+ 29.6	+ 67	
14.	...	...	...	...	...	Sugar maple and gooseberry bushes flowering.
17.	...	...	...	...	...	Willows, gooseberries, and aspens *(Populus trepida)*, in leaf. Various *Drabæ* in flower.

TABLE VI.—*Continued.*

Date.	*Means for the Month and 10 days preceding the respective Phenomena.* Mean Temp. of preceding month.	Mean Temp. of preceding 10 days.	Means of Maxima for 10 days.	Means of Minima for 10 days.	Highest Temperature observed within 10 preceding days.	PHENOMENA.
1820. May 20.	...	+ 51.0	+ 60.4	+ 41.0	+ 84°	
25.	...	...	...	...	...	Pine Island Lake clear of ice.
28.	...	...	...	...	...	*Prunus virginiana*, *Prunus pennsylvanica*, and *Aronia ovalis*, flowering.
31.	+ 49°.1	+ 60.0	+ 70.0	+ 51.0	+ 80	The mean temperature of this month being only 49°, is nearly 3° below that which Baron Humboldt considered necessary for the evolution of deciduous leaves; but the influence of the direct rays of the sun was at this time very great, and the high temperature of the last decade of the month compensated for the defect of the first.

In the course of the month of May, ground was prepared at Cumberland House; and towards the end of it, barley sown, to be reaped again in August, after an interval of about 90 days, whose mean temperature may be stated at 67°.8. This latitude is therefore well adapted for the cultivation of barley and of spring wheat. Maize ripens readily here, although it frequently fails in the climate of Britain. At Edinburgh, for instance, in Lat. 56°, where the mean temperature of the year is 47°.8, and there are five months that reach a mean of 51°.8, maize rarely ripens except in very favourable situations, and under the shelter and reflection of a wall, because the mean temperature of these warm days does not exceed 55°.8, or 12° below the summer temperature of Cumberland House.

The great plains on the Saskatchawan and Red Rivers, immediately to the north of the United States boundary line, are extremely favourable to the cultivation of the Cerealia, the crops seldom suffering from late frosts or heavy rains, and at a future period may provide for a redundant population. At Carlton

House, which is only sixty-six miles to the southward of Cumberland House, but where the sandy soil speedily feels the influence of the sun's rays, and where the presence of an icy lake, such as Pine Island Lake, does not moderate the spring heats, barley and wheat were sown in April, and by the middle of May the fields were green with the young blade.

These extensive plains are, however, at present subject to a great scourge,—a periodical visit of locusts or grasshoppers, at intervals of twenty years.

At Cumberland House there were 7 days in September 1819, 3 in April 1820, 16 in May, the whole of June and July, and 27 days in August, which exceeded 51°.8 of mean temperature, making in all 114, the sum of whose mean temperature is 7584, which give a general mean of 66°.53, as in Table V.

The largest pine-trees and balsam-poplars (*Pinus alba* and *Populus balsamifera*) were between eight and nine feet in circumference. The Saskatchawan River, or Lat. 54°, and perhaps the isothermal line of 32°, is the most northerly limit, in the longitude of Cumberland House of the sugar-maple (*Negundo fraxinifolium*), elm, and ash (species unknown), hazel (*Corylus Americana*), and Arbor-vitæ tree (*Thuya occidentalis*). At Carlton House the maple goes to about fifty miles north of the river, so as nearly to reach the latitude of Cumberland House. Oak and beech (species unknown) terminate about 4° to the southward in Lat. 50°, within the limits of the Red River Colony. The mean annual temperature of that colony cannot be much wide of +38° Fahrenheit, but the mean temperature of the three summer months may perhaps rise to 72°, a degree of heat sufficient for ripening the vine, if the shortness of its duration and the severity of the winter do not preclude the cultivation of that plant. The natural families of *Polemoniaceæ* and *Lineæ* seem also to have their northern limit at Lat. 54° in these longitudes, a solitary species of each being found on the banks of the Saskatchawan. The *Cisteæ*, *Geraniaceæ*, *Rhamneæ*, *Umbelliferæ*, *Araliæ*, *Apocineæ*, *Valerianeæ*, *Hydrophylleæ*, *Chenopodeæ*, *Santaleæ*, *Urticeæ*, *Aroideæ*, and *Asparageæ*, send some straggling species a few degrees farther north, on a rude estimate not passing beyond the isothermal line of + 27°.

It will be seen by an inspection of Table I., that, in the year

1819–20, the month whose mean temperature, at Cumberland House, approached nearest to the mean of the year, was April; but perhaps, the mean of observations continued for a series of years, might point out the month of October as approaching more nearly to the mean of the year. Baron Humboldt observes, that this last month coincides generally within a degree of that of the year on the isothermal line of + 35.6° Fahrenheit. The mean of the spring and autumn temperatures at Cumberland House + 32.4° coincides very nearly with the annual mean, and the same thing occurred at Fort Enterprize, and also at Melville Island, within the fraction of a degree. At Igloolik and Winter Island, the climate being more of a maritime nature, the coincidence was not so exact. Melville Island, lying directly north of the centre of the Continent, must be warmed in the summer by occasional southerly breezes, which may account for its greater proportional summer temperature, when compared with Igloolik and Winter Island.

The mean temperatures for the last ten days of October at Cumberland House, and for the last ten days of April at Fort Enterprize, correspond very nearly with the mean annual temperatures at the respective places. Baron Humboldt remarks, that "it is an object of importance for travellers, whose observations are necessarily limited as to time, to know the ratios that exist between the temperatures of certain portions of the year and the mean annual temperature;" and although observations for a single year, in high latitudes, are not to be depended upon, yet they may form the groundwork for future correction or verification; and we trust that the expeditions of Parry and Franklin will supply much that is wanting.

On comparing the seasons at Cumberland House with the seasons found on different isothermal lines in Europe, as laid down by Baron Humboldt, we find that the winter of Cumberland House, in Lat. 54°, and isothermal line of + 32°, is colder than that of Enontekies, in Lat. 68°, on the isothermal line of + 27°; that the *isocheimal line*, or line of equal winters, at Cumberland House —4°.6 passes to the north of Europe, being much colder than that of the North Cape in Lat. 71°, which has a maritime climate, and 4° below that of Enontekies, which has a more interior climate, and higher elevation above the sea.

The *isothæral* line, or line of equal summer-heats, which in this instance is + 67.8°, on the contrary, when carried across the Atlantic, diverges to the southward nearly three degrees of latitude, passing to the southward of London, Brussels, and Paris, which lie in the isothermal band of from 50° to 52°. In more interior continental situations, however, the isothæral line again curves to the north, passing to the north of Warsaw in Lat. 52.25°, on the isothermal line of +49°, and to the south of Moscow in Lat. 55.75°, and on the isothermal line of +40. In the interior of Siberia, the severity of the winter being great, it is more than probable that an entirely similar climate may be found. Humboldt, in one of his tables, has assigned the mean summer-heat of Cumberland House to Central Russia, in Lat. 58° 30′, and Long. 36° 20′ E., and to Canada, in Lat. 47°, Long. 71° W., on the isothermal line of 41. The low summer-heat here assigned to Long. 71°, in Canada, may be ascribed to its much more maritime climate, when compared to the interior situation of Cumberland House. The differences of these climates may be rendered more manifest by the following tabular view.

TABLE VII.

Difference of Summer and Winter on the Isothermal Line of + 32°.

Situation.	Winter.	Summer.	Difference
Cisatlantic Region, Long. 1° W. and 17° E.	+14.0° Fah.	+53.6°	39.6°
Transatlantic Region, Long. 58° W.—72° W.	+ 1.4 —	+55.4	54.0
Cumberland House (*Continental*) 102¼ W.	— 4.6 —	+67.8	72.4

The effects of the Cumberland House climate, which may be considered as a perfect specimen of the *interior continental climate*, seems to be, as Baron Humboldt has somewhere remarked, that, after a long and severe winter, there is generated a great degree of irritability, both in animals and vegetables, which renders them more susceptible of the succeeding summer-heats. It may be, that it is this excess, as it were, of irritability, that renders the puncture of the mosquito so much more distressing at Hudson's Bay than in any other part of the world, and not the more poisonous nature of the insect itself.

The following *Cree names of the months* are indicative of certain natural phenomena which recur with the returning seasons.

March,	*Meegeshew-eepæ̀shim,*	Eagle-moon.
April,	*Neesca-'pæ̀shim,*	Goose-moon.
May,	*Atheek-eepæ̀shim,*	Frog-moon.
June,	*Opuskow-eepæ̀shim,*	Hatching-moon.
July,	*Opeeneyoo-eepæ̀shim,*	Moulting-moon.
July, August,	*Opahow-eepæ̀shim,*	Flying-moon.
August, September,	*Atteehteh-eepæ̀shim,*	Ripe-berry-moon.
September, October,	*Tawkquaggan-eepæ̀shim,*	Fall-moon (Fall of the leaf).
October, November,	*Onotcheehtow-eepæ̀shim,*	Rutting-moon (of moose-deer).
November, December,	*Weetheekopeyoo-eepæ̀shim,*	Hoar-frost-moon.
December, January,	*Keesheh-pawattagganum,*	The great-dreaming-moon, the moon in which the sun travels low.
January, February,	*Keesheh-pawattagganawsees,*	Lesser-dreaming-moon.

The February moon, including part of March, is sometimes termed *Keesheh 'peeshim*, or Great Moon. The names of the months are by no means fixed in the Indian languages, varying with the nature of the district the hunter resides in, and perhaps with the fancy of the individual who speaks.

Remarks upon the Climate of Athabasca and Slave Lakes.

Having discussed as many facts respecting the Cumberland House climate as we could collect, I shall, before proceeding to details regarding the climate of Fort Enterprize, notice some circumstances connected with two intermediate spots, namely, Fort Chepewyan, on the Athabasca Lake, in Lat. 58° 43′ N., and Long. 111° 18′ W., and the Little Lake, near the *debouche* of Slave River into Slave Lake, in Lat. 61° 12′ N., Long. 113° 12′ W., because, at the former, barley, and I believe wheat, are advantageously cultivated, and the latter is the most northerly fur-post, at which, as far as my information goes, barley has been tried, and succeeded. We possess no observations of the temperatures of these districts for an entire year; but the summer temperatures of 1820, were obtained whilst we were travelling through them, and agree sufficiently near with the following interpolations; from which, however, the chilling effect of the icy covering of both lakes, in spring, is excluded.

TABLE VIII. *Interpolated from* TABLE II.

SEASONS.	Athabasa, Lat. 58¾ N. Long. 111⅓ W.	Slave Lake, Lat. 61¼ N. Long. 113¼ W.
Six summer months. April,—September, . .	+ 47°·33	+ 43°·24
Six winter months. October,—March, . .	— 0 ·40	— 4 ·14
Spring. March, April, and May, . . .	+ 20 ·61	+ 15 ·52
Summer. June, July, August, ...	+ 60 ·16	+ 57 · 0
Autumn. September, October, November, . .	+ 26 ·87	+ 23 ·59
Winter. December, January, February, . .	— 13 ·36	— 18 ·00
Mean annual temperature, .	+ 23°·56	+ 19°·53

TABLE IX. *Interpolated from* TABLE I.

SITUATION.	MEAN TEMPERATURES.			
	May.	June.	July.	Aug.
Athabasca, Lat. 58¾ N., . . .	41°·0	53°·6	62°·0	64°·5
Slave Lake, 61¼ N., . . .	37 ·2	50 ·6	60 ·5	60 ·0

These Tables shew, that, at Athabasca, there are three months which reach 51°·8, and that their united mean temperatures amount to 180°. At Slave Lake, there are only two months that attain that height; and the sum of their mean temperatures is 120°. At Slave Lake, in the year 1822, it was nearly the end of May before the mean temperature of any considerable number of days reached the vernal temperature of 42°·8. On the 25th of that month, Slave River broke up, the passage of the lake over the ice being at that time considered unsafe. From the 25th of May to the 2d of June, we observed, on the voyage to Fort Chepewyan, willows, gooseberries, the *Anemone Nuttalliana* (D.C.), *Aronia ovalis*, *Prunus Virginiana*, and *Hippophäe Canadensis*, flowering nearly in the order in which they are here mentioned. The leaves were also rapidly evolving at this period, in perfect accordance with Humboldt's observations as to the temperature required.

The *Prunus Virginiana* was not observed to the north of Slave Lake; and the *Pinus balsamea* also terminates there; although, farther to the westward on Mackenzie's River, it is said to attain a higher latitude. The *Populus balsamifera* sends straggling trees as far north as Lat. 63°; and the *Populus trepida* grew in pretty large clumps half a degree farther north, beyond which, however, it was not seen. The *Populus balsamifera* forms a large proportion of the drift-timber observed on the shores of that part of the Arctic Sea which we visited, and is supposed to come principally from the south branch of Mackenzie's River, named also *Rivière aux liards.*

Remarks upon the Climate of Fort Enterprize.

Fort Enterprize (now dismantled) stood in a district of primitive rocks, about $2\frac{1}{4}$° N. of Slave Lake, and $3\frac{1}{4}$° south of the Arctic Sea, above which it was supposed to be elevated about 800 feet. The banks of Winter River, upon which it was built, are ornamented with groves of the *white spruce-tree (Pinus alba)*, and flanked on each side by an irregular marshy plain, varying in breadth from one to three or four miles, somewhat broken by abrupt elevations of coarse gravel, and bounded by an amphitheatre of disconnected hills. The summits of these hills generally consist of naked, smooth, rounded masses of *gneiss:* their sides are very thinly covered with a loose gravelly soil, and frequently exhibit accumulations of large cubical fragments of gneiss, which are the *debris* of mural precipices of various heights. In the upper parts of the inclined valleys, at the bases of the hills, there is commonly a thin stratum of mountain peat, but the bottom of almost every valley is occupied by a lake. Many of these lakes are of a considerable depth, but a large proportion of them are entirely land-locked, communicating with each other only when flooded by the melted snow. Winter River is merely a succession of small rapids, connecting lakes of various magnitude with each other. This is the case with all the rivers that traverse the *barren grounds;* and the features of the description here given are characteristic of the whole district. The sides of the hills, and all the drier spots of the valleys, are clothed with a beautiful carpet of the lichens, which form the favourite food of the rein-deer, amongst which the *Cenomyce rangiferina*, *Cetraria nivalis* and *cucullata*, and *Cornicularia ochroleuca*, are predominant. The principal shrubs are the *Vaccinium uliginosum*, *Empetrum nigrum*, *Ledum palustre*, *Betula glandulosa*, and several *Salices*. The *Vaccinium vitis Idæa*, *Arbutus Uva Ursi* and *alpina*, are very common, and the *Andromeda polifolia*, and *Kalmia glauca*, occur in almost every peaty spot. In sheltered situations, where the peat is deeper than usual, there are frequently a few starved *larches* and *black spruces* scattered. There are also some thin clumps of the *Betula papyracea*, upon the borders of the rapids. The *white spruce* itself, which thrives better here than any other tree, is found only in sandy spots by the side of the river, or in valleys upon the borders of the lakes. Farther to the eastward, and more within the *barren grounds*, the trees disappear altogether; but a little to the westward, upon the secondary and transition strata of the Coppermine River, the white spruce, in scattered clumps, attains the Lat. of 67° 34′ N., within 13 miles of the Arctic Sea. Amongst the spruces cut down at Fort Enterprize one of

16 inches in circumference,	had	45	annual rings.
18	ditto,	90	ditto.
21	ditto,	90	ditto.
36	ditto,	130	ditto;

the greatest increase being an inch of circumference in three years, and the least an inch in five years. The average is four rings or years, to an increase of 1 inch in circumference, or about 1 inch of diameter in twelve years. The tree above mentioned, which measured 36 inches, was one of the best grown that was observed; but some, with short crooked trunks, measured more. Our house was 24 feet wide; and considerable difficulty was experienced in obtaining half a dozen transverse beams long enough to support the roof, most of the trees tapering too much. The spruces seen near the mouth of the Coppermine, were about one-third of the size of those which grew at Fort Enterprize. In a few sheltered alluvial spots on the barren grounds, the *Betula glandulosa* was about 4 feet high, and in a warm crevice at the mouth of Hood's River, Lat. 67$\frac{1}{3}$°, the *Alnus glutinosa* was found growing to the height of 5 or 6 feet.

Names of the Months in the Copper Indian Language, adapted to the meridian of Fort Enterprize.

1.	March, April,	*Det-anee-chazah.* Eagle-moon.
2.	April,	*Bennee-thleeng-thillah.* Dog-rump Moon. The month in which deer are run down with a dog, owing to a crust having formed upon the ice, sufficiently strong to bear a dog, but through which the deer break, and are impeded. Termed also Crust-moon.
	April, May,	*Khtunsee-hawzing-nawrœ-zelleh.* The month in which the icicles with crooked tips hang from the rocks.
3.	May, June,	*Bennee-akkawzœ.* Egg-moon. Laying-moon.
4.	July,	*Bennee-atchithœh.* Moulting-moon.
5.	August,	*Bennee assitzillœh.* The month in which the female rein-deer pass during the dewy nights with their young from the coast.
6.	September,	*Bennee-arasseetcho.* The moon in which the large or male rein-deer arrive from the coast.
7.	October,	*Bennee-awrhawnteh.* Rutting-moon.
8.	November,	*Bennee-tsee-ch' ellyee.* The moon in which the fœtus floats.
9.	November, December,	*Nea-ts-tsaillah.* Hoar-frost-moon. Trees covered with festoons of snow.
10.	January,	*Nee-tsa-tchoh.* The big moon of the earth. The long moon. Half the winter.
11.	January, February,	*Nintzee-za-tsillah.* The moon of light winds.
12.	February, March,	*Nintee-za-tchoh.* Big windy moon.

Table X.

Tabular view of the Progress of Spring in the year 1821 *at Fort Enterprize, Lat.* 64° 28′ *N. Long.* 116° 6′ *W.*

Date,	*Mean Temperatures.* Of preceding Month.	Of 10 preceding Days.	Of maximum for 10 Darys.	Of minimum for 10 Days.	Highest temperature within 10 Days.	Phenomena.
1821. Mar. 7.						Coloured spirit thermometer in the sun + 39°. In the shade + 6°
10.		—8.10°	+ 2.10°	—18.30°	+ 15°	+ 2 — 2
20.		—23.55	—13.80	—33.30	—1	
26.						+ 46 + 5
31.	—11.73°	—3.54	+ 8.73	—15.82	+ 24	+ 32 + 24
April 1.	...	...	...	...	...	+ 63 + 40
						Smart thaw all day. The snow at this time was nearly 3 feet deep on the lakes, and the ravines were nearly filled.
10.	...	+ 8.20	+ 18.70	—2.30	+ 40	Eagles seen. Rein-deer making a northerly movement. The fineness of the weather at this time induced the Indians to think that the spring, and consequent migration of the deer towards the coast, had commenced, but their hopes were deferred by the subsequent cold weather.
20.	...	—7.90	+ 3.20	—19.00	+ 21	Arctic hares copulating, and beginning to change their fur.
30.	+ 4.70	+ 13.80	+ 27.20	—0.10	+ 45	
May 3.	...	...	...	...	...	Temperature in the shade + 42. Hawks first seen. Young in the nests of the cinereous crow (*Corvus canadensis*). Down of the American hare becoming grey. Trees thawed. Sap beginning to flow.
5.	...	...	...	...	...	Twilight all night. Snow melted from the summits of the hills. Ptarmigan pairing. Temperature in the shade + 46.
7.	...	...	...	...	...	Large patches of ground on the sides of the hills visible, 7 weeks later than the same occurrence at Cumberland House, 10½ degrees more to the southward. Snow every where moist. Temperature in the shade + 41°.
8.	...	...	...	...	...	A house-fly seen.
9.	...	...	...	...	...	A merganser seen. Rein-deer migrating northwards, exactly a month later than the Indians had predicted, from the fine weather in April.

TABLE X.—*Continued.*

Date.	*Mean Temperatures.* Of preceding Month.	Of 10 preceding Days.	Of maximum for 10 days.	Of minimum for 10 Days.	Highest temperature within 10 Days.	PHENOMENA.
1821. May 10.	...	+ 31°.75	+ 42°.90	+ 20°.40	+ 52°	Two gulls seen. Berries of the *Vaccinium Vitis Idæa*, *Empetrum nigrum*, and *Arbutus alpina* may now be gathered abundantly, having withstood the winter. The berries of the *Vaccinium uliginosum* are also very fine in flavour at present, but so ripe and tender, that they can scarcely be plucked without crushing beneath the finger. The ground is still frozen, but the snow thaws rapidly in the sunshine. Many of the *Musci* are beginning to sprout, and the *calyptræ* of some *Jungermanniæ* are already visible.
11.	...	...	...	...	...	Loons (*Colymbus glacialis*) arrived.
17.	...	...	...	...	...	Teals (*Anas crecca*) killed. Their crops were filled with insects which now swarm in the small rivers.
20.	...	+ 26.55	+ 37.20	+ 15.90	+ 52	The weather for ten days past has been disagreeably cold and blowing, but the arrival of the summer birds shews, that the fine weather has set in to the southward; and we were informed by the natives, that, on the northern shores of Great Slave Lake, only 2½° to the southward, the snow was quite gone before the 10th of the month. A difference of nearly 10 days in the progress of spring was noticed in the following month, on advancing only 30 miles to the northward. The cold weather experienced at this period at Fort Enterprize, arose from northerly winds, caused, I suppose, by the heating of the earth, and consequently of the atmosphere to the southward. This cause of northerly winds terminated this year about the 20th of June, by the ground to the northward being cleared of snow, and getting rapidly heated. Up to this date, there was no external appearance of vegetation amongst the phenogamous plants except the gradual evolution of the willow catkins.

TABLE X.—*Continued.*

Date.	*Mean Temperatures.* Of preceding Month.	Of 10 preceding Days.	Of maximum for 10 days.	Of minimum for 10 Days.	Highest temperature within 10 Days.	PHENOMENA.
1821. May 21.	...	...	...	...	...	Geese arrived (*Anas Canadensis*, and *hyperborea*). Temp. + 39°.
28.	...	...	...	...	...	Temp. in shade + 68°. Plovers seen (*Charadrius pluvialis*). *Eriophorum* flowering.
31.	+ 31.60°	+ 36.50°	+ 48.27°	+ 24.73°	+ 68°	Snow nearly gone at Fort Enterprize, but on Point Lake half a degree farther north, and at the same elevation above the sea, scarcely begun to melt.
June 7.	...	...	...	...	...	On the 7th, in Lat. 55°, about 32 miles directly north from Fort Enterprize, and about 150 feet of greater elevation, the snow had scarcely diminished, except on the sides and summits of the hills which are all of small elevation. The first, or female band of reindeer passed Lat. 65° at this time, their progress over the *barren grounds* being regulated by the uncovering of the lichens. When the thaw is farther advanced, the lichens become too tender and pulpy, and the deer resort to the swamps to feed upon the hay or grass, which, frozen up in the end of autumn, retains its sap and nutritive qualities, on the snow first melting from around it in the spring. In a few days, however, the culms become dry, and the seeds are shed, the deer by that time having reached the sea-coast, where the sprouting *carices* form their food, but are not so fattening as the lichens.
8.	...	...	...	...	...	Sudden thaw at Point Lake, Lat. 65° 10′. *Eriophorum* just bursting forth there. It flowered ten days earlier at Fort Enterprize. *Note.* The temperatures up to the 10th, are from the register kept at Fort Enterprize; the following observations were made on Point Lake, Lat. 65°–66° N. Long. 113°–114 W.
10.	...	+41.55	+52.80	+30.30	+ 73	

Table X.—*Continued.*

Date.	*Mean Temperatures.* Of preceding Month.	Of 10 preceding Days.	Of maximum for 10 Days.	Of minimum for 10 Days.	Highest temperature within 10 Days.	PHENOMENA.
1821. June 12.	...	...	...	...	...	Thermometer at Point Lake rose to 78° in the shade. Hard rain. Small lakes broken up. Point Lake still covered with ice five feet thick. Robins (*Turdus migratorius*), Godwits *Limosa Fedoa*) and ducks hatching. A species of martin arrived. It builds a nest on the rocky precipices of the barren grounds, similar to the nests ef the house-martin in England.
14.	...	...	...	...	...	Temperature + 56°. Calm and fine weather. Snow melting fast. It lies at present only under the steep cliffs. The radiation of heat from the rocks that bound Point Lake is such, that the ice is perforated by large holes under every precipice. By these holes the water from the melted snow runs off. The diminution of ice on the lakes proceeds most rapidly on its under surface, from the contact of the warmer water. The *Salix desertorum* burst its catkins to-day.
15.	...	...	...	...	...	Temperature 60°. The streams that issue from the melting snow under the precipices and sides of the hills, are now pretty large, some of them scarcely fordable, and all the valleys are flooded. The *Arbutus alpina* began to flower to-day. All the small birds are hatching.
17.	...	...	...	...	...	Snow and sleet. Temperature 30° to 35°.
19.	...	...	...	...	...	Temperature 54°. Ice on the lake honey-combed from the action of the sun. *Anemone cuneifolia* in flower.
20.	...	+ 43°.35	+ 52°.10	+ 34°.60	+ 78°	
21.	...	...	...	...	...	*Midsummer-day.* Dwarf-birch (*Betula glandulosa*) opened its buds to-day. The last or male bands of deer have passed to the north, a few stragglers only remaining.
30.	+ 42°.05	+ 47.10	+ 35.40	+ 41.25	+ 56	The ice on Point Lake much decayed and honey-combed.

TABLE X.—*Continued.*

Date.	*Mean Temperatures.* Of preceding Month.	Of 10 preceding Days.	Of maximum for 10 Days.	Of minimum for 10 Days.	Highest temperature within 10 Days.	PHENOMENA.
1821. Juy 4.	...	...	...	...	...	The ice on the larger lakes in Lat. 66°, Long. 114° completely broken up. About the 18th or 19th of this month, the sea-ice at the mouth of the Coppermine River, in Lat. 67° 45′, is supposed to have broken up. The *Dryas integrifolia*, *Stellaria Edwardsii* and *Equisetum arvense*, flowered to-day. *Epilobium spicatum* sending up young shoots.
6.	...	...	...	...	...	In Lat. 66° 30′N. *Salix reticulata*, *Alnus glutinosa*, *Hippophaë Canadensis*, *Andromeda tetragona*, *Draba* —? *Draba aizoides* and *alpina*, *Pyrola rotundifolia Saxifraga cernua*, *nivalis*, *hirculus*, and *oppositifolia*, *Tofielda palustris*, *Phaca astragalina*, *Pedicularis Nelsonii*, *hirsuta*, and *Lapponica*, *Silene acaulis* and various Willows and Carices were observed in flower to-day. The *Juniperus communis* grows in the hills here, but was not seen in flower.
Aug. 17.	...	...	...	...	...	In Lat. 68° on the coast, we had a severe storm this day, which, with frosty weather and snow, continued for several days. The snow that fell at this time disappeared again, but on the 5th
Sept. 5.	...	...	...	...	...	of September a storm set in, which clothed all the Barren Grounds from Lat. 65° to 68° with snow for the winter.
Oct. 9.	...	...	...	...	...	On the 9th of October, the party walked over the small lakes between Point Lake and Fort Enterprize, which they had crossed on the ice in the middle of the preceding June, being an interval of 116 days. The ground was this year covered with snow a month before the lakes froze over, so that the snow lay for nine months, and there were occasional snow-showers in the three summer months.

By examination of Table III. we perceive that the summer temperature of Fort Enterprize is found at Churchill, in Latitude 59°; the neighbourhood of the ice which floats in Hudson's Bay until August, compensating, in this case, for a difference of 6½ degrees of latitude. The *isotheral line*, carried across to the Old Continent, passes near to Enontekies.

In no part of the barren grounds did we discover the ground to be perpetually frozen. The subsoil, however, at York-Factory is always frozen, a circumstance which is also to be attributed to the constant presence of ice in the Bay during the summer. The thaw at York (Latitude 57°) in September, was observed to penetrate three feet.

In Latitude 65° the sap of the spruce-tree freezes early in October, and in a short time the wood becomes as hard as a stone, the chips produced by a highly tempered hatchet being similar to saw-dust. The hatchets are speedily broken in this employment, which renders the Indians anxious to find dead and dry trees for winter use; and to procure a constant supply of this kind of fuel, they occasionally set fire to a clump of trees, expecting to find their trunks fit for use in two or three years.

At Slave Lake, where our attention was directed to this subject, the sap of all the other trees, and of the juniper-bush and other shrubs, was observed to freeze equally with that of the white spruce. The power of the direct rays of the sun upon the trees, causes them to shew signs of returning life before the earth acquires any warmth, and the ground about the roots of the larger trees is first cleared of snow, and thawed.

Having, in the preceding details of climate, mentioned the circumstances most likely to influence the distribution and growth of vegetables in the districts travelled through, I may remark, that the agency of man, so powerful in modifying the appearance of the vegetable kingdom in other quarters of the globe, is scarcely to be detected in these remote lands. Cultivation of the ground is entirely confined to a few small gardens at the fur-posts, and the utmost effect that can be ascribed to it, is the introduction of a few herbs from Canada and Europe, along with the *Cerealea* and culinary vegetables. The majority of the introduced plants is perhaps comprised in the following brief list of the species, which were found only in the direct trading route; but several, even of these, may nevertheless be indigenous. *Blitum capitatum, Veronica peregrina, Lycopus Virginicus, Hordeum jubatum, Myosotis lappula, Rumex acutus, Cerastium viscosum, Spergula nodosa, Euphrasia officinalis, Lepidium ruderale, Atriplex* , *Urtica gracilis.*

The only mode in which the arts and customs of the natives affect the vegetable kingdom, is by their setting fire, either accidentally or intentionally, to the forests. These fires, when they occur during summer in the woody district, spread rapidly through the dry moss, consuming the soil down to the rocks, and are only extinguished by heavy showers of rain. Several years elapse before any thing grows in the district thus laid waste. The blackened and branchless trunks of the trees are in a season or two stripped of their bark and bleached, if not sooner thrown down by the wind. The surface of the ground next acquires a little verdure from the *Funaria hygrometrica, Bryum pyriforme, Didymodon purpureum, Marchantia polymorpha* and *conica*, and some other *Musci* and *Hepaticæ.* By and by other vegetables take root, and in process of time the site of a pine-forest is occupied by dense thickets of slender aspens *(Populus trepida).* The growth of this tree, instead of a renewal of the pine-forest, may be attributed either to a change in the nature of the soil, perhaps by the introduction of a greater quantity of alkaline matter,—to its winged seeds favouring its dispersion,—or to both causes conjoined. The ashes of the poplar yield much more alkali than those of any of the pines do.

Fires frequently spread amongst the dry grass in the plains of Carlton House; but their principal effect there seems to be the production of finer pasture in the following season. They do not seem in general severe enough to destroy the roots of the grass, or to burn the soil. The migrations of the herds of the bison or buffalo, are much influenced by the extent and direction of these fires.

Table XI. *Arrangement of Plants growing in the Hudson's Bay countries, and adjoining Lands, from* Lat. 53° N., *and to the westward of* Long. 116° W.

Classes and Families.	Total of Species.	Woody Region.	Barren Grounds.	Common to both districts.
CL. I. ACOTYLEDONES, -	302	96	138	68
Ord. I. Fungi.				
Sphæria,	2	2		
Hysterium,	1	1		
Agaricus,	3		3	
Cantharellus,	1		1	
Lycoperdon,	2	1		1
Schizophyllum,	1	1		
Dædalia,	1	1		
Polyporus,	5	5		
Hydnum,	1	1		
Thelephora,	2	2		
Tremella,	2		1	1
Peziza, -	2	2		
Erinæum,	1	1		
	24	17	5	2
II. Lichenes.				
Lepraria, -	2		1	1
Arthonia,	1	1		
Spiloma, -	1	1		
Solorina, -	1		1	
Gyalecta, -	1		1	
Lecidea, -	24	10	12	2
Calicium,	4	2		2
Gyrophora,	7		4	3
Opegrapha,	2	2		
Verrucaria,	2	2		
Endocarpon,	2		2	
Thelotrema,	1			1
Variolaria,	1		1	
Urceolaria,	1		1	
Lecanora,	22	3	14	5
Parmelia,	14	5	4	5
Borrera, -	3	1	1	1
Cetraria, -	7		4	3
Peltidea, -	2	1		1
Nephroma,	2	1		1
Evernia, -	1	1		
Dufourea,	2		2	
Cenomyce,	10		2	8
Cerania -	1		1	
Stereocaulon,	1			1
Sphærophoron,	1		1	
Lichenes.				
Alectoria,	1			1
Ramalina,	2			2
Cornicularia,	6		6	
Usnea, -	3	1	1	1
Collema, -	2		2	
	130	31	61	38
III. Algæ.				
Oscillatoria,	1			1
Conferva,	2	1	1	
Ulva, -	2		2	
Fucus, -	7	1	6	
	12	2	9	1
IV. Characeæ.				
Chara, -	1	1		
V. Hepaticæ.				
Riccia, -	1	1		
Jungermannia,	13	3	10	
Marchantia,	2	1		1
	16	5	10	1
VI. Musci.				
Voitia, -	1		1	
Andræa,	1		1	
Sphagnum,	2			2
Gymnostomum,	1		1	
Anictangium,	1			1
Tetraphis,	1	1		
Sphlachnum,	10	1	9	
Asplodon,	1		1	
Encalypta,	2			2
Weissia, -	1	1		
Grimmia,	3		2	1
Syntrichia, Barbula, Tortula,	4	1	2	1
Trichostomum,	1			1
Dicranum,	12	2	9	1
Fissidens,	1			1
Didymodon,	1		1	
Orthotrichum,	7	2	2	3

Classes and Families.	Total of Species.	Woody Region.	Barren Grounds.	Common to both districts.
Musci.				
Bartramia,	3		3	
Webera, -	3	1	2	
Funaria, -	1	1		
Meesia, -	1		1	
Timmia, -	1		1	
Pohlia, -	3		3	
Bryum, -	5	1	2	2
Mnium, -	5	3		2
Climacium,	1	1		
Neckera,	1	1		
Leskea, -	1	1		
Hypnum,	17	12	3	2
Polytrichum,	9		7	2
	101	29	51	21
VII. Filices.				
Polypodium,	2	2		
Woodsia,	2	2		
Athyrium,	1	1		
Nephrodium,	1			1
Pteris, -	1	1		
Cryptogramma,	1	1		
	8	7		1
VIII. Lycopodineæ.				
Lycopodium,	5	1	1	3
IX. Equisetaceæ.				
Equisetum,	6	1	1	1
CL. II. MONOCOTYLEDONES,	113	70	26	17
Ord. I. Gramineæ.				
Hierochloe,	3	1	2	
Oryzopsis,	1	1		
Stipa, -	2	2		
Aira, -	1	1		
Trisetum,	1			1
Deschampsia,	1		1	
Dupontia,	1		1	
Pleuropogon,	2		2	
Elymus, -	3	2	1	
Festuca, -	3		2	1
Poa, -	8	3	3	2
Beckmannia,	1	1		
Avena, -	1	1		

Classes and Families.	Total of Species.	Woody Region.	Barren Grounds.	Common to both districts.
Gramineæ.				
Bromus, -	1			1
Hordeum,	1	1		
Calamagrostis,	3	2	1	
Agrostis, -	1	1		
Colpodium,	1		1	
Phippsia,	1		1	
Alopecurus,	2	1	1	
	38	17	16	5
II. Cyperaceæ.				
Eriophorum,	4	1	1	2
Scirpus, -	4	3		1
Eleocharis,	1	1		
Kobresia,	1	1		
Carex, -	24	17	5	2
	34	23	6	5
III. Junceæ.				
Juncus, -	8	4	2	2
Luzula, -	3	1	1	1
	11	5	3	3
IV. Melanthaceæ.				
Tofieldia,	3	1	1	1
V. Asparageæ.				
Smilacina,	3	3		
VI. Asphodeleæ.				
Allium, -	2	2		
VII. Liliaceæ.				
Lilium, -	1	1		
Uvularia, -	1	1		
Zygadenus,	1	1		
	3	3		
VIII. Irideæ.				
Sisyrinchium,	1	1		
IX. Orchideæ.				
Habenaria,	5	5		
Neottia, -	1			1
Corallorhiza,	1	1		
Calypso, -	1	1		
Cypripedium,	3	3		
	11	10		1

Classes and Families.	Total of Species.	Woody Region.	Barren Grounds.	Common to both districts.
X. Aroideæ.				
Calla, -	1	1		
Lemna, -	2	2		
Typha, -	1	1		
	4	4		
XI. Juncagineæ.				
Triglochin,	2			2
XII. Fluviales.				
Potamogeton,	1	1		2
CL. III. DICOTYLEDONES,	425	278	85	62
Ord. I. Coniferæ.				
Pinus, -	5	4		1
Juniperus,	2	1		1
Thuya, -	1	1		
	8	6		2
II. Corylaceæ.				
Corylus, -	1		1	
III. Salicinæ.				
Salix, -	30	20	8	2
Populus, -	2	2		
Alnus, -	1			1
Betula, -	3	2		1
Myrica, -	1	1		
	37	25	8	4
IV. Urticeæ.				
Urtica, -	1	1		
V. Eleagni.				
Eleagnus,	1	1		
Hippophaë,	1			1
	2	1		1
VI. Santaleæ.				
Comandra,	2	2		
VII. Polygoneæ.				
Polygonum,	2	1		1
Rumex, -	3	2		1
Oxyria, -	1		1	
	6	3	1	2

Classes and Families.	Total of Species.	Woody Region.	Barren Grounds.	Common to both districts.
VIII. Chenopodeæ.				
Blitum, -	1	1		
Atriplex, -	1	1		
	2	2		
IX. Plantagineæ.				
Plantago,	3	2	1	
X. Plumbagineæ.				
Statice, -	1			1
XI. Primulaceæ.				
Lysimachia,	1	1		
Primula, -	4	3	1	
Androsace,	2		1	1
Dodecatheon,	1	1		
Trientalis,	1	1		
Glaux, -	1			1
	10	6	2	2
XII. Lentibulariæ.				
Utricularia,	1	1		
Pinguicula,	2	1		1
	3	2		1
XIII. Labiatæ.				
Lycopus, -	3	3		
Mentha, -	1	1		
Stachys, -	1	1		
Dracocephalum,	1	1		
Scutellaria,	1	1		
	7	7		
XIV. Scrophularinæ				
Euphrasia,	2	2		
Bartsia, -	3	3		
Rhinanthus,	1	1		
Pedicularis,	10	3	6	1
Veronica,	1	1		
	17	10	6	1
XV. Boragineæ.				
Myosotis,	1	1		
Lithospermum,	4	3		1
	5	4		1

Classes and Families.	Total of Species.	Woody Region.	Barren Grounds.	Common to both districts.
XVI. Hydrophylleæ				
Eutoca, -	1	1		
XVII. Polemoniaceæ				
Phlox, -	1	1		
XVIII. Gentianeæ.				
Swertia, -	1	1		
Gentiana,	4	4		
Menyanthes,	1	1		
	6	6		
XIX. Apocineæ.				
Apocynum,	1	1		
XX. Ericinæ.				
Kalmia, -	1			1
Rhododendron,	1		1	
Menziesia,	1	1		
Azalea, -	1			1
Andromeda,	4	1		3
Arbutus, -	2			2
Ledum, -	2	1		1
Empetrum,	1			1
	13	3	1	9
XXI. Vaccineæ.				
Vaccinium,	5	3		2
Oxycoccos,	1			1
	6	3		3
XXII. Monotropeæ.				
Pyrola, -	5	3		2
XXIII. Campanulaceæ.				
Campanula,	3	2	1	
XXIV. Compositæ.				
1. *Cichoraceæ.*				
Sonchus, -	1	1		
Leontodon,	1			1
Troximon,	1	1		
Hieracium,	3	2	1	
Crepis, -	1		1	
2. *Cinarocephalæ.*				
Saussuria,	1		1	
3. *Corymbiferæ.*				
Tanacetum,	1	1		
Artemisia,	8	5	2	1
Compositæ.				
Antennaria,	3	2	1	
Erigeron,	6	5	1	
Tussilago,	4	2	1	1
Senecio, -	6	5	1	
Cineraria,	6	2	3	1
Aster, -	9	8	1	
Solidago,	9	9		
Arnica, -	2	1		1
Grindelia,	1	1		
Chrysanthemum,	2		2	
Achillea, -	2			2
	67	45	15	7
XXV. Valerianeæ.				
Valeriana,	2	2		
XXVI. Rubiaceæ.				
Galium, -	2	2		
XXVII. Caprifoliaceæ.				
Linnæa, -	1	1		
Caprifolium,	1	1		
Xylosteum,	3	3		
Symphorium,	1	1		
Viburnum,	2	2		
Cornus, -	2	2		
	10	10		
XXVIII. Araliæ.				
Aralia, -	1	1		
XXIX. Umbelliferæ				
Cicuta, -	2	2		
Smyrnium,	1	1		
Heracleum,	1	1		
	4	4		
XXX. Halorageæ.				
Hippuris,	2	2		
Myriophyllum,	1	1		
	3	3		
XXXI. Onagrariæ.				
Œnothera,	1	1		
Epilobium,	4	2	1	1
	5	3	1	1

Classes and Families.	Total of Species.	Woody Region.	Barren Grounds.	Common to both districts.
XXXII. Papilionac.				
Thermopsis,	1	1		
Lupinus, -	1			1
Lathyrus,	1	1		
Pisum, -	1			1
Vicia, -	1	1		
Hedysarum,	3	2		1
Phaca, -	2	1		1
Oxytropus,	6	3	3	
Astragalus,	6	5	1	
	22	14	4	4
XXXIII. Rosaceæ.				
Sorbus, -	1	1		
Aronia, -	1	1		
Rosa, -	1	1		
Rubus, -	5	4		1
Geum, -	1	1		
Sieversia,	3	2	1	
Potentilla,	13	9	3	1
Sibbaldia,	1	1		
Comarum,	1	1		
Dryas, -	2	1		1
Prunus, -	2	2		
Spiræa, -	1	1		
	32	25	4	3
XXXIV. Grossular.				
Ribes, -	9	9		
XXXV. Saxifrageæ.				
Saxifraga,	16	4	6	6
Chrysosplenium,	1			1
Parnassia,	2		1	1
Adoxa, -	1	1		
Mitella, -	1	1		
Heuchera,	1	1		
	22	7	7	8
XXXVI. Rhamneæ.				
Rhamnus,	1	1		
XXXVII. Aceraceæ.				
Acer, -	1	1		
XXXVIII. Geraniac.				
Geranium,	1	1		
XXXIX. Lineæ.				
Linum, -	1	1		
XL. Caryophylleæ.				
Silene, -	1		1	
Lychnis, -	3	1	2	

Classes and Families.	Total of Species.	Woody Region.	Barren Grounds.	Common to both districts.
Caryophylleæ.				
Spergula, -	1	1		
Cerastium,	4	2	1	1
Arenaria, -	8	3	5	
Stellaria, -	7	4	2	1
	24	11	11	2
XLI. Cisteæ.				
Hudsonia,	1	1		
XLII. Violaceæ.				
Viola, -	7	7		
XLIII. Polygaleæ.				
Polygala, -	2	1		1
XLIV. Cruciferæ.				
Nasturtium,	1	1		
Barbarea,	1	1		
Braya, -	1		1	
Platypetalum,	2		2	
Eutrema,	1		1	
Turritis, -	1	1		
Arabis, -	5	4	1	
Parrya, -	1		1	
Cardamine,	4	1	2	1
Vesicaria,	2	1	1	
Draba, -	11	3	7	1
Cochlearia,	1		1	
Capsella,	1	1		
Sisymbrium,	3	2		1
Erysimum,	1	1		
Lepidium,	1	1		
	37	17	17	3
XLV. Fumariæ.				
Corydalis,	2	2		
XLVI. Papaveraceæ.				
Papaver, -	1		1	
XLVII. Nymphæac.				
Nuphar, -	1	1		
Sarracenia,	1	1		
	2	2		
XLVIII. Ranuncul.				
Thalictrum,	1	1		
Anemone,	6	3	1	2
Ranunculus,	12	7	3	2
Caltha, -	3	2	1	
Coptis, -	1	1		
Aquilegia,	1	1		
Actæa, -	1	1		
	25	16	5	4

Remarks upon Table XI.—The materials of the preceding Table are principally derived from the *Botanical Appendix* to Captain Franklin's *Narrative*, which has furnished upwards of 700 of the species. To these, 65 phænogamous plants have been added from Pursh, that were collected at Hudson's Bay by Tilden and others, and are preserved in the Sherardian and Banksian herbaria. The most northerly of Michaux's plants being collected to the southward of Latitude 53°, do not enter into our list; and the plants collected by Nelson and Menzies on the North-west coast, being from countries to the westward of the Rocky Mountains, and for the most part too far to the south, are also excluded. Thirty-three species, however, of phænogamous plants, from Mr Brown's *Botanical Appendix* to Captain Parry's first voyage, have been added to the column headed "Barren Grounds," together with seven from the herbaria made in Captain Parry's second voyage, and a few from Mr Brown's *List of the Plants* collected by Captain Ross, making the entire list in the Table amount to 840 plants.

The collections of Captains Parry and Ross compensate for the loss of the summer collection of 1821, in Captain Franklin's journey.

The structure of the Table is too simple to require explanation. The Woody Districts extend from Latitude 53½ or 54° to Latitude 64° south, or nearly to Fort Enterprize. The Barren Grounds from Latitude 64° to the most northerly parts visited, or to 74°. By adding the plants in the last column to those in either of the two preceding ones, the whole vegetation of that district, as far as detected, is found.

The phænogamous plants in the preceding Table stand thus:

Woody Region.	Barren Grounds.	Total.
427	190	538

there being 79 species common to the two districts.

TABLE XII.

Names of Families arranged in the order of the Numbers of their Species which inhabit the Woody District.	*Woody District, Lat.* 53½°—64°.		*Barren Grounds, Lat.* 64°—70°.		*Lancaster Straits, about Lat.* 74°.	
	No. of Species.	Prop. borne by a Family to all the Phenogamous Plants of the District.	No. of Species.	Prop. borne by a Family to all the Phenogamous Plants of the District.	No. of Species.	Prop. borne by a Family to all the Phenogamous Plants of the District.
PHANEROGAMÆ,	427		190		70	
DICOTYLEDONES,	340	1 : 1.26	147	1 : 1.29	50	1 : 1.40
MONOCOTYLEDONES,	87	1 : 4.79	43	1 : 4.37	20	1 : 3.50
Compositæ, -	52	1 : 8.21	22	1 : 8.64	5	1 : 14.00
Salicinæ, - -	29	1 : 14.72	12	1 : 15.83	1	1 : 70.00
Rosaceæ, -	28	1 : 15.26	7	1 : 27.14	4	1 : 17.50
Cyperaceæ, -	28	1 : 15.25	11	1 : 17.27	4	1 : 17.50
Gramineæ, -	22	1 : 19.41	21	1 : 9.05	14	1 : 5.00
Cruciferæ, -	20	1 : 21.35	20	1 : 9.50	11	1 : 6.36
Ranunculaceæ,	20	1 : 21.35	9	1 : 21.11	5	1 : 14.00
Papilionaceæ,	18	1 : 23.72	8	1 : 23.75	2	1 : 35.00
Saxifrageæ, -	15	1 : 28.46	15	1 : 12.66	10	1 : 7.00
Caryophylleæ,	13	1 : 32.84	13	1 : 14.61	6	1 : 11.66
Ericinæ, -	12	1 : 35.58	10	1 : 19.00	1	1 : 70.00
Scrophularinæ,	11	1 : 38.82	7	1 : 27.14	1	1 : 70.00
Orchideæ, -	11	1 : 38.82	1	1 : 190.00	—	—
Caprifoliaceæ,	10	1 : 42.70	—	—	—	—
Grossulariæ, -	9	1 : 47.44	—	—	—	—
Junceæ, -	8	1 : 53.38	6	1 : 31.66	2	1 : 35.00
Primulaceæ, -	8	1 : 53.38	4	1 : 47.50	—	—
Coniferæ, -	8	1 : 53.38	2	1 : 95.00	—	—
Labiatæ, -	7	1 : 61.00	—	—	—	—
Violaceæ, -	7	1 : 61.00	—	—	—	—
Vaccineæ, -	6	1 : 71.16	3	1 : 63.33	—	—
Gentianeæ, -	6	1 : 71.16	—	—	—	—
Polygoneæ, -	5	1 : 85.40	3	1 : 63.33	2	1 : 35.00
Monotropeæ, -	5	1 : 85.40	2	1 : 95.00	—	—
Onagrariæ, -	4	1 : 106.75	2	1 : 95.00	—	—
Umbelliferæ, -	4	1 : 106.75	—	—	—	—
Aroideæ, -	4	1 : 106.75	—	—	—	—
Lentibulariæ, -	3	1 : 143.33	1	1 : 190.00	—	—
Melanthaceæ, -	2	1 : 213.50	2	1 : 95.00	—	—
Juncagineæ, -	2	1 : 213.50	2	2 : 95.00	—	—
Plantagineæ, -	2	1 : 213.50	1	1 : 190.00	—	—
Campanulaceæ,	2	1 : 213.50	1	1 : 190.00	1	1 : 70.00
Eleagni, - -	2	1 : 213.50	1	1 : 190.00		
Polygaleæ, -	2	1 : 213.50	1	1 : 190.00		
Plumbagineæ, -	1	1 : 427.00	1	1 : 190.00		
Papaveraceæ, -	—	—	1	1 : 190.00	1	1 : 70.00

The following families, as well as those distinguished in the preceding list by blank spaces in the column headed " Barren Ground," were not observed to extend beyond the wooded district.

7 families of two species,

Asphodeleæ	Santaleæ	Chenopodeæ
Valerianeæ	Rubiaceæ	Fumareæ
Nymphæaceæ		

And 13 families of one species,

Irideæ	Fluviales	Corylaceæ
Urticeæ	Hydrophylleæ	Polemoniaceæ
Apocineæ	Araliæ	Rhamneæ
Aceraceæ	Geraniaceæ	Lineæ
Cisteæ		

Table XII. is compiled from Table XI. The column headed "Lancaster Straits" is from *Mr Brown's Botanical Appendix to Captain Parry's First Voyage*, with the addition of two *Cruciferæ* and one of the *Caryophylleæ* from his *List of Captain Ross's Plants.*

Table XIII.—*Principal Families of Plants in the Three Districts, arranged in the order of the Number of their Species.*

Woody District.	*Barren Grounds.*	*Lancaster Straits.*
Compositæ	Compositæ	Gramineæ
Salicinæ	Gramineæ	Cruciferæ
Rosaceæ	Cruciferæ	Saxifrageæ
Cyperaceæ	Saxifrageæ	Caryophylleæ
Gramineæ	Caryophylleæ	Compositæ
Cruciferæ	Salicinæ	{ Cyperaceæ
Ranunculaceæ	Cyperaceæ	{ Ranunculaceæ
Papilionaceæ	Ericinæ	{ Rosaceæ
Saxifrageæ	Ranunculaceæ	{ Papilionaceæ
Caryophylleæ	Papilionaceæ	{ Junceæ
Ericinæ	Rosaceæ	{ Polygoneæ
Scrophularinæ	Scrophularinæ	{ Salicinæ
Junceæ	Junceæ	{ Scrophularinæ
Polygoneæ	Polygoneæ	{ Ericinæ

Chatham,
January 1. 1825.

CORRIGENDA.

Page 200. Tab. I. *insert* Long. of Winter Island, 83½° W.; of Igloolik, 82½° W.; and of Melville Island, 111° W.

P. 202. Tab. II. col. 3. *for* Lat. 66° near Fort Enterprize, *read* Lat. 64°; and in col. 4. *for* Lat. 64¼° *read* Lat. 66¼° Winter Island.

P. 203. Tab. III. line Near Fort Enterprize, *for* Lat. 54° *read* Lat. 64°; and in line Melville Island, *for* Long. 11° *read* 111°; and in a line with *Europe* col. Long. *insert* E.

P. 206. Tab. VI. line 2d of title, *for* Lat. 58° 57′ *read* 63° 57′

P. 224. Tab. XI. line 2d of title, for *westward* read *eastward*

Art. II.—*Tables of Summer Temperatures observed in Spitzbergen by Captain* Franklin *and Captain* Buchan.

The following Tables of summer temperatures, observed during Captain Franklin's voyage to Spitzbergen with Captain Buchan, communicated to us for publication in the Philosophical Journal, are important, not only as connected with the climate of Spitzbergen, but also as illustrating some of the views taken of climate by Dr Richardson, in his very interesting and able memoir, "On the Climate and Vegetable Productions of the Hudson's Bay Countries," also published in the present Number.

TABLE of Temperatures taken on board H. M. S. Trent, Captain Franklin. Observations made every hour, and the daily means deduced from the 24 observations.

Month.	Temp. Atmosphere.	Temp. Sea at surface.	Month.	Temp. Atmosphere.	Temp. Sea at surface.	Month.	Temp. Atmosphere.	Temp. Sea at surface.
June 1.	24°.8	27°.7	July 1.	39°.0	33°.6	Aug. 1.	35°.8	37°.5
2.	22.8	28.1	2.	37.3	33.7	2.	31.0	36.9
3.	24.0	28.7	3.	36.6	33.8	3.	34.6	37.5
4.	29.4	31.1	4.	36.2	34.1	4.	33.4	37.3
5.	32.4	33.5	5.	36.6	34.1	5.	33.9	37.3
6.	29.2	30.1	6.	34.6	34.3	6.	36.1	38.5
7.	30.8	31.1	7.	33.8	34.5	7.	36.6	37.3
8.	32.1	31.0	8.	34.8	32.0	8.	36.1	36.9
9.	32.5	27.6	9.	32.8	30.8	9.	37.3	37.1
10.	32.2	30.8	10.	36.1	31.2	10.	35.8	36.9
11.	37.4	34.9	11.	38.7	31.5	11.	37.3	37 0
12.	37.7	35.0	12.	36.7	31.5	12.	38.9	38.2
13.	34.8	30.2	13.	38.3	31.4	13.	30.7	36.5
14.	36.8	30.0	14.	39.1	32.2	14.	35.0	36.9
15.	43.0	30.8	15.	37.0	32.7	15.	37.4	36.9
Lat. 80° N.; Long. 10° East. 16.	36.9	31.6	16.	36.8	32.3	16.	33.5	35.7
17.	35.5	30.3	17.	36.3	32.7	17.	32.1	36.9
18.	30.2	30.7	18.	36.4	32.8	18.	32.2	36.1
19.	36.9	30.5	19.	33.3	32.2	19.	31.9	35.9
20.	36.3	30.9	20.	34.9	32.3	20.	29.5	35.9
21.	36.4	30.5	21.	33.9	32.2	21.	31.6	34.0
22.	36.8	30.0	22.	33.2	31.8	22.	33.3	31.5
23.	36.3	30.7	23.	37.1	31.8	23.	31.5	35.5
24.	35.5	32.8	24.	35.8	32.0	24.	33.1	36.1
25.	31.5	32.7	25.	34.7	31.5	25.	37.6	37.3
26.	34.9	33.2	26.	33.6	31.8	26.	35.8	36.1
27.	32.4	32.7	27.	34.4	31.7	27.	30.7	35.2
28.	36.2	33.0	28.	36.2	31.6	28.	30.8	35.4
29.	37.3	33.0	29.	36.1	32.5	29.	31.4	35.5
30.	39.0	33.6	30.	39.8	35.1	30.	30.4	33.6
			31.	34.6	34.7	31.	31.3	35.8
Means,	33°.73	31°.22	Means,	35°.98	32°.60	Means,	33°.80	36°.40

Mean Temperature of the Air for 10 *or* 11 *days, taken on board H. M. S. Trent, Lieutenant Franklin, in the year* 1818, *at Spitzbergen.—Means deduced from hourly observations.*

Date.	Means of 10 days.	Situation. Lat.	Situation. Long.
May 20–31.	32°.55	76° 30′	12° 0′ E.
June 1–10.	29.02	79 45	10 0
... 11–20.	36.55	79 55	10 0
... 21–30.	35.63	79 55	10 0
July 1–10.	35.78	80 0	10 15
... 11–20.	36.75	80 25	10 30
... 21–31.	35.40	80 15	11 15
Aug. 1–10.	35.06	79 45	9 45
... 11–20.	33.85	79 40	9 45
... 21–31.	32.50	79 40	9 45

Mean Temperatures for the Summer, *June, July and August, shewing that Latitude is of less importance in a Maritime Climate in Summer.*

Place.	Temp. of Atmosphere.	Latitude.	Longitude.	Year.
Spitzbergen,......	34°.50	80° 0′ N.	10° 0′ E.	1818
Melville Island,...	37.11	74 45	110 0 W.	1820
Winter Island,...	35.23	69 30	82 30	1822–3
Igloolik,...........	32.37	66 15	83 0	1821–2

Mean Temperature of Warmest Month.

Spitzbergen,............35°.98 July.
Melville Island, ... 42.41 July, (climate partly continental).
Winter Island,..........40.00 July.
Igloolik,.................36.60 Aug. (July, 36°.50).

Art. III.—*Table of the Temperature of the Sea, at various depths, made during Captain* Franklin*'s Voyage to Spitzbergen with Captain* Buchan.

May 26.—In Lat. 76° 48′ N., Long. 12° 26′ E., a bottle was attached to a line, and let down to the depth of 600 fathoms.

It came up filled with water, having a temperature of 43°, the temperature of water at the surface of the sea being then 33°, and of the atmosphere 29°. Small pieces of ice were floating round the ship, and the land of Spitzbergen was distant 6 or 7 leagues.

The following observations were made on water brought up from different depths, in a leaden-box prepared on the suggestion of Mr Fisher, with two valves which remained open in descending, but were closed in the ascent.

Date.	Lat.	Long.	Temp. of water at surface.	Temp. of water brought up.	Depth to which the vessel was let down.	Remarks.
1818, June 20.	79° 58′ N.	11° 25′ E.	31°.5 F.	31°.0 F.	Fathoms. 24	At the bottom.
21.	79 56	11 30	30.0	31.0	19	Do.; ship surrounded by ice.
22.	80 0	11 14	30.0	31.0	33	Do.
23.	79 59	10 12	31.5	32.5	21	Do.; beset by ice.
25.	79 51	10 0	33.0	34.0	60	At the bottom.
...	...	...	33.0	34.0	17	Clear water near the land.
26.	79 44	9 33	34.0	34.0	15	At the bottom. Clear water some miles from the ice.
27.	79 51½	10 0	34.0	34.5	72	
29.	79 51	10 0	34.0	34.0	17	
...	...	...	34.0	34.0	19	Near the land in a current.
July 6.	74 48	10 15	34.0	34.5	34	At the bottom.
7.	80 18	11 10	33.0	36.0	120	Do.; beset by ice.
8.	80 20	11 10	31.5	36.5	130	Do. do.
9.	80 20	10 55	30.5	35.5	110	Do. do.
10.	80 19	11 24	32.0	36.0	119	Do. do.
11.	80 22	10 30	32.0	36.0	120	Do. do.
12.	80 20	11 7	32.0	35.8	145	Do. do.
13.	80 22	10 2	32.0	35.5	235	Do.
14.	80 26	10 45	32.0	35.5	233	Do.; beset by ice.
15.	80 27	10 20	32.0	36.0	198	Do.
16.	80 26	11 25	36.5	36.3	173	Do.
17.	80 27	11 0	34.0	35.5	285	Do.; beset by ice.
18.	80 26	10 30	32.5	36.0	331	Do. do.
19.	80 24	11 14	31.5	36.5	103	Do. do.
20.	80 21	10 12	32.5	35.5	108	Do. do.
21.	80 14	11 12	32.5	35.3	95	Do. do.
22.	80 13	11 31	31.0	35.8	83	Do. do.
23.	80 15	11 36	32.5	36.8	73	Do. do.
25.	80 18	11 40	32.5	36.0	91½	Do. do.
26.	80 20	11 25	32.5	36.0	55	Do.

Art. IV.—*On the Fog of the Polar Regions.* By Professor Hansteen. (Continued from page 93. of this Volume).

Hudson's Bay and Straits, Baffin's Bay, and the sea around Greenland, are distinguished, in a remarkable manner, by a thick fog, which almost constantly prevails there. Captain Parry suffered much inconvenience from this fog, when he got into Lancaster Sound, and into the Straits discovered by him, which he calls Barrow's Straits; and the more on this account, that the compass ceased here to have any fixed direction, or, as the sailors say, it wandered.

Lieutenant (now Captain) Franklin, too, if I remember right, experienced the same thing on his land expedition, along the northern coasts of America on the Polar Sea. Captain William Scoresby's explanation of the origin of this fog seems very admissible, though there may be found other circumstances concurring to the production of the same effect. A similar thick fog prevails likewise in the sea which surrounds Terra del Fuego. I have mentioned already, that Don Antonio de Ulloa says, in his letter to Mairan, that, in sailing round Cape Horn, he found only a few moments when he could obtain a slight glance of the sky. As the same fog is neither so thick nor so constant in other places of the same latitude, in Behring's Straits for instance, or south from the Cape of Good Hope, it is not impossible that the streaming of the magnetic power, or of the polar lights, here, too, played their part. It is known by experience, that, while these streamers are flowing, the sky has a tendency to become opake and misty. While the polar lights pass through the air, they must have the effect, in penetrating the watery vapours existing in it, in a transparent state, of taking from them their heat, and thereby rendering them opake. When a solid body passes over into a fluid, or a fluid body into a gaseous state, it acquires a greater quantity of heat; and, in acquiring it, thus robs every surrounding body with which it comes in contact, of a part of what they contain. It is thus, in warm climates, they cool vessels by surrounding them with wet cloths; so that the evaporation of the water in the form of steam, deprives the vessel of a great portion of its heat. In the same manner has Nature provided for the cooling of the animal body, in the time of excessive heat, by the increased perspiration, the evaporation of which preserves it in an almost unchanged temperature. Now, as the polar lights are an expansible substance, which, in regions surrounding the magnetic poles, is continually issuing from the surface of the earth, even at times when we who lie at a distance from these points perceive nothing of this, it may be conceived, that this stream, in passing through the atmosphere, is continually lowering its temperature, and thus, in decomposing the watery vapours, producing fog. In this manner, too, may be explained another well known phenomenon. It might be expected, that, in the same parallels, the mean temperature would be every where nearly the same, as the length of the day, and the height of the sun, depend alone on the latitude. But this is by no means the case. In that parallel which passes the 60th degree of north latitude, the temperature is the lowest in Hudson's Bay, and at the south point of Greenland. As we approach the coasts of Norway it rises, and in Christiania and Stockholm, is about $+5°$. In Petersburgh it has begun to descend, and the farther we advance to the east it becomes the lower; so that a Siberian cold has become a proverbial expression. Although Cape Horne lies in the 56th degree of south latitude, that is about the same latitude with Copenhagen, the cold there is intolerable; and yet at other points of the same parallel it is less. It seems also pretty well proved, that, in one and the same parallel, the mean temperature is least in the meridians which pass through the magnetic poles. Count Humboldt has rendered this distribution of temperatures subject, in a very remarkable manner, to our observation, by connecting, on a chart, all the points where the mean temperature is the same, by a sort of curve lines, which he calls Isothermic Lines. These lines are by no means parallel to the equator, as might be supposed, but remove to the greatest distance from it in the Atlantic Ocean, sinking again both in America and in the eastern hemisphere. Comparing this chart with the lines of the inclination of the needle, in the seventh table of my *Magnetismus der Erde*, it will be found that these different lines follow very much the same course; a circumstance which is to be explained in this manner: A greater inclination of the needle proves a smaller distance from the magnetic poles, and, consequently, from the place from which the polar lights issue. But if this meteor has any influence on the temperature, the mean temperature in the same parallel must decrease as the inclination increases; and, consequently, the isothermic lines have the same curvature as the lines of inclination.

It is a matter of experience perfectly well known here in the north, which I have found confirmed by the observation of a good many years, that the aurora borealis is generally accompanied by strong biting cold. When a sudden cold succeeds a milder day, it is often accompanied for the first two evenings by the aurora borealis, and likewise by a considerable increase of magnetic intensity. These three phenomena are for the most part contemporaneous; but where they are not so, experience has taught me, with considerable certainty, to view the one as a near forerunner of the other. The magnetic powers seem thus to act a part in meteorology hitherto unknown. There are, perhaps, various other powers unseen by us, operating in the great chemical laboratory of this globe. The possibility of this ought to teach the prognosticators of the weather some diffidence, when they imagine that, from the situation of the heavenly bodies, or a few circumstances perhaps of little influence, they can foresee its approaching changes; while these are the result of the general powers of the globe, acting from the centre to the surface, and from pole to pole, excited by the light of the sun and moon, and modified in countless ways, by local circumstances of the most different nature.

Is it so, then, that the polar lights have a certain connexion with the magnetism of the earth, and the diminution of temperature with the polar lights and a higher magnetic intensity? We are then, perhaps, prepared to explain the seemingly permanent changes of climate in certain northern regions of the globe, if these changes can be actually proved to have taken place. But the accurate observation of temperature by the thermometer, is still too recent a discovery, and the range of thermometrical observations in the same place, too limited, to enable us to determine this point with absolute certainty. In the mean time, the surrounding of the east coast of Greenland with ice, for a number of ages, is a very remarkable fact. The magnetic pole in North America approaches slowly towards the east; and ought, therefore, if the foregoing possibilities have any reality, in the succession of ages, to surround the northern part of our peninsula with the same barrier, by which it has for ages shut out the east coast of Greenland from all participation in the commotions of Europe. However desirable this might be in some respects, we cannot help wishing, on other accounts, that this prediction may turn out like other prognostications of the weather.

Art. V.—*On the British Testaceous Annelides.* By the Rev. John Fleming, D.D. F.R.S.E. M.W.S. Minister of Flisk. (Communicated by the Author.)

A considerable degree of uncertainty seems to prevail with regard to the number of species of the Testaceous Annelides at present inhabiting our seas, and the antiquity of those which occur in a fossil state.

Among the recent species, there are a few which inhabit stations accessible to the diligent inquirer, and afford opportunities for investigating their structure. Others, however, live in deep water, and are seldom found in a condition fit for anatomical investigation. Even among those which can be procured in a living state, the few which are of ordinary occurrence present, in their diminutive size, formidable obstacles to the knife, or even the needle and microscope of the physiologist. Nor is it to be concealed, that British naturalists have, in too many instances, confined their attention to the characters furnished by the shell, while they have overlooked or undervalued those which are exhibited by the other organs of the animal.

The history of the extinct species which occur in our rocks, appears likewise to be involved in considerable obscurity. There is so little variety in their form and markings, that it becomes extremely difficult to establish definite specific characters. Our principal reliance must therefore be placed on the accuracy of our knowledge with regard to the strata in which they occur, and we must endeavour to derive assistance equally from the zoologist and geognost. A few months ago, an eminent English naturalist expressed a wish to know the evidence upon which I asserted, in the "Philosophy of Zoology," vol. ii. p. 97. that relics of the genera Dentalium and Spirorbis had been found in the strata belonging to the Coal Formation; and added, at the same time, that he had failed to procure authentic examples from any rock older than the *Inferior Oolite* *.

In the following observations, an attempt is made to give a condensed view of the history, not only of the recent species, but of those which have become extinct, in order to exhibit the changes which this tribe has experienced during the different stages of the Earth's formation. Several circumstances prevent me from giving the subject all the illustration which may seem requisite. The few additional facts, however, which are here recorded, will not fail to interest those who occupy themselves with the characters of our recent species, or who are anxious to determine the physical distribution of our extinct kinds.

I.

Testaceous Annelides, with the shell free.

Genus DENTALIUM.—Apex perforated. The shell is round and tapering. The sides of the body of the animal are furnished with tufts of bristles, and at the posterior extremity there is a radiated disc.

A. Recent Species.

a. *Shell furnished with longitudinal striæ or ridges.*

Species 1. *D. dentalis.*—Shell marked with about twenty striæ. Linn. Syst. 1263.—D. striatum of Montagu, Test. Brit. 495. On the coast of Cornwall and Devon, Montagu.

This shell is about half an inch in length. Diameter at the mouth of the shell, where there are a few faint rings, is about one line, and it retrally tapers to a fine point.

2. *octangulatum.*—Shell with eight ribs, and three intermediate striæ. Donovan, Br. Sh. V. tab. 162. Lelant, Cornwall, Miss Pocock.

The number of intermediate striæ may serve to distinguish it from the Dentaliam striatulum of Gmelin, with which British writers seem disposed to confound it.

b. *Shell destitute of longitudinal markings.*

3. *D. entalis.*—Common Tooth Shell.—Shell tapering regularly from the one extremity to the other. Linn. Syst. 1263.—Borl. Corn. 276. tab. lxxviii. fig. 5.—Penn. Brit. Zool. iv. p. 145. tab. xc. fig. 154.—Don. Brit. Sh. tab. 48. Common on all our shores, but usually in a dead state.

The shell is frequently marked with circular wrinkles and bands. It is probably an inhabitant of deep water. The shell, inhabited by a Siphunculus, the characters of which have not been determined, is frequently found entangled in the skate-lines in the estuary of the Forth.

* *Dentalites* occur in the Shell Limestone which lies under the Inferior Oolite in the vicinity of Weimar; and in Limestone of the coal formation in Silesia. *Serpulites* in Mountain Limestone in Gothland, and in Shell Limestone in different parts of Germany.—Ed.

4. *D. Gadus.*—Hake's Tooth.—Body of the shell contracted towards the mouth. Mont. Test. Brit. p. 496. tab. xiv. fig. 7. Common in the British Channel, adhering to the sounding-line, Montagu.

The length is about $\frac{3}{8}$ths of an inch. Diameter, where thickest, $\frac{1}{16}$th. The shell is white, subpellucid, glossy, and tapers to a fine point.

B. Extinct Species.

a. *Shell furnished with longitudinal striæ or ridges.*

5. *D. striatum.*—Shell with 10 or 11 acute, prominent striæ, and several obsolete intermediate ones. Sowerby's Mineral Conchology, tab. lxx. fig. 4. Hordwell and Barton Cliffs, Mrs Tylee and Rev. Mr Bingley.

The striæ are less distinct and prominent towards the mouth. The intervening striæ, from 1 to 4, are most obvious near the middle of the shell. The lines of growth are numerous and fine. The aperture is circular.

6. *D. decussatum.*—Shell with about 20 striæ, and intermediate obscure ones. Sower. Min. Conch. ib. fig. Sussex, William Borrer, Esq.

The lines of growth are numerous, distinct and oblique. The mouth is elliptical.

7. *D. costatum.*—Shell with about 12 closely set ridges. Sower. Min. Conch. ib. fig. 8. Holywell Craig, Mrs Cobbold.

The ridges and grooves are nearly equal and rounded. The lines of growth are obscure. The aperture is circular.

8. *D. septangulare.*—Shell with 7 rounded ridges and grooves. Plate IX. Fig. 1. Belfast.

I found this species at Colin Glen in the bed beneath the chalk, and which probably corresponds with the Green-sand Formation of England. It is about $\frac{3}{4}$ths of an inch in length, and scarcely $\frac{2}{10}$th in diameter at the aperture. The shell is very thick, and has a considerable curvature. The marly sandstone in which it was imbedded, filled the cavity of some individuals, while others contained a cast of crystalline carbonate of lime, mixed with iron-pyrites. The shell itself was changed into a substance resembling in its texture the conchoidal varieties of the older chalk.

b. *Shell destitute of longitudinal markings.*

9. *D. nitens.*—" Nearly straight; surface even and shining, aperture circular; mouth expanded." Sower. Min. Conch. lxx. fig. 1. 2. Highgate clay, Mr Sowerby.

The shell tapers gradually to the smaller end, where it is thickest. It reaches an inch and a half in length.

10. *D. entaloides.*—" Slightly arched, surface waved, nearly smooth; edge of the mouth acute; apertures smooth." D. entalis? Sower. Min. Conch. ib. fig. 3. Hordwell Cliffs, and Stubbington, Mr Sowerby.

Mr Sowerby entertained some doubt whether this was a fossil shell, or different from our 3d species; but his subsequent addition of the second habitat intimated that these had been removed.

11. *D. ellipticum.*—" Nearly straight, quickly tapering, rather compressed, surface uneven, aperture circular; external edge elliptical." Sower. Min. Conch. ib. fig. 6, 7. Folkstone, Kent, Mr Gibbs.

" The shell being thicker along two sides, gives the tube a depressed form, and makes the outer margin of the mouth elliptic; the lines of growth give the surface a rugged aspect; internally it is beautifully polished: the diameter of the mouth is sometimes nearly half an inch."

12. *D. planum.*—" Gently tapering and curving, smooth; aperture round; lip a little thickened, sharp-edged." Sower. Min. Conch. tab. lxxix. fig. 1. In greenish sandy limestone, Bognor, Mr Boys.

This species, the shell of which is nearly an inch in length, appears to have been gregarious.

Fig. 1.

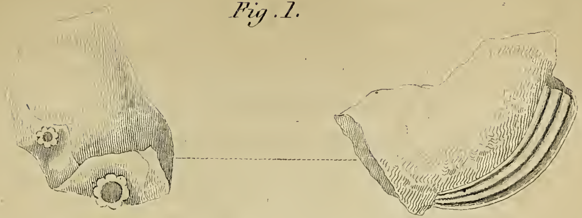

Fig. 2.

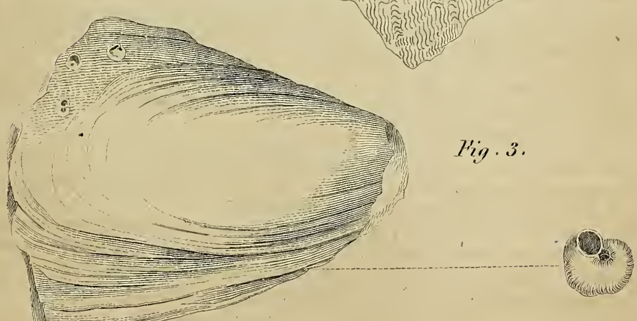

Fig. 3.

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13. *D. cylindricum.*—" Cylindrical, or scarcely tapering, nearly straight, smooth; aperture rounded." Sower. Min. Conch. ib. fig. 2. In ochraceous sandy ironstone, near Exmouth, Mr Cunnington. In sandpits at Emsworth, common, Mr Sowerby.

About three-fourths of an inch long, and almost a line in diameter; the smaller end nearly as large as the other.

14. *D. incrassatum.*—" Very tapering, curved, smooth, swelled near the aperture; aperture round, lip sharp." Sower. Min. Conch. ib. fig. 3, 4. Clay at Highgate and Richmond, Mr Sowerby.

This seems likewise to have been a gregarious species.

15. *D. medium.*—" Shell tapering; mouth round; lip sharp; tube somewhat trumpet-formed within, or broad at the mouth, and becoming suddenly small; external transverse striæ or lines of growth conspicuous." Sower. Min. Conch. ib. fig. 5, 6. From the green sand at Blackdown, Miss E. Hill.

16. *D. indistinctum.*—Shell about 2½ inches long, and nearly half an inch in diameter. The surface, where entire, is smooth, dull, and of a whitish colour. It consists of several layers, the surfaces of which have a shining, mother-of-pearl aspect. Plate IX. Fig. 2. In the limestone of the coal formation West Lothian.

The general characters of the limestone in which this shell is imbedded, I have noticed in the Annals of Philosophy, vol. v. p. 118.; and in the same volume there is a description of the following species of ORTHOCERA:—*pyramidalis*, *cylindracea*, *convexa*, *annularis*, and *rugosa*, from the same station. The species of Producti, which Mr Sowerby has figured under the titles, *longispinus*, *Flemingii*, *spinulosus*, *spinosus*, and *Scoticus*, are likewise of cotemporaneous origin. The same limestone likewise contains examples of nearly all those species of fossil shells and zoophytes which are figured in the History of " Rutherglen and Kilbride," by the late Rev. David Ure, Glasgow, 1793. This work, I may here observe, contains an accurate enumeration of the principal fossils belonging to the Independent Coal Formation of Scotland.

Specimens of this Dentalium were sent to the late Mr Sowerby in 1814; but he delayed giving a figure of the species in his Mineral Conchology, in expectation of receiving more satisfactory examples. I have likewise recently communicated a specimen to Lewis Weston Dillwyn, Esq. All the specimens are much bruised, and, by belonging to a species destitute of much character, from the simplicity of its external form, it is impossible to fix definite specific marks. In such circumstances, the geognostical relations of the species acquire great importance, and ought to be cautiously established. This, indeed, appears to be the oldest species of the genus yet ascertained, as may be seen by the following tabular view of the genealogy of the genus, which is offered with considerable hesitation:

Independent Coal Formation.

Dentalium indistinctum,................No. 16.

Lias ?

Dentalium cylindricum,.................. 13.

Green-sand.

Dentalium medium,........................ 15.
———— septangulare,.................. 8.

Chalk.

Dentalium ellipticum,..................... 11.
———— decussatum,..................... 6.

London Clay.

Dentalium nitens,.......................... 9.
———— entaloides,...................... 10.
———— striatum,......................... 5.
———— costatum,........................ 7.
———— planum,........................... 12.
———— incrassatum,..................... 14.

Recent.

Dentalium dentalis,......................No. 1.
———— octangulatum,.................. 2.
———— entalis,........................ 3.
———— Gadus,......................... 4.

The species, Dentalium imperforatum, trachea and glabrum of Montagu, which constitute my genus Cæcalium, have recently been investigated with care by an acute observer, and he has arrived at the conclusion that they are portions merely of multilocular shells.

II.

Testaceous Annelides with the shell permanently attached to other bodies, closed at the retral extremity, with the anterior orifice free. Branchiæ (or arms?) in the form of a double fan-shaped tuft of pinnated filaments, usually with coloured bands. At the base of each tuft there is a fleshy filament, one of which, being produced and terminating in an enlarged head, serves as a lid to the shell when the animal has retired.

A. *Shell irregular. Lid simple.*

GENUS VERMILIA.—Shell attached throughout its whole length, the aperture rounded, with a toothed margin, and testaceous lid.

I.—RECENT SPECIES.

a. *Lid double.*

Species 1. *V. intricata.*—Shell round, flexuose, and tapering to a fine point. Serpula intricata, Linn. Syst. 796.—Penn. Brit. Zool. iv. p. 146. tab. xci. fig. 158.—Serpula vermicularis, Zoologia Danica, tab. lxxxvi. fig. 9.—Mont. Test. Brit. p. 509. Adheres to stones, old shells and corals, and is common.

This species is remarkably distinguished from its congeners, by its double infundibuliform lid, which, according to Montagu, bears a close resemblance to his Serpula reversa, the Heterodisca reversa of this article. It is probable that a more minute examination of the animals inhabiting shells of this form may lead to the establishment of several new species.

b. *Lid Single.*

2. *V. vermicularis.*—Shell transversely wrinkled, subcarinated. Lid concave, with a crenated margin. Tubus vermicularis, Ellis, Cor. tab. xxxviii. fig. 2.—Serpula triquetra, Bast. Op. Sub. vol. i. p. 79. tab. ix. fig. 3.—Mont. Test. Brit. p. 511. On stones, common.

According to Ellis, the right filament is subclavate and pointed. The branchiæ are ciliated only on the upper side. In the "Remarkable Ruins" of North Britain, by the late Rev. Charles Cordiner, Banff, there is one of the plates of objects in Natural History, No. V. inscribed Scolopendra, containing a figure of this species, in which the tentacula are improperly represented as ciliated on both sides. It is to be regretted that this author, in his figures of animals, studied effect as a painter, more than accuracy as a naturalist. Many of his representations of rare British species, I have, however, been able to identify with the products of the Zetland seas.

3. *V. triquetra.*—Shell triangular, dorsal ridge distinct. Lid concave, with a produced central forked process. Serpula triquetra, Sower. Brit. Mis. vol. i. p. 63. tab. xxxi. On an oyster shell.

According to the figure referred to, the branchiæ are ciliated on both sides. It is probable that Montagu, in the Supplement to his Testacea Britannica, p. 157. No. 4. refers to this species in his account of the different animals inhabiting shells resembling his Serpula triquetra, " With a smooth termination, grooved on each side for the reception of two *cirrhi* placed at the base of the operculum, which is corneous, furnished with a bifid style."

4. *V. serrulata.*—Shell translucent, triangular, with a serrated dorsal ridge. Lid concave, with a smooth margin. Serpula serrulata, Flem. Edin. Ency. vii. p. 67. tab. cciv. fig. 8. Adheres to stones, in deep water, in the Zetland seas.

This species, which I observed in 1809, is remarkable for its smooth, glossy, translucent shell, which is flexuous, with a spreading base. The breadth near the mouth equals $\frac{2}{10}$ths of an inch. The animal referred to by Montagu in Sup. Test. Brit. p. 157. No. 1. " with a smooth and slightly concave testaceous termination or operculum," agrees with this species in the form of the lid, though the shell itself possesses characters sufficiently distinct from any of the varieties of his Serpula triquetra which I have observed.

5. *V. armata.*—Lid testaceous, and armed with two or three spines in front. Serpula vermicularis, Zool. Dan. tab. lxxxvi. fig. 8.—Mont. Test. Brit. Sup. p. 157. No. 2.

6. *V. conica.*—Lid testaceous and conical. Mont. Test. Brit. Sup. p. 157. No. 3.

These two species have been noticed by Montagu as inhabiting shells resembling his Serpula triquetra. In a manuscript volume of descriptions of animals, drawn up by Dr David Skene of Aberdeen, the correspondent of Linnæus (Syst. Nat. p. 1267. No. 805.), and of Ellis (Zooph. p. 14. &c. and in honour of whom the Millepora Skenii received its designation), and which I have been permitted to peruse through the kindness of his relative Alexander Thomson of Banchory, Esq. there is evidence of his acquaintance with these two species, which he notices in his account of the inhabitant of Serpula triquetra: " Tegmen vel operculum est testa parva, orbiculata, hinc convexa, inde (interne) concava, sæpissime spinis tribus armata, aliquando, omnino conica quasi ex spinis in unam confluentibus."

II.—Extinct Species.

7. *V. crassa.*—Shell triangular, acutely conical, with a flat radiated lid. Serpula crassa, Sower. Min. Conch. vol. i. p. 73. tab. xxx. Adhering to Rostellaria macroptera, Highgate, Dr Leach.

The dorsal ridge is very distinct. The diameter of the mouth is about one-fourth of the length of the shell. Its geognostic station is probably referable to the London clay.

Genus SERPULA.—Shell adhering only in part to other bodies. Aperture toothless. Lid cartilaginous.

Species 1. *S. tubularia.*—Shell at the apex adhering to other bodies, round, and, where free, flexuous and nearly cylindrical. Mont. Test. Brit. p. 513.—Flem. Edin. Encyc. vii. p. 67. tab. cciv. f. 9. Adheres to stones and shells on many parts of the coast.

The shell sometimes reaches to one-fifth of an inch in diameter at the mouth, and to seven inches in length. According to Montagu (ib. 514.), " the animal is an *Amphitrite*, with between fifty and sixty annulations; the head long, white, barred with pink and green; on each side a loose, scalloped, transparent membrane, capable of contraction and expansion, and frequently surrounding the under part: *tentacula* two, beautifully feathered, each originating from a single stalk, placed near to each other on the fore part of the head: on one side of each of these stalks are long fibres, placed in regular order; these, again, are furnished on each side with finer fibres. When the animal withdrew its *tentacula*, it became somewhat convoluted as the fibres closed, and turned a little spiral up the stalk: their colour pale yellow, or yellowish-white, the fibres or *pinnæ* annulated with pink, so as to form regular semicircular lines when the plumes were spread."

In Cordiner's work, already quoted, there is an indication of another species, probably belonging to this genus, from the Murray Frith, which deserves to be noticed, and may be termed

2. *S. Cordineri.*—Shell triangular, branchiæ stellular, lid produced, with an obtuse termination, and five lobes on each side, opposite, in pairs. Cor. Ruins, No. 2. Terebellæ. Adhering to a stone dredged up in forty fathoms water.

In the same work, No. 22. plate "Peacock's-feather Coralline," a representation is given of a Serpula with the margin of the mouth deeply notched, and the surface of the shell furnished with longitudinal denticulated ridges. This species, which may be termed *muricata*, was probably brought from the coast of Norway, but has been here mentioned as one likely to occur as a northern Scottish production.

B.—*Shell regular, discoid and spiral.*

The shells of this division seldom exceed an eighth of an inch in the diameter of their outline. The side by which they adhere is, in general, far too tender to admit of being detached, entire, from the body to which it adheres. The young of the sulcated kinds are nearly smooth.

Genus SPIRORBIS.—Shell with the spires dextral. Animal furnished at the neck with radiated, pinnated branchiæ, and a pedunculate, clavate, or funnel-shaped lid. The number of the branchiæ, and character of the lid, vary according to the species, and merit an attentive examination.

I.—Recent Species.

a. *Shell with longitudinal ridges. The last formed whorl only visible. Aperture circular.*

Species 1. *S. granulatus.*—Shell with three ridges and two grooves. Serpula gr. Linn. Syst. 1266.—Serpula sulcata, Adams, Linn. Trans. iii. 255.—Serpula gran. Don. Br. Sh. tab. c.—Montagu, Test. Brit. p. 500. On old shells, but more frequently on the under side of loose stones about low water-mark, very common.

The shell consists of two whorls, with a distinct central cavity. The base of the shell is narrow, and the sides are nearly vertical. The three ridges which occupy the upper surface are rounded. The outer one is marginal, and of the same size as the inner one, which is also marginal, in reference to the central cavity; the middle one is the largest. The two grooves are rounded. There are a few irregular, transverse wrinkles. Colour dull white. The animal, according to Montagu, is furnished with ten ciliated branchiæ. Lid lateral, subfunnel-shaped, with a brown, ciliated, hyaline margin. The rest of the body is of a buff colour.

2. *S. carinatus.*—Shell flat, with a single marginal ridge. Serpula car. Mont. Test. Brit. p. 502.—Spir. car. Flem. Edin. Ency. vii. p. 68. tab. cciv. fig. 13. Adheres to old shells. Devonshire and Zetland.

The shell consists of two whorls, with a narrow base, and nearly vertical sides. The upper surface is almost flat, or slightly concave, with a central cavity surrounded by a sharp, rather elevated margin. The outer margin is nearly rectangular, with a sharp ridge. The surface is transversely wrinkled, the whole less regular in its growth than the preceding, with the aperture more ascending.

b. *Shell destitute of longitudinal ridges.*

3. *S. communis.*—Shell subtriangular, the base spreading. Serpula spirorbis, Lin. Syst. 1265.—Penn. Brit. Zool. iv. p. 1245.—Mul. Zool. Dan. tab. lxxxvi. f. 1,–6.—Don. Brit. Sh. tab. ix. Every where common on old sea-weeds and shells.

The shell is opaque, slightly wrinkled across, spreading at the base, and forms a very blunt ridge along the top, leaving a funnel-form central cavity. The whorls are lateral, three or four in number; the first and part of the second, however, generally concealed. According to Müller, the animal is of a blood colour, with a dark dorsal line formed by the intestine. The pinnated branchiæ are six in number. The lid is peltate, terminating obliquely.

4. *S. spirilium.*—Shell rounded, base narrow. Serpula spir. Linn. Syst. 1265.—Mont. Test. Brit. p. 499.—Pult. Dor. 2d ed. tab. xix. fig. 27. Common on Corallina officinalis and algæ.

The shell is round, slightly wrinkled, glossy and subpellucid. The whorls are three, placed laterally, or sometimes rising one above the other, and having the margin of the mouth nearly free. The central cavity is more or less distinct, according to the manner of growth. There is reason to doubt if this be the Serpula spirilium of Pultney, Dorset, 1st ed. p. 52. since his specimens are stated to have been striated longitudinally. Probably he referred to S. granulatus.

5. *S. corrugatus.*—Shell wrinkled, with the base a little spreading. Mont. Test. Brit. p. 502. On slate rocks at Milton, Devonshire.

It is thus described by Montagu: "With a strong spiral white shell, roughened by transverse wrinkles; a small portion of the second volution only visible; centre umbilicated; base very little spreading; aperture orbicular. Diameter about $\frac{1}{8}$th of an inch."—"Animal orange-red, with eight greenish, ciliated rays (branchiæ); and a subfunnel-shaped proboscis (lid) of the same colour."

6. *S. Montagui.*—Shell with one very thick, rounded, glossy, white volution. Serpula, new species, Mont. Test Brit. p. 502. On Haliotis tuberculata from Guernsey, Montagu.

The shell is very convex, and wrinkled transversely with a minute central cavity at top; sometimes only a suture. The animal is of a buff colour, with ten ciliated rays, and a subfunnel-shaped lid, at one side, having a brown, ciliated, hyaline margin.

7. *S. incurvatus.*—Shell rounded, with three continuous whorls at the apex, with the anterior extremity produced and cylindrical. Serpula recta anfractibus tribus contiguis regulariter involutis, Walker's Test. Min. Rar. p. 3. tab. 1. f. 11.—Vermiculum incurvatum, Mont. Test. Brit. p. 518. From Sandwich, rare, Walker.

8. *S. pervius.*—Shell rounded, with a single pervious whorl at the apex, and produced anteriorly into a cylindrical tube. Serpula recta umbilico pervio anfractu apicis unico involuto.—Walk. Test. Min. Rar. p. 4. tab. i. fig. 12.—Vermiculum pervium, Mont. Test. Brit. p. 518. From Reculver, rare, Walker.

9. *S. retorta.*—Shell with the last whorl concealing the others, circular, marginated, slightly depressed near the centre, with a conico-tubular produced lateral aperture. Serpula (Retorta) rotunda marginata cervice curvatim exerto, Walk. Test. Min. Rar. p. 3. tab. 1. fig. 10.—Vermiculum retortum, Mont. Test. Brit. p. 524. Sandwich, Walker.

The characters of these three last shells remain to be determined. It is probable that they belong to the present genus, although Montagu seems inclined to consider them as free shells. The Serpula cornea of Adams, Linn. Trans. v. p. 5. tab. f. 33. 35. is no other than the Helix depressa of Montagu, a shell belonging to the Turbonidæ *.

II.—Extinct Species.

10. *S. ambiguus.*—Shell of one whorl, finely wrinkled across, with a large central cavity, and a rounded mouth. Plate IX. Fig. 3. natural size and magnified.

Ure, in his History of Rutherglen and Kilbride, is the first observer that has announced the occurrence of a fossil species of this genus, and in the coal formation. " The *Serpula planorbis* may be ranked among the univalves. I have not met with more specimens than two or three, adhering to fragments of shells ;" p. 309. Although there is no reason to believe that a recent shell ever occurred as a petrifaction, along with those which are extinct, in the independent coal formation, yet the evidence of Ure leads to the conclusion that he was acquainted with a fossil species, corresponding generally with the imperfect description which Linnæus has given of his Serpula planorbis. This evidence is strengthened by the circumstance, that I found the shell of which I have here given a representation, adhering to a Modiolus, from a thin bed associated with the limestone of the coal-field in the Cult Hills, and county of Fife. This species, which is probably the same with the one previously observed by Ure, by belonging to the second section of the genus, is destitute of any obvious characters.

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* The true situation of this shell seems to be but imperfectly understood. It belongs to the genus Turbo of Linnæus, (though inserted by Montagu along with serpuloides and unispiralis, to which it is closely related, in the genus Helix), and to the Delphinula of Lamarck. It has been referred to, along with H. serpuloides of Montagu, by Captain Marryat, as an example of his genus Cyclostrema, (Linn. Trans. vol. xii. p. 338.) Doubts, however, may reasonably be entertained of the propriety of this alliance. All the British species now mentioned, as well as the Cyclostrema cancellata, being discoid shells, with an entire margin to the mouth, belong to Delphinula. A subdivision, however, of this genus, may be effected with advantage. If we restrict the genus Delphinula, so as to include only those species which have a simple mouth, and whorls furnished with processes, as the recent *Turbo delphinus* of Linnæus, and the fossil *Delphinula calcar* of Lamarck ; the genus Cyclostrema, having for its type C. cancellata of Marryat, will include those species, having the whorls destitute of processes, but furnished with transverse ridges, the last formed one constituting a thickened margin to the mouth. Three species, Helix depressus, serpuloides, and unispiralis of Montagu, being thus excluded, call for the construction of a new genus, which will in some respects have the same relation to Cyclostrema, as Turritella bears to Scalaria. This genus I feel inclined to term *Skenea*, in honour of Dr Skene mentioned above, whose labours, though but little known, justify this appropriation of his name. Several species of Skenea occur in a fossil state, among which may be noticed those figured by Mr Sowerby in his Min. Con. vol. i. plate 57. as Vermiculariæ : and it is probable that some of the species figured at plate 140. of the same work, as belonging to Planorbis, as *æqualis* and *euomphalus*, should occupy a similar position. The species constituting Mr Sowerby's genus Euomphalus, may be conveniently distributed among the three genera now established of an interesting astulideous family.

GENUS HETERODISCA.—Shell with the spires sinistral. The reverse character in the following species is uniform, and thus, independent of other circumstances, forbids us to regard them as accidental varieties of any of the species of the former genus Spirorbis.

a. *Shell with longitudinal ridges.*

Species 1. *H. heterostropha.*—Shell triangular, with three ridges. Serpula het. Mont. Test. Brit. p. 503.—Spirorbis het. Flem. Edin. Ency. vii. p. 68. tab. ccv. f. 1. On stones and shells, common.

The shell is white, opaque, with three lateral whorls, the last and part of the second only apparent. The base spreads a little. The middle ridge is prominent, the lateral grooves are wrinkled, and the lateral ridges are indistinct. The inner ridge forms in part the central cavity.

2. *H. minuta.*—Shell rounded, with two grooves. Serpula minuta, Mont. Test. Brit. 505.—Spirorbis minutus, Flem. Edin. Fncy. vii. p. 68. tab. ccv. f. 2. On rocks, stones, but especially the Corallina officinalis, common.

The grooves, on the back, form that part into three obsolete ridges. The central cavity exposes more of the second whorl than in the preceding species. According to Montagu, the inhabitant has ciliated branchiæ, and a clavate lid, varying from brown to green. This species adheres to substances exposed directly to the motion of the waves, while the heterostropha occupies a more sheltered station, attached to the under side of stones.

3. *H. conica.*—Shell triangular, with a single groove. Flem. Edin. Ency. vii. tab. ccv. f. 3. On shells, Zetland. Coast of Appin, Captain Carmichael.

When young, the upper part of the whorl has a distinct groove, with a low acute ridge on each side, and a very small central cavity. In this state, the whorls are two in number, the outer one lateral, with a spreading base. The third whorl, in its growth, not only embraces the others laterally, but ascends, and forms the outline of the shell into a truncated cone, with the mouth at the top, sublateral. The groove and central cavity are in this state less distinct, the latter generally obliterated. It is a strong shell, and remarkable for being hyaline, like Vermilia serrulata. It is seldom found but on stones and shells brought from deep water.

b. *Shell destitute of longitudinal ridges.*

4. *H. lucida.*—Shell smooth, glossy, subcylindrical, with a blunt apex. Serpula quatuor anfractibus umbilicata apertura rotunda, and S. apertura rotunda anfractibus duobus umbilicata, Walk. Test. Min. p. 4. tab. 1. f. 13, 14. Serpula reflexa, Adams, Linn. Trans. v. p. 4. tab. tab. 1. fig. 31, 32.—S. sinistrorsa, Mont. Test. Brit. p. 504.—Serp. lucida, ib. p. 506.—Spirorbis lucidus, Flem. Edin. Ency. vii. p. 69. tab. ccv. f. 4. On crustaceous animals and corallines, common.

The shell is nearly cylindrical, translucent and glossy. When growing on an even surface, it forms two or three lateral whorls, with a small central cavity. When seated on corallines, its growth is very irregular. The whorls, in some, are placed contiguous, one above the other, with the aperture ascending, while, in others, the shell is simply twisted, round, and unconnected. So variable, indeed, is this species, that scarcely two specimens can be found alike, a circumstance which has given rise to the preceding synonymes. According to Montagu, the animal (his lucida) is red, with pale plumose branchiæ, and two brown spots on the head.

5. *H. reversa.*—Shell transversely wrinkled, subcylindrical, with a fine apex. Serpula reversa, Mont. Test. Brit. p. 508. Upon shells and crabs, Devonshire, Montagu. On corals, Zetland.

This shell resembles the preceding in the variableness of its mode of growth. In some cases, there are three or four whorls placed laterally, making a diameter of half an inch, others have the smaller end projected, and the larger end coiled. Montagu's specimens reached to $\frac{1}{10}$th inch in diameter at the aperture. Those which I possess are smaller. The same author states, "the animal is a Terebella, with branched, ciliated *tentacula* (branchiæ), spotted with crimson, which, when spread, almost surrounds a double funnel-shaped proboscis (lid), placed one within the other, the stalk of which is long and slender, and originates on the left side, below the tentacula: this in some is green, others reddish; the interior funnel is cut in deep longitudinal striæ; external one ciliated round the margin: on the right side, corresponding with the proboscis, is a short cylindric appendage." It is probable, that, when our knowledge of the structure of the animals of the Serpuladæ shall have become more extensive, and better fitted to regulate their methodical distribution, the present species will be transferred to a station near *Vermilia intricata.*

The plan which I have adopted, in this monograph of British Testaceous Annelides, appears in a peculiar manner calculated to promote an acquaintance with our recent and extinct animals, by exhibiting the connecting links between the ancient and modern species; and the zoological characters of the different geognostical epochs of the Earth's history. Other genera of testaceous and crustaceous animals are even better fitted to promote the end in view, than those which are here employed. We may particularly refer to the unrestricted genera Nautilus, Terebratula, and Echinus. The last of these presents a peculiarly tempting subject for a monograph, to those who have access to authentic documents in reference to the fossil species.

Manse of Flisk,
8th May 1824.

Art. VI.—*New Corrections for the Effects of Humidity on the Formula for measuring Heights by the Barometer.* By Adam Anderson, A. M. F. R. S. E. Rector of the Academy of Perth.

The method of measuring heights by the barometer is at once so simple and expeditious, that, if the results deduced by the common formulæ which are now employed for the purpose could be relied upon, in all the varying conditions of the atmosphere, that mode of finding the difference of elevation between places, either remote from each other, or so situate as not to admit, without great difficulty, of the application of geometrical measurement, would frequently, in these instances, be attended with the most obvious advantages. The geometrical methods of determining heights require, even where a good base-line can be obtained, a degree of accuracy in procuring the other necessary data of the problem, of which few, who do not possess a practical knowledge of the subject, are at all aware; and of which still fewer can form any idea, who are ignorant of the refinements of which geodesic measurements are susceptible, when the most rigid exactness is aimed at. In such cases, not only must the base-line itself be repeatedly measured with the most scrupulous care, but, in taking the various angles which connect its extremities with the vertical line to be determined, the instrument with which the angles are observed, must be placed, at each station, so that its centre may be exactly in the angular point; and such is the degree of adjustment necessary for the purpose, that the slightest deviation from the proper position would lead to very considerable errors in the calculation of the ultimate result. Again, admitting that the angles have been duly measured, the corrections to be made upon each of them for atmospheric refraction, varying with the temperature and humidity of the air, and depending partly upon the height of the object, the very quantity to be determined, all conspire to throw a shade of uncertainty over the whole operation, which nothing can remove but a repetition of the measurements, under different circumstances, conjoined with a sameness of result. Lastly, the height thus obtained must be corrected for the curvature of the earth; and though the allowance thus rendered necessary, is but small when the object is near, as it yet increases with the square of the distance, it becomes too considerable to be neglected when the object is pretty remote.

The measurement of heights by levelling is free from many of the difficulties which are inseparable from the geometrical methods, but it is liable to others of a nature no less objectionable, and equally unavoidable. The multiplicity of observations which it demands, increases both the chance of error, and the labour of measurement; and hence this method of determining differences of elevation is never resorted to, unless in cases where the object to be attained is sufficiently important to afford an adequate remuneration for the time and trouble which must be devoted to it.

Barometrical measurements, if they could be relied upon, would frequently be greatly preferable, both to levelling, and the geometrical methods. It is to be feared, however, that, notwithstanding the numerous and refined corrections, by which the formulæ for deducing heights by the barometer have been gradually modified and improved, these formulæ will not always lead to the same result, in different states of the atmosphere. This is chiefly to be ascribed to the neglect of one very important element in the calculation, namely, the humidity of the air, which has either been entirely disregarded, or introduced into the formulæ, by such as have attempted to make a correction for its influence, in so vague and general a form, as to be inapplicable to cases, in which there is a considerable deviation from the mean hygrometric state of the atmosphere. The new coefficients, which I propose to apply to the common formula, will, I am convinced, account for several anomalous results, which have hitherto received no satisfactory explanation, as well as remove all the sources of error which attach to barometrical measurements, when they are made in different states of the air, in respect of humidity. To point out, in a more distinct manner, the nature of these coefficients, it may be proper to bring before those, who have not particularly attended to the subject, a view of the formula which is commonly employed, as it has been improved by the labours of De Luc, Sir G. Shuckburgh, and General Roy.

It may be remarked, then, at the outset, that, if the air possessed perfect elasticity, and uniformity of temperature throughout its whole mass, it is demonstrable, that, if β and b represented the heights of the mercurial columns in the barometer, at the upper and lower stations, respectively, the difference of elevation h, expressed in some assumed measure of length, would be expressible, by an equation of the form

$$h = m \log.\left(\frac{b}{\beta}\right),$$

in which m is a constant coefficient, to be determined either by experiment, or by means of the relation between the specific gravities of air and mercury, and the logarithm of $\frac{b}{\beta}$ to be taken in any system of logarithms whatever.

The diminution of temperature, however, as we ascend into the upper regions of the air, requires, that this generic expression, for the difference of elevation between the two stations, so simple in its form, and easy in its application, should receive two corrections: the first of these being made upon the length of the mercurial column, at either of the two stations, in order to reduce it to the same standard, in point of temperature, as the other; and the second, upon the coefficient m, which, in consequence of the elongation or contraction of the aërial column by heat and cold, must be modified, so as to adapt it to the actual temperature of the atmosphere, when it is either above or below the temperature at which m was originally fixed. The lengths of the mercurial columns, at the two stations, must therefore be reduced to what they would be, on the supposition, that the mercury in the barometers, at both, were at the same temperature, either by computing the length of the lower, in reference to the temperature of the higher, or that of the higher in reference to the temperature of the lower; or even by reducing each of them to what they would have been, at some common temperature, different from that of either. In short, the design of this correction being to estimate the pressure of the air at both stations, by mercury of the same specific gravity, it is a matter of perfect indifference to what temperature the barometrical columns may be brought, by calculation. If the length of the mercurial column, however, at the upper station, be reduced to what it would have been, on the supposition, that its temperature had been the same as at the lower station, the expression for the height will become

$$h = m \log. \left(\frac{b}{q\beta} \right)$$

the coefficient q depending, partly upon the difference of temperature of the mercury in the barometer, at the two stations, and partly upon the rate of the expansion of mercury, by increase of temperature. If T denote the temperature of the mercury in the barometer, at the lower situation, and T′ that at the upper, then $q = 1 + \cdot 000102\,(T - T')$ the expansion of mercury for 1° of Fahrenheit being about a ten thousandth part of its volume.

The other correction to which I alluded, depending upon the expansion or contraction of the air, according as its temperature is above or below the standard temperature, to which the coefficient *m* refers, reduces the formula to the form

$$h = mr \log. \left(\frac{b}{q\beta}\right)$$

The coefficient *r* has been so assumed as to apply to the expansion of air, holding in admixture with it the usual proportion of humidity which exists in the atmosphere. As the quantity of aqueous vapour, however, which mingles itself with the different strata of the air is extremely various, at different times, as well as over different places, it must be obvious, that, when the hygrometric condition of the atmosphere departs far from the mean state at which *r* is supposed accurately to apply, corresponding deviations from the real difference of altitude, between the two stations, will be produced upon the height *h*. Without doing any thing more at present, than simply adverting to this fact, it will be sufficient, in giving a brief exposition of the corrections which have hitherto been applied to the formula for barometrical measurements, to state that it was found by comparing the experiments and observations of Sir G. Shuckburgh and General Roy, that atmospheric air, in its ordinary condition with respect to humidity, expanded $\frac{244}{10{,}000}$ of its original bulk for each degree of Fahrenheit; that when *h* was expressed in English fathoms and common logarithms employed, the coefficient *m* was 10,000, the mean temperature of the column of air between the two stations being the freezing point of water; but that, when the mean temperature was different, the formula required the application of the coefficient *r*, which, in that case, became $1 + \cdot 00244\left(\frac{t + t'}{2} - 32\right)$, the symbols *t* and *t*′ denoting the temperature of the air at the lower and upper situations, respectively. The whole formula, therefore, in its present state, when the common logarithms are employed, becomes

$$h = 10{,}000\left[1 + \cdot 00244.\left(\frac{t+t'}{2} - 32\right)\right]\log.\left(\frac{b}{(1 + \cdot 000102\,\overline{T - T'})\beta}\right)$$

In addition to the corrections which have been described, two others have indeed been proposed ; one for the change produced by temperature upon the substance of the scale, which measures the lengths of the mercurial columns, and the other for the influence of gravity upon the aërial particles, by a change of geographical position. The first of these corrections, however, is too minute for the ordinary range of temperature, within which barometrical observations are made, to deserve the slightest attention ; and the last is a refinement in calculation, carried, perhaps, beyond the limits of exactness which are furnished by the grosser and more palpable data of the problem. The corrections which I mean to apply, in order to adapt the formula to the actual state of the air, with respect to humidity, are, I conceive, of a far more important character, as they appear calculated to account for the difference in the results of barometrical measurements, which have been obtained by different individuals, in determining the same heights, or by the same individuals in different states of the air, with regard to moisture.

If the density of the atmospheric vapour at different heights above the surface of the earth, were regulated by the same law as that of the aërial medium in which it floats, it is evident, that the presence of a greater or less quantity of vapour would not render any correction necessary upon the present formula ; so far at least as the result depends upon mere pressure. For if b and β denote, as before, the lengths of the mercurial columns, produced by the weight of dry air alone ; and if f and f' represent the elasticity of vapour, at the lower and upper stations, we should have

$$b : f = \beta : f'$$

Therefore, $b : b + f = \beta : \beta + f'$

And, $\frac{b}{\beta} = \frac{b + f}{\beta + f'}$

Hence also, Log. $\left(\frac{b}{\beta}\right) = \log.\left(\frac{b + f}{\beta + f'}\right)$

From this result it appears, that the intermixture of vapour with air, provided the density of both fluids decreased in the same ratio, should have no effect upon the expression already obtained for h, beyond rendering necessary a slight accommodation of the coefficient m, to make it apply to the diminished density of the air. This at least would be the case, so far as pressure is concerned; though it will afterwards appear, that the presence of vapour requires another correction, on account of the dilatation of the air which it produces,—a circumstance which has been entirely overlooked by all who have written on barometrical measurements.

The supposition, however, that the density of atmospheric vapour diminishes in the same ratio as dry air, is far from being conformable to observation. The diminution of temperature as we ascend in the atmosphere; the frequent precipitation of moisture from the strata of it contiguous to the surface of the earth, by which the ascent of moisture is continually checked,—and even the very form of the atmospherical columns, which may be regarded as pyramidal frusta, having the earth's centre for a common apex,—all conspire to render the more elevated strata of the atmosphere absolutely, as well as relatively, drier, than those which press upon the surface of the ocean. I have elsewhere * endeavoured to shew, by general considerations, that the absolute humidity of the air is reduced one half, by an ascent of about 4500 feet; and by some observations which I lately made, under very favourable circumstances, from the base to the summit of Bengloe, one of the loftiest mountains of Perthshire, I ascertained that the line of humidity was a species of logarithmic curve, according to which it appeared, that the density of atmospheric vapour, (regarded as ordinates to the heights, as abscissæ), accorded nearly with the deductions I obtained from theory. Various observations which I made, about the same time, on the sides of Benvracky, the lofty hill which overlooks the Pass of Killikrankie, and terminates the northern extremity of the vale of Athole, afforded results which agreed almost exactly with the conclusions which had been deduced from the observations made on Bengloe,—a result the

* Edin. Encyc. Art. *Hygrometry*, Sec. 97.

more satisfactory, as the absolute quantities of moisture in the air, were in the two cases exceedingly different.

Now, if it be kept in view that the density of air is reduced one-half by an ascent of about 18,000 feet, while that of vapour undergoes the same degree of attenuation at the height of about 4,500 feet, it follows, that the varying humidity of the atmosphere must, at different times, affect, in different degrees, the law of the density of the aërial columns, and give rise to deviations from the geometrical progression, however strictly it might apply to the diminution of the density of dry air, or even to that of the atmospheric vapour, when they are taken separately. For, if a, ar, ar^2, &c. represent the density of successive strata of dry air, and v, $v\varrho$, $v\varrho^2$, &c. that of corresponding strata of vapour, at the heights h_0, h_1, h_2, &c. the sums of the terms representing the densities produced by the joint pressure of air and moisture, will be $a + v$, $ar + v\varrho$, $ar^2 + v\varrho^2$, &c. a series of terms no longer in geometrical progression. In conformity with these views, and the actual constitution of the atmosphere, it might be inferred, at first sight, that the difference of elevation deduced by the common formula, ought to exceed the true height so much the more as the air is charged with moisture in the state of vapour; the elasticity of the vapour at the lower station producing a greater relative effect upon the height of the mercurial column, than at the upper station. This conclusion, however, is by no means supported by experience, but directly contradicted by it; as I have found, by numerous observations, that the heights computed by the common formula always turn out less than the truth, in proportion as the air is warm and damp. The cause of this is to be ascribed to the dilatation of air by moisture, already alluded to; which, acting in opposition to the influence of the pressure of vapour, frequently neutralizes its effects, and renders the mechanical constitution of the atmosphere, so far at least as the law of its density at different heights is involved, nearly the same as would result from dry air alone. Hence a new coefficient, a function of the dilatation of air by moisture, depending partly upon the absolute humidity of the air, at the two stations, and partly upon the temperature of the intermediate column, must be applied to the formula, in a way analogous to that in which the correction for the excess or defect of the mean heat of the column above or below the standard temperature is applied.

The two corrections for the influence of humidity which I have suggested, the first depending upon the pressure of vapour, and the second upon the dilatation which that vapour produces upon dry air, will, I am persuaded, reconcile, in a very satisfactory manner, the discordant results which have hitherto been obtained from barometrical measurements, even when conducted by persons of undoubted accuracy and skill. Their importance will best appear, by stating, that, in all cases, the heights deduced by the formula, modified, as I have proposed, by corrections for humidity, coincide, as nearly as can be expected, with the heights obtained by levelling, or accurate geometrical measurement; whereas, the results obtained from the formula of De Luc, improved as it has been by the labours of Sir G. Shuckburgh and General Roy, or even those furnished by the more refined formula of Laplace, sometimes differ 40 or 50 feet from the truth, in a difference of elevation of 1000 feet. At the same time, I readily admit, that, in this country (and perhaps the remark may be applied to the greater part of Europe), when the air is in a mean state of humidity, the increase of pressure upon the mercurial column, arising from the mere weight of vapour, and the additional increase of pressure at the upper station, produced by the elongation of the aerial column by moisture, generally balance each other so exactly, as to render the results deduced by these formula, as they now stand, extremely correct.

Having thus shewn the necessity of applying to the common *formula* two corrections for the effects of humidity, I shall now proceed to point out the manner in which these corrections are to be determined and applied.

In the *first* place, the absolute elasticity of the atmospheric vapour, at each station, must be accurately ascertained, either by reducing the indications of a well adjusted hygrometer to the corresponding tension of vapour, or by determining the point of deposition by actual experiment, agreeably to the method recommended for that purpose by Mr Dalton. The first of these methods, it must be confessed, is exceedingly troublesome, and liable to a good deal of uncertainty; as the law which connects the tension of vapour with the degrees of a hygrometer, has been accurately investigated *, only with respect to one of these instruments, namely, the hair hygrometer of Saussure; and that, too, at a particular temperature, so that the deductions drawn from it can scarcely be extended to cases in which the temperature is different. The method of Dalton, too, though susceptible of great precision, when the necessary experiments are performed with care, is not practicable in all circumstances; nor are the objections to which it is liable greatly obviated by the hygrometer of Daniel, which is intended to supersede it. The law, however, by which the evaporation of water is regulated, in a medium either absolutely dry, or partially charged with humidity, will enable us to determine the elastic force of vapour with greater correctness and simplicity, than it can be deduced from the indications of a hygrometer; while it will not require so much calculation for computing the ultimate result, as the method of Dalton renders necessary. When I make this remark, I by no means wish to be understood as having the slightest intention of undervaluing, in any respect, the labours of that eminent and philosophic chemist. On the contrary, the method which I am about to propose, for finding the elasticity of atmospheric vapour, is founded upon one of his most valuable discoveries respecting the laws of evaporation; and I should not do him justice, did I not embrace this opportuntity of remarking, that it affords, in my opinion, the surest basis for an accurate investigation of the hygrometrical constitution of the atmosphere, that has yet been proposed. The result of an investigation, such as I allude to, was given some time ago in the Edinburgh Encyclopædia, *Article* HYGROMETRY, p. 583; and I shall now briefly develope the physical and mathematical principles on which it rests.

Since water, during its transition to the state of vapour, absorbs as much caloric as would raise its temperature, had it continued in the liquid condition, about 900° of Fahrenheit's scale; it follows, that the evaporation of a 900th part of a portion of that fluid would depress the temperature of the remaining mass

* The investigation to which I allude, is contained in Biot's Traité de Physique, tome ii. p. 197., and possesses all the precision, perspicuity and elegance, which characterise the physical researches of that distinguished philosopher.

at least 1°, provided it received no accession of heat from contiguous bodies. But if F denote the entire elasticity of vapour, corresponding to the temperature of the medium, which we shall represent by T, and f the elasticity of the vapour which that medium already holds in solution; it appears, by the experiments of Mr Dalton, that the quantity of water evaporated, in some assumed unit of time, is proportional to $F-f$. As the cold induced by evaporation must evidently be a function of the same quantity, if t represent the temperature indicated by a thermometer having its bulb covered with moistened tissue paper, or any other bibulous substance, it is evident we may assume, as a first approximation,

$$T-t=A\,(F-f)$$

In this expression A is a coefficient to be determined by experiment, from known values of T, t, F and f, and modified afterwards, if necessary, to adapt it to the varying conditions of atmospheric evaporation. No limits, indeed, could be set to the value of $T-t$, nor, consequently, to that of A, were it not that the extent of the depression of temperature of the thermometer with the moistened bulb, below that of the surrounding medium, T, is more and more powerfully counteracted by the influx of heat from the adjacent air, which increases with $T-t$, and is nearly, if not exactly, proportional to it.

If the curve, whose co-ordinates connect the difference of temperature induced by evaporation with the elastic force of vapour, be assumed to be of the kind denominated, by analogy, parabolic, we may apply to it the equation,

$$T-t=A\,(F-f)+B\,(F-f)^2+C\,(F-f)^3+\&c.$$

Now, the quantity $F-f$ being, within the range of temperature at which hygometrical observations are made, always a small fraction, it will be sufficient to assume

$$T-t=A\,(F-f)+B\,(F-f)^2.$$

The solution of this quadratic, when $T-t$ is represented by δ, gives

$$f=F+\frac{A}{2B}\left(1\mp\sqrt{1+\frac{4B\delta}{A^2}}\right)$$

To determine the coefficients A and B in this expression, in which, from the nature of the case, the negative sign of the radical part is only admissible, two conditional equations are necessary, in which the values of F, f and δ are known. I have thus found A = 34.75, and B = 3.11, so that by the substitution of these numerical values of A and B we obtain

$$f = F + 5.586\ (1 - \sqrt{1 + .0103\ \delta})$$

To illustrate this by an example, let it be required to determine the actual elasticity of atmospheric vapour when the temperature of the air is 60°, and a thermometer, having its bulb covered with moistened paper, stands at 51½°.

Here by Mr Dalton's table of the elasticity of vapour at different temperatures, the maximum elasticity of vapour at 60°, is ·524 inches, = F and $\delta = 60° - 51\frac{1}{2}° = 8\frac{1}{2}°$.

$$\text{Hence } f = \cdot524 + 5\cdot586\ (1 - \sqrt{1 + \cdot0103 \times 8\cdot5}) =$$
$$= \cdot524 - \cdot239 = \cdot285.$$

According to this result, the *relative tension* of the atmospheric vapour, at the time of observation, or the ratio of the elasticity of the vapour actually existing in the air, to the maximum elasticity for the temperature, is expressed by the fraction $\frac{285}{524}$, or ·5439. To compare this result with the tension of vapour deduced from the experiments of Dulong * for the degrees of De Luc's hygrometer, I employed one of these instruments which I had recently adjusted, and observed that it stood at 35°, reckoning from absolute dryness towards perfect humidity, which was marked, as usual, 100. Now according to the experiments of Dulong, which seem to have been made with great care, it appears that ·4874 of the tension of vapour, corresponds with 31°·8 of De Luc's hygrometer, while ·5912 corresponds with 37°·5. From these data, the tension of vapour answering to 35° is, by interpolation, ·5456, which differs from the result by my formula ·0017. Not having one of Saussure's hygrometers, I can only compare that result with the relation which Biot has deduced between the tension of vapour and the degrees of that instrument, by taking the degrees of Saussure's hygrometer, corresponding with those of De Luc's, from the

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* See Biot's Traité de Physique, tom. ii. p. 208.

most accurate comparisons of them which have been made. By the results furnished by De Luc himself, 35° of his hygrometer answers to 73° of Saussure; whereas, according to the observations of Du Long, 31°·8 answers to 75°, and 37°·5 to 84°; which would make 35° to correspond with 80°. Some allowance must be made for the aberrations of different instruments; but if we adopt the mean of these results, 35° of De Luc's should correspond with 76·5° of Saussure's, which, according to the elegant analytical investigation of Biot, founded on the experiments of Guy Lussac *, answers to ·5599 as the tension of vapour. This differs ·016 from the result furnished by my formula, a difference so small as to be within the limits of the deviations of different instruments.

(To be continued.)

Art. VII.—*On the Principles and Practice of Ventilating and Warming Buildings.* By Thomas Tredgold, Esq. Civil Engineer, and Honorary Member of the Institution of Civil Engineers. (Concluded from p. 47.)

Of Warming Buildings.

The principles of warming buildings depend on the laws by which hot bodies communicate heat, limited by the circumstance that the air which is to be respired, must not be injured by the heating surface. And it is obvious, that the quantity of heat required, must depend very much on the closeness of the windows and doors, the kind of walls, and the proportion of windows. The effect of different kinds of walls will be most sensible in the time necessary to raise the room to its proper temperature, but the escape of heat from doors and windows will be constantly taking place. It may be shown, that each foot of surface of glass will cool about 1½ cubic feet of air per minute, from the temperature of the room to that of the external air; and hence the loss of heat from windows is easily estimated. To the loss of heat from the windows, must be added the quan-

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* Physique, tom. ii. p. 199.

tity for ventilation, and an allowance for other causes of loss should be made. We then have no difficulty in proportioning the quantity of heat, and reducing that to a regular system which has been conducted by guess. A minute is made the measure of time in both cases, and a cubic foot the measure of the quantity of air heated or cooled. That is, if there be 150 cubic feet of air cooled per minute by the windows, and 400 cubic feet per minute changed for ventilation, and 50 cubic feet be allowed for loss by apertures; then there must be $150 + 400 + 50 = 600$ cubic feet of air warmed per minute, to maintain the room at the proposed temperature.

The bulk of air in a room has no concern in such calculations; but the temperature is more slowly obtained, after setting the apparatus to work, when a room is large, both on account of the greater quantity of air to be heated, and the greater extent of walls, floors, &c. to be warmed. What an immense length of time it would require to warm the walls and air of a large cathedral, while its height must render it nearly impossible to warm it by hot air. The only course that could be relied upon in such a case, would be to communicate the heat as directly as possible to the solid matter of the seats, &c. instead of expending it upon air to rise to the upper regions of the building.

But we have yet to consider how a hot body communicates its heat, and the temperature to which its surface should be limited, when the air is to be warmed at that surface.

A hot body radiates or projects heat through air from its surface; and it also communicates its heat to any solids or fluids in contact with it. Both these methods of communicating heat are employed in warming buildings. There are cases in which it is not prudent to employ radiant heat, but in all cases where it can be employed with safety, the union of the two methods renders the place which is warmed most healthy and agreeable.

To afford radiant heat, we have a fire in an open grate, so constructed as to expose a considerable surface to send out heat; and all the other parts of the fire-place, in contact with the fuel, should be slow conductors of heat, such as fire-brick and the like. To understand the reason of this precaution, we have only to consider that fuel does not send out radiant heat freely till its temperature be about 800°; and, as a given quantity of fuel only supplies a certain quantity of heat in a given time, it is obvious, that, if we expose too much surface at a temperature of 800°, more heat will be given out than the fuel can supply, and the temperature of the fire must be lowered, or will burn *dead*, as it is termed. If the back of the grate containing the fuel be of iron, the surface of hot fire must be less than when slow conductors are used, because there will be a greater loss of heat through the iron-back. It is often attempted to employ the heat which is given off by an iron-back to warm air; but air warmed in this manner is burnt, and unfit for respiration, besides creating a great deal of dust; and the loss of radiant heat is nearly equivalent to the quantity communicated to air in that manner. It is one of the advantages of an open grate, when properly constructed, that it allows all the burnt air, and the noxious gaseous matter from the fuel, to escape up the chimney, as they are formed; but this desirable property does not belong to all kinds of grates, even when their chimneys are good, and not liable to smoke. In order that the arrangement may produce the effect, the entrance to the chimney should be immediately above the fire, and large enough to give passage to the smoke, burnt air, &c. from the fire; it should not be larger, because, then, too much air will be abstracted from the room, and much heat will be lost. This leads me to notice a defect of a species of grate, lately much in use, in which the opening for the smoke is at the back of the grate, and very little above the level of the fire; as shewn in Fig. 2. Plate II., where the smoke passes through a long narrow opening at AB. A chimney of this kind will not act, unless it has a powerful draught; and the greater the draught is, the less effect will be obtained from the fire; but, however powerful the draught may be, a quantity of sulphureous vapour and burnt air will be intercepted at A, by the thin edge of the plate in which the aperture is made, and rise into the room. Common iron-stoves, with open fires, and descending flues, have the same defect; they are very commonly employed for warming shops and counting-houses in London, but are only felt oppressive where the doors are not opened with sufficient frequency, to change the air of the place very often.

Where air is not in any degree injured by fire, but merely heated, it is felt oppressive; because, air being increased in bulk by heat, we must either take a greater quantity into the lungs at once, or breathe oftener in the same time, to obtain that quantity of oxygen our system has been accustomed to absorb. But the diminished proportion of oxygen, in a given bulk of air, is not the only cause of our feeling oppressed in heated air; for, by heating air we increase its power of abstracting moisture from us. If a room be warmed by radiant heat alone, the solid matters in the room are warmed, without heating the air to the same degree, because radiant heat, passing through the air, does not materially increase its temperature.

The impressions of radiant heat diminish as the squares of the distance from the fire, and consequently extend, so as to be effective, to a small distance only. This suggests the expedient of employing a moveable screen, to receive the impressions of heat, and protect the family circle from the influx of cold air, from the distant parts of the room. Such a screen may be contracted or expanded, according as the weather is more or less severe, and entirely removed in summer. The Chinese or Japenese screen is partially used for this purpose, but the taste of our countrywomen is capable of giving it more appropriate ornaments, and of rendering it as interesting as it is useful.

The lively and cheerful blaze, and genial heat, of an open fire, is not, however, to be obtained at a small expence; and, by other methods, the same room may be warmed by one-third of the fuel required by an open fire. These methods I shall proceed to explain, noticing every variety that is not objectionable, by being injurious to health.

In the methods I am about to describe, warmth is communicated by contact; and, since the heat is ultimately communicated to the air of the place which it is the object to warm, it is of the utmost importance that that air should not be injured by the hotness of the surface from which it obtains heat. The fact that air receives no injury from a surface of the temperature of boiling water, is very well ascertained; and, perhaps, it may pass over a surface, heated to 300°, without material injury, but not when the temperature is higher. Air which has passed over red-hot iron, or red-hot brick, acquires a disagreeable odour, and, in respiration, produces a harsh dry sensation in the organs, and a tendency to cough. Air which has passed over the same surfaces, with their temperatures under 300°, is mild and agreeable. The precise nature of the change which an excess of heat produces in air, is not, perhaps, thoroughly understood, but it is supposed to consist in a partial combustion of the particles of animal and vegetable matter suspended in the air; it is a change, however, which produces a very sensible effect on any person who lives a considerable portion of his time in air which has undergone it.

Hence, in selecting those methods which are adapted to give warmth to the air of an apartment, it will be desirable to avoid those where the air must be in contact with surfaces of a higher temperature than 300°, and even that should be considered the extreme limit of the heat of a surface to warm air. To confine the temperature of the heating surface within this limit, excludes so many of the usual methods of warming, that we have only few left to consider.

The most useful for small houses is that where the fuel, &c. is confined by such a thickness of matter that the external surface cannot be heated beyond 300°. A stove of this kind should be as completely insulated as possible; so that the heat of the fire, and of the smoke and hot air passing through the flues, may be given out to the air it is intended to warm. The flues will be effective, with a good chimney, at a horizontal distance of 40 feet from the fire, and of from 50 to 60 feet where the flue rises, either regularly or by steps. It is sometimes necessary to make flues descend again, before the smoke passes into the chimney; but this renders them liable to explode, whenever the fire is so mismanaged as to fill the flues with gas. In hot-houses for plants, the flues are extended in one direction, so as to afford as equable a heat as possible to a considerable length of house; but, in other cases, the flues may be made to wind backwards and forwards, so as to occupy only a small horizontal space, of which we have an example in Swedish stoves. The materials of these stoves should be of such a nature that the air may be warmed against the surface, without becoming loaded with dust. Indeed all passages for air to circulate through, should be hard, smooth, clean, and durable. The wear of soft bricks, mortar, &c. by the friction of air, is much more considerable than those who have not observed it with care can have any idea of; and, besides the disagreeableness of dusty rooms, it is not desirable to inhale air charged with particles of brick and mortar. When the matter of the stove is of sufficient thickness to limit the temperature to the proposed degree, it is not economical to make it thicker, unless the fire be kept on only a certain time, and then the damper and the ash-pit both shut close, so that no air can pass through the flues: then a considerable mass of materials will afford a regular supply of heat for a long time after the fire is out; and you have to wait nearly as long a time before the stove affords any heat, if it be suffered to remain till it be cold. In fact, it requires a regular and systematic attention to manage such a stove, which renders it unfit for our uncertain climate, where the weather would very often change before the stove could be rendered capable of affording its warmth. Consequently, it is an obvious advantage to have the parts of the stove no thicker than is required to limit the temperature of its surface, because it then affords its heat speedily, and no attention to closing valves or dampers is necessary; and yet the mass of heated matter round the fire-place is considerable, and therefore it is not very soon cooled, if the fire be neglected. As the length of horizontal flue is limited, and it is not convenient to make any material change in the size of the flues, the power of the stove is usually regulated by the size of the fire-place; but it is better to do it by the area of the aperture into the chimney; for then we can have a slow fire, which will require less attention. By a quick fire, we gain most heat from a given quantity of fuel, but it requires constant attention; hence, where labour is more valuable than coal, a slow fire should be preferred. The area of the aperture into the chimney may be determined by the rule $\frac{10\,c}{\sqrt{h}} = a$. Where c is a number of pounds of coal to be consumed in an hour, h the vertical height of the chimney in feet, and a the area of the aperture in inches, and if the quantity of air to be warmed per minute, in cubic feet, be multiplied by 0·00472, the results will be the pounds of coal which the stove to warm it should consume in an hour.

Where a greater quantity of fuel than 10 lb. of coal per hour is required to sustain the temperature, it will be necessary to have two stoves; as this is better than increasing the surface of the flues.

In these rules, the fire is estimated to be capable of keeping the temperature of the room 30° above that of the external air, when it is supplied with Newcastle coal; and the fire being rendered capable of regulation by a damper in the chimney, and a register at the ash-pit, it is easy to have any variation of heat within that range.

In churches, and buildings of a like kind, the whole of the air, or nearly the whole, may be supplied to the stove from within the building; but, in smaller buildings that are in more frequent use, a part of the air should be brought from the exterior, and the rest from the interior; the relative proportions of which will be determined by what has been remarked in treating the subject of ventilation.

Enough has, perhaps, been said respecting the properties and powers of stoves of this kind; and if the importance of the principles of limiting the temperature of the surface, and of preventing the heated air becoming charged with minute particles of dust be admitted, it must be acknowledged, that very few of the contrivances called Stoves, are proper instruments for affording heat.

About the year 1796, a new method of limiting the temperature of a surface, for affording heat, was discovered by Messrs Strutt of Derby. It consists in placing the surface at such a distance from the fire, that its temperature cannot exceed 300°; and as, from the nature of the arrangement, this surface can only be of small extent, it was found necessary to direct the air in small streams against the heated surface with great velocity, to cause it to absorb a greater quantity of heat, and by that means compensate for want of surface.

It will be obvious, that, in this arrangement, the fire should either be raised in an open grate in the centre of the *cockle* (for that is the name given to the vessel which is heated), or the fire should give off heat through sides of slow conducting matter;—the latter appears to be the plan adopted by Messrs Strutt. It will also be evident, that the smoke of the chimney cannot be brought to a lower temperature than that of the surface giving off heat, unless it be given off through the sides of the flue which conducts it to the chimney. Consequently, the whole of the heat cannot be obtained without in part employing the principle we have already considered. It has already been remarked, that, in employing the cockle, we obtain only a very limited surface for affording heat; but to render the small surface it affords as effective as possible, Messrs Strutt have contrived a most ingenious method of causing the air to be projected in small streams with considerable velocity against the hottest part of the cockle; and, again, that air can only ascend into the air-chamber which has been brought into close contact with the heating surface on the upper part of the cockle.

The method of warming by the cockle is rather more limited in application than that by slow conductors; as, in order to get power to move the air through with sufficient velocity, the cockle must be at about the depth of twenty feet below the rooms it is intended to warm.

I have considered the cockle as a means of affording heat a little out of its place as an invention, for it was preceded by another, and more safe and convenient mode of distributing heat. I allude to Steam, which was first proposed by Colonel William Cook, in the Philosophical Transactions for 1745; but it does not appear to have been much used till after its application to cotton-mills at Glasgow in 1799.

The value of steam, as a vehicle for distributing heat, consists in the facility with which it can be conveyed from one fire to any part of the buildings to be warmed,—in the temperature of the surface affording heat never exceeding that degree which is injurious to the air,—and in the perfect safety from fire. Low pressure steam should always be employed for distributing heat, for when the just proportion of heating surface is prepared, the increased temperature of high pressure steam is not wanted; and it may be proved, that there is no economy in using it, while it must be dangerous in proportion to the pressure it is worked at; for it cannot be expected that an experienced engineer will be employed in attending the boiler of an apparatus for warming a building. But employing a simple apparatus, and low pressure steam, with a species of safety-valve inaccessible to the attendant of the fire, and yet not likely to be out of order, will render a steam apparatus perfectly safe, and capable of producing the greatest effect from a given quantity of fuel.

The boiler for producing steam is usually constructed in the same manner as a steam-engine boiler, and of the same proportions. It should contain as much steam as will fill all the pipes, or other vessels, for affording heat, besides about an equal space for water. From the boiler the steam flows into pipes, which convey it to the places where heat is required, and where it flows into larger pipes, or into other appropriate vessels for affording surface to give out heat. From these pipes, or vessels, the condensed water is returned to the boiler, provided the pipes or vessels be situate above the level of the water in the boiler; but if this should not be the case, the condensed water is allowed to run off by an inverted syphon, where a column of about nine feet of water is opposed to the force of the steam. Sometimes the same thing is effected by an apparatus termed a *steam-trap*, which acts by means of a hollow ball, similar to a ball-cock. And, in both these methods, it is necessary to have a small outlet, for clearing the pipes of air when the steam is let in. The valve by which the air is let out, and admitted at, when the pipes are clear of steam, is often made self-acting; the motion being produced by the expansion and contraction of the pipes. When the pipes are cool, the valve is open; but when they become heated, by the steam being admitted, they expand in length, and close the valve.

In some cases, the condensed water may be let off by a common cock; which, when the apparatus is at work, should be only opened just so as to let the condensed water escape. For hot-houses, this answers very well, and requires very little more attention than the other modes. The conveying pipe should ascend as nearly in a vertical direction as possible from the boiler, and then descend to the vessels for containing steam to afford heat; by this arrangement, the steam is not interrupted by the return of condensed water down the pipe. It must be obvious, that the condensed water should be let out at the lowest part of the pipes or vessels; but it is not equally obvious, that the air in the pipes should be let out at the same place; and, from a want of attention to this circumstance, there has sometimes been a difficulty in expelling the air from the pipes. Common air is, however, heavier than steam, and should be let out at the lowest part of the pipes.

The heating surface may be obtained in various ways. For ordinary circumstances, common flange pipes, of from three to five inches interior diameter, and cast as thin as they can be cast, sound and perfect. Double cylinders, one of which is shown by Fig. 5. Plate II., and its section in Fig. 4., may, in other cases, be used with advantage, as they afford a large quantity of surface; and by introducing a pipe A, for fresh air, into the central part of the cylinder, it warms the air as it enters the room.

The top and the base fit on to the cylinder, and it is supplied with steam from the wrought iron-pipe B, and the air and condensed water are taken away by the pipe C. The admission of fresh air is to be regulated by the handle D. The steam occupies the space between the two cylinders at *a*, *a*, in the section. It is necessary that the cylinder should have an open top, as shown at E; and as the height should not exceed about three feet, it is requisite to make the open work ornamental.

In other instances, I have used pipes joined in short lengths, nearly in the form of a distiller's worm, and placed an open trellis screen over them.

The proportion of pipe required to heat a given quantity of air per minute is easily calculated, by the following formula:

$$\frac{\cdot 48\ C\ (T - t)}{200 - T} = \text{superficial content of surface of steam-vessel}$$

that will heat C cubic feet of air, from the temperature t to T, in one minute. Therefore, the quantity of ventilation and loss of heat per minute, being ascertained by the principles already given for ventilation, it is easy to provide the requisite supply of heat. It is assumed, that the pipes are of cast-iron, that being the fittest material, except for the small conveying pipe, which may be of wrought-iron; but other surfaces will afford about the same quantity of heat, if of a dark colour, and the surface a little rough and spongy: a bronze colour is very well adapted for giving of heat.

In applying steam-heat, it should always be made to warm that part of the air which is introduced for ventilation, before it enters the rooms; but it should only be warmed to a temperature a little lower than the mean temperature of the room; the proportion of pipe to be applied for that purpose our formula will show, and a register to regulate the quantity which enters, will put it in the power of any person to alter it at pleasure.

When steam-heat is employed in a dwelling-house, the distilled water is found useful for many domestic purposes; and, as the saving of fuel, by returning it to the boiler, is much less than it is imagined to be, not exceeding one-twelfth of the whole expenditure, the convenience of having this kind of water will be a sufficient compensation.

Within the limit of an article of this kind, it is impossible to enter into all the *minutiæ* of the art of applying heat and conducting ventilation; but I hope, short as it is, it will afford some useful hints, and cause some inquiry to be instituted by those who are better able to investigate those important subjects.

ART. VIII.—*On certain Antediluvian Plants susceptible of being illustrated by means of Species now living within the Tropics.* By Dr C. F. P. DE MARTIUS. Read at a Meeting of the Royal Botanical Society of Ratisbon. (Continued from page 56.)

ALMOST all authors agree in representing the family of *Palms* as having existed among the first vegetables, and as being frequently found buried with the others. Nor is it to be doubted, that their remains, viz. the stems, fronds and fruits, occur in the older coal formation, although they are much less frequent than is commonly believed. A fragment of stem, represented by the illustrious Count *Sternberg*, in his celebrated work, Pl. 5. Fig. 1., exhibits the singular structure of palm-wood; and the fruits depicted there, Pl. 7. Fig. 12., seem to belong to a species of cocos or areca. But that later catastrophes have overwhelmed a great abundance of palms, is proved, both by the petrified woods, ocellated with fasciculi of fibres, and very easily distinguishable by them, frequently observed in the East Indies and in Europe, and which I have also seen in Brazil; and by the various impressions of fronds in calcareous schistus found in different places in the Tyrol, the south of France, and other countries in the vicinity of the sea, as well as on the Continent of Germany. I have in my possession an excellent sample of this period, found in the sandstone quarries near Herbipolis, being a piece of stem nearly a foot long, marked with three annuli produced by the fall of the fronds, and with the tubercles arising from the solution of the fasciculi of spiral vessels. The Palmacites obsoletus of *Schlotheim*, Pl. 16. Fig. 3., and Palmacites annulatus of the same author, Fig. 5., agree in many of their characters with stems of palms, and the latter, from its umbonate impressions arranged in rows alternating with transverse striæ or annuli, seems to belong to the aculeate palms.

The following are the characters of the *Palmacites:*

An unbranched woody or *arborescent stem*, straight, with the surface smooth, or armed with spiniform processes, marked with *annular cicatrices*, which are broader on one side (the back), narrower on the other (the belly), and placed alternately or subspirally at the broader part. Flabelliform or pinnate *fronds*.

Various genera of *arborescent grasses*, allied to *Bambusa*, seem to have been much more frequent than palms, in former times. Of these plants, to which the older writers applied the name of *Calamites*, some specimens have been figured by Succow, in the Act. Theod. Palat. Vol. V. Pl. 16, 17, 18, Fig. 10. and 11; Pl. 14. Fig. 8. and 9. Sternberg represents the smooth culm of a calamite in his work, so often cited, Pl. 5. Fig. 2; Schlotheim exhibits others longitudinally canaliculate over their whole surface, as are all those of Succow, and somewhat prominent or contracted at the joints, under the names of *Calamites cannæformis*, *interruptus*, and *nodosus;* see his Pl. 20. Fig. 1, 2, 3. I can scarcely venture to say, whether the *Calamites scrobiculatus* of the same author, Fig. 4., should not rather be referred to the palms. Another species of Bambusite, found in the sandstone of Scania, is exhibited by the celebrated Nelson, in the Act. Acad. Suec. 1820, p. 284, Pl. 5. Fig. 6., which agrees with various smaller Bambusæ, and is, therefore, with less propriety, referred to Calamus. The numerous furrows in *Bambusites*, seem to be owing to the natural structure of Bambusa, and not to have arisen from the circumstance, that the fragile tubular culms, perfectly round at first, and stuffed full of clay, while they lay overwhelmed in the general ruin, were broken into longitudinal pieces by the weight of the superimposed bodies, an equality of pressure on all sides producing a corresponding equality in the fractures. It therefore remains doubtful to what species the sulcate calamites are properly to be referred, the determination of which I leave to others who may have had opportunities of seeing more genera of arborescent grasses; for I am not acquainted with any that in all respects corresponds with the structure of the petrified plants. Nor does it seem at all inconsistent with probability that these forms of primeval vegetation are now entirely lost.

The *Bambusites* may be characterised as follows:

An arborescent *culm* or *caudex*, simple, or very rarely verticillato-ramose, articulate, with contracted or continuous sutured *geniculi*, and smooth or canaliculate *joints*.

The *Cuciphoræ*, *Draconæ*, *Pandani*, *Yuccæ*, and *Vellosiæ*, of which last I have seen enormous stems in the subalpine regions of Brasil, constitute another series allied to the palms. This family, which differs in structure from most of the monocotyledones, in having the stem broadly expanded above by a more or less perfect dichotomy, and is pretty intimately connected on the one hand, with the Cycadeæ, and on the other with the Coniferæ, also makes its appearance among the primitive forms. Nor is it at all to be wondered at, that specimens should occur in our coal mines of the same order with plants of which we still have living examples as evidences of a former world, the most ancient of all our vegetable productions, and of which may be adduced as an instance, the famous dragon-tree of Orotava. The marks by which they may be distinguished, are chiefly connected with the circumstance, that the stems are invested all around with the semi-amplexicaul base of the leaves which remains after the upper parts have fallen off, and hence resemble a surface covered with imbricate scales, spirally arranged in various ways, according to the various disposition of the leaves. It appears that these scales, being imbricated upwards, are not distinct from each other in their whole extent, and therefore may easily be distinguished from the scales of Filicites, so called. The thicker these leaves are the more gibbous does their persistent base become on the back, and leaves a concavity in the impressions left in slate-clay, which has been erroneously considered by authors as the cicatrix left by the fall of the leaf. The variously denticulate or erose margin of the scales, must of course shew the place from whence the upper part of the leaves has proceeded.

After premising this much with regard to the structure of the stems, we now give the character of *Yuccites:*

A woody *stem*, simple or branched above, with branches nearly equalling the stem in thickness, covered with plane or gibbous scales, crenated or erose at the margin, imbricated upwards, and thence not distinct beneath, destitute of cicatrices.

I am acquainted with three species of this genus, dug up from the coal-mines of St Imbert, and remarkable for the still persistent covering of scales reduced to charcoal.

1. *Yuccites microlepis.*

With triangular scales, twice as broad as long, having their margins, which are entire, meeting at an acute angle, plane, impressed with a subhemispherical pit from the middle to the base.

2. *Yuccites sphærolepis.*

With triangular scales, twice as broad as long, their eroded margins meeting so as to form the segment of a circle, gibbous on the back, the gibbosities triangular, attenuated downwards.

3. *Yuccites trigonolepis.*

With triangular scales, having their straight, entire margins meeting at an acute angle, elevated on the back, the gibbosities attenuated upwards.

Figured by *Succow*, Pl. 18. f. 15.

This species is remarkable for the size of its scales. Schlotheim's *Palmacites affinis*, Pl. 15. should perhaps be referred to this; but as the figure seems to have been taken from a specimen which had been deprived of its bark, we can only form a doubtful opinion with regard to it. The reason that the texture of the scales is found best preserved in these petrifactions, is, that the leaves, when involved in the general destruction, offered more resistance on account of their fleshy or cartilagino-fibrous structure, and, being converted into charcoal, adhered firmly to one another and to the petrified parts; while the internal parts of the stem, by absorbing the mud with which every thing was then invested, assumed a stony nature. Thus, in the greater number of specimens, we see the scales themselves;

in others, from which the carbonaceous bark has been removed, impressed or elevated dots spirally disposed around the stem, in the same manner as the scales.

I have now finished my observations with regard to the monocotyledonous genera of antediluvian plants; but there remain certain other forms, the structure of which so far differs from that of the above, as to render it necessary to call in the aid of dicotyledonous plants for their determination. There exist in our coal-mines sufficiently numerous examples of petrified forms, frequently several feet long, remarkable for tubercles or polygonal impressions distinct from each other, and longitudinally disposed in straight lines, separated by parallel grooves or ridges, and marked with a simple cicatrix impressed in the specimen itself, upon the carbonaceous bark, but elevated in the impression or cast. A species of this kind has been figured by *Sternberg*, Pl. 9. f. 1., under the name of *Lepidodendron alveolatum*; another by *Schlotheim*, Pl. 19., under the name of *Palmacites oculatus*; a third, more remarkable for its size, by *Nau*, Pl. 4., who first referred these vegetables to the Cacti, on comparing, at my instigation, several species of our garden. The same opinion has been embraced by *Rhode*, who, however, seems to have gone farther than he was warranted, in considering many remains of vegetables as Cacti, which belong to different orders; for some of his specimens are, without doubt, to be referred to arborescent ferns. But various kinds of Cacti have been so altered while involved in the general ruin, as to be in a great measure unfit for investigation. We have, for instance, some species, such as *Cactus tetragonus*, *pentagonus*, *hexagonus*, which are furnished with broad and plane surfaces; others, as *C. cylindricus*, entirely cylindrical, and furnished over their whole surface with reticulate furrows, among which tubercles project; others, as *C. repandus*, whose obtuse and repand surfaces are much approximated; and, lastly, others, such as all the *Opuntiæ*, remarkable for their compressed joints, which are plane or sparsely tuberculate. These different forms, then, while they lay buried among stones and mud, have been changed in various ways. A great many have been reduced by the extreme pressure into broad flat laminæ, longitudinally canaliculate or areolate; a few have preserved their orbicular form, their dense and fleshy texture having prevented the impletion of their trunks with mud, and their subsequent conversion into a stony substance, as we observe to have taken place in other vegetables, and especially the arborescent ferns. For which reason, it would seem, that round petrified Cacti have sometimes been taken for Calamites, as may be exemplified in the case of *Succow*, who, in the Acta Theod. Pal. vol. v. pl. 15., has figured a cactite for a calamite. With regard to the surface, in a few specimens the cortical layer itself remains reduced to a state of charcoal, and exhibiting areolæ formed of lanigerous tubercles, such as we see in Pl. 9. fig. 1. of *Sternberg;* in others, again, and those more numerous, this layer is loosened from the internal parts of the plant, and is agglutinated to the slate-clay, in such a manner that its internal surface comes into view, of which an example may be seen in *Sternberg's* Pl. 13. f. 2. ; in others, again, the internal substance itself appears converted into stone, and denuded of its bark. The fourth condition in which cactites occur, is when the impression of the natural entire surface has been left upon slate-clay ; and the fifth, when the surface, previously deprived of the cortical layer, has been impressed upon clay or mud ; the latter of which affords but a very imperfect idea of the nature of plants, as may be seen by *Succow's* figures, Pl. 19. f. 14. and 15., which cannot be reduced to any species. Having now stated the circumstances by which the *Cactites* may be distinguished from other petrified plants, I proceed to give their generic character :

A woody *trunk*, simple or articulato-dichotomous, with contracted entire geniculi, either longitudinally furrowed, with straight or waved sulci, which are impressed at the top with polygonal tubercles perpendicularly imposed upon them, or smooth (without furrows), with sparse or reticulate tubercles.

The species with which I am acquainted are the following :

1. *Cactites giganteus.*

Cylindrical ? sulcate, the sulci straight, with somewhat convex faces, subhexagonal, contiguous areolæ, which are ovate from the lower angles, being rounded, and the upper contracted, and marked with three cicatrices toward the tip.

Figured by *Succow*, Pl. 15.

Diameter from 5 to 6 inches. The sulci equal, straight, not waved. The faces, when covered with the carbonaceous bark, little convex; when the bark is removed, more convex, and marked with raised longitudinal lines; among which there is seen in the middle, an orbiculus pitted in the centre.

Found in the quarries at *St Imbert.*

2. *Cactites alveolatus.*

Angulate? sulcate, with hexagonal tubercles, which are subovate, from the upper angles being contracted, and cicatrized beneath the tip.

In this species each of the faces seems to exhibit rows of from six to twelve tubercles.

Lepidodendron alveolatum, Sternb. Pl. 9. f. 1. From the quarries at Horsowitz; Sternb. Occurs also in the coal-mines at St Imbert.

3. *Cactites trigonus.*

Angulate? sulcate, the sulci straight, with subhexagonal tubercles cicatrized in their upper third part.

The cicatrices placed at the distance of 5 lines from each other.

Lepidodendron trigonum, Sternb. Pl. 11. f. 1. At Radnitz in Bohemia; Sternb. I have also seen it at St Imbert.

4. *Cactites distans.*

Angulate? furrowed with straight sulci; with oblong slightly convex tubercles, cicatrized above the middle; the distance of the cicatrices exceeding the height of the tubercles by two or three times.

Cicatrices separated more than an inch. The *Palmacites oculatus* of Schlotheim, Pl. 17., and, perhaps, *Rhode*, Pl. 2. f. 1., seem very like this species, which occur very seldom with the bark entire, but frequently in the form of impressions without the bark.

From the quarries at St Imbert, as well as those of Swina, from which place, an impression of sandy marl was kindly communicated to me by Count *Sternberg.*

A species much allied to this, but differing, in having its parts of a larger size, has been figured by *Nau.*, pl. 4., from an impression only.

5. *Cactites longesulcatus.*

Round ?, with several straightish subequal sulci, marked with a linear cicatrix at the distance of nearly an inch; the faces somewhat convex.

In the quarries at *St Imbert.*

I have seen specimens of this two feet long by half a-foot broad, but all excoriated, marked with numerous furrows, running down at the distance of from 4 to 6 lines.

6. *Cactites subundulatus.*

Round ?, with several subundulate sulci, marked at the distance of half an inch with a linear cicatrix; the faces convex.

Occurs with the former, from which it differs in having the sulci narrower, with more elevated faces, and approximate cicatrices.

7. *Cactites tesselatus.*

Plane ?, with contiguous rhombiform areolæ, marked in the middle with the linear cicatrix.

This seems to belong to the Opuntiæ. I have only seen a single impression. It is found at *St Imbert.*

A genus of plants described by Count *Sternberg*, under the name of *Syringodendron*, agrees in many of its characters with the Cactites, nor can it be doubted that it belongs to the succulent or ficoid vegetables; but as the impressions situated in the middle of the fistulæ, and commonly remarkable for having the form of a bifid nail, can scarcely be formed by the tubercles of Cacti, it is probable that they belong to some cereiform species of Euphorbia, whose twin spines unite at the base, but diverge above. To those *Euphorbites*, which I imagine to belong to this division, we may ascribe the following character.

A straight woody *stalk* or *trunk*, simple or branched, impressed with rectilinear furrows, with the faces marked in the middle with oblong, emarginate, or often bifurcate cicatrices, longitudinally disposed.

To this genus are to be referred :

1. *Euphorbites cicatricosus.*

With the faces more than an inch broad ; solitary, elliptical cicatrices, emarginato-bifid, above and below.

At *St Imbert.*

2. *Euphorbites sulcatus.*

With the faces two-thirds of an inch broad ; twin linear, entire cicatrices.

Palmacites sulcatus. Schloth. pl. 16. f. 1.

From quarries in *Silesia* and at *St Imbert.*

Perhaps Schlotheim's *Palmacites canaliculatus*, pl. 16. f. 2., differs only in having its proportions larger.

The genus *Rytidolepis*, constituted by *Sternberg*, pl. 15., remains doubtful between Cactites and Euphorbites. With regard to Schlotheim's *Palmacites variolatus*, pl. 15. f. 3., I cannot affirm any thing with certainty, although it appears to approach rather to Cactites.

There is less doubt regarding another sort of fleshy plant, to which Sternberg gives the name of *Variolaria ficoides.* The arborescent stalk, branched above, is every where furnished in the upper part and branches with lanceolate leaves, after the fall of which, there remains an orbicular cicatrix mamillated in the middle, and which is the more prominent, the greater the degree of decortication which the specimen has undergone. We observe a similar structure in many succulent plants, which exhibit, when their bark is removed, knots of spiral vessels projecting from the alburnum opposite to each of the leaves, as I have represented in the *Sempervivum arboreum.* The disposition and form of the leaves in *Variolaria ficoides*, as well remarked by Sternberg, correspond very well with *Cacalia ficoides*, L. ; but the trunk is proportionally much thicker than we observe in the living plant ; and, although the petrified plant cannot, therefore, be referred to this species, it certainly bears indications of being allied to the tribe of *Cacaliæ* or *Ficoideæ.*

There remains for me now to speak of a very remarkable form, with branches attenuated upwards, and having the whole surface covered with foliiferous scales, arranged in an imbricated manner, neither referable to the genus *Yucca* nor to that of *Cactus*, and to which *Sternberg* has given the name of *Lepidodendron dichotomum*. There are, indeed, certain species of Ficoideæ, such, for example, as *Sempervivum arboreum*, which resemble this plant in having the bark marked with squarish or rhombiform areolæ, but their bark never forms scales separable from the wood, and rather presents the appearance of tessellar spaces, than true and distinct scales. I am of opinion that the Lepidodendron dichotomum may, with more propriety, be referred to a new genus which I met with in Brazil. The fields of the province of *Minas Geraes*, at a height of 2000 feet and upwards above the level of the sea, and especially the diamond district, afford a genus of the order Compositæ, much allied to the *Vernoniæ* of Linnæus and the *Pollalestæ* of Humboldt, which seems to correspond in every character with our petrified plant. I propose naming it *Lychnophora*, and shall describe several species of it in another dissertation, confining myself here to the characters derived from its general habit.

The *Lychnophoræ* are shrubs of about the height of a man, or a little higher, with the trunk, simple beneath, and divided above into several corymboso-fastigiate branches, everywhere invested with a very dense tomentum of very fine hairs, elevated into small elliptical or squarish areolæ, which emit a leaf from the middle. The leaves are thickish, commonly revolute at the margin, narrow, linear, or lanceolate, densely scattered toward the summits of the branches, patent or erecto-patent, more rarely recurvate, readily falling off, and then leaving small foveolæ in the pulvinate tessellæ of the down. The flower terminal, densely capitate, either furnished with floral leaves, or bare.

Whoever compares the figures and description of *Lepidodendron dichotomum* with these living plants, in respect to habit, ramifications, and the tessellated work investing the trunk, which in the fossil plants is converted into charcoal, will be convinced, by their numerous points of agreement, of the existence of a perfect identity, and be constrained to join in my opinion.

I therefore distinguish the *Lychnophorites* by the following character:

Trunk dichotomously branched above with attenuated branches, all invested with tessellated work, the tessellæ foliiferous on the back; *leaves* crowded towards the summits, straight, subacerose.

1. *Lychnophorites dichotomus.*

With rhombiform tessellæ, narrow, and very long leaves.

Lepidodendron dichotomium, Sternb. p. 19. pl. 1, 2, 3.

In quarries at *Sconia* in Bohemia.

The other species is still doubtful.

2. *Lychnophorites laricinus.*

With subtriangular tessellæ, and narrow leaves.

Lepidodendron laricinum, Sternb. p. 21. pl. 11. f. 2, 3.

In quarries at *Radnitz* in Bohemia.

With regard to this, as well as the preceding genera, we have to repeat the remark which we made respecting ferns, namely, that they are all vegetables, furnished with a singular structure of organs subservient to respiration, and highly adapted for inhaling nutritious juices from the atmosphere. It is well known, that the Cacti, as well as most succulent plants, derive their existence more from their relation to the air than to the earth; and I consider the Yuccæ, also, and Lychnophoræ, which choose for their habitation a dry sandy soil, that has undergone little preparation by the decomposition of previously existing vegetables, as peculiarly adapted for inhabiting the rude wastes of a recently-formed world, at that time destitute of vegetation, but much warmer than now. There may be some, who, in objection to this opinion, may express their surprise that plants which in our times inhabit only dry, sandy, or rocky, exposed places, and which do not grow in the midst of trees, nor even thrive in their vicinity, should, in these primeval periods of the earth, have constituted lofty and dense woods, and have admitted those genera among them, which, like the ferns, now vegetate in damp and shady places. To this I reply, that it is not at all inconsistent with probability, that those plants, the Cacti namely, Lychnophoræ, &c. which we still find occasionally associated with Agavæ, Bromeliæ, and arborescent ferns in the tropical regions, being extended to an enormous magnitude by a vegetative power at that time much more vigorous, formed vast umbrageous woods, which, from the generation of much humi-

-dity, arising from the air and their own putrefaction, had afforded a suitable retreat to many plants fond of marshy and shady situations, such as the Scitamineæ and various genera of grasses and ferns. But I do not wish to court the vain support of opinion, and shall rest satisfied with having gained your concurrence in regard to the judgment which I have formed as to the similarity existing between the parts of those antediluvian, and still living, vegetables which have formed the subject of the present essay.

It is only necessary to observe, that these petrified vegetables have undoubtedly lived in the same countries in which they are now found, and have not been transported from remote places by floods, and buried in ruins of various kinds. But that those formations, to which we give the name of Black Coal (Schwarzkohlen-formationen), have derived their origin from ages much more remote than those in which the beds of Brown Coal (Braunkohlen formationen) were deposited, is also proved by the vegetables which occur in the latter, and which, for a great part, exhibit leaves, fruits, and woods, of modern plants, and especially natives of the north of Europe. On this subject, should the present essay be honoured with your approbation, I propose to speak at another opportunity.

Art. IX.—*Geological Distribution of the Fossil Organic Remains enumerated by* Baron Von Schlotheim, arranged by Dr Boué. (Concluded from p. 146.)

Jura Limestone.

Monitor, &c.
Remains of Fishes
Belemnites acuarius
    paxillosus
    irregularis
    tripartitus
    lanceolatus
    penicillatus
    polyphoratus
Ammonites planulatus
    α vulgaris
    β nodosus
    γ comprimatus
    δ anus
Ammonites annulatus
    colubrinus major
    ammonius, amaltheus (perhaps only in Lias)
    costatus
    coronatus
    dubius
    convolutus
    caprinus
    varians
    comprimatus
    colubratus
    noricus
    naviculatus
    interruptus
    radians
    lævis
Nautilites egoniticus
    pictus
Lenticulites antiquus
    globulatus
    discorbinus
Serpulites gordialis
    lumbricalis
Helicites delphinulatus (in Lias ?)
    viviparinus
Conulites ventricosus
    viarius
Buccinites tornatus (in Lias ?)
    perdicarius
Muricites
Trochilites politus (in Lias)

T. niloticiformis
granulatus
nodosus, var.
Turbinites trochiformis
Lepadites anatiferiformis
lineatus
radicatus
Myacites protogæus
tellinarius
ovatus
radiatus } in
asserculatus } Lias?
Tellinites rostratus
lacteus
elongatus
gnidius
lævigatus
lucinius
Donacites trigonius
costatus
alatus
hemicardius
Venulites crenatus
arcarius
proavius
trigonellaris
simillimus
subaratus
Arcacites corbularis
Bucardites lævis
rugosus
hemicardius
hemicardiiformis
cor-bovis
longirostris
pectinatus
Chamites forensis
pectiniformis
lævis
α giganteus
β donacinus
Pectinites jacobæus
regulatus
subspinosus
articulatus
Ostracites chamatus
tubulatus
gryphaëtus
adavius
flabellatus
sessilis
haliotiformis
crista-galli
crista-g. complicatus
hastellatus
Terebratulites lævigatus
pectunculatus
subsimilis
variabilis
varians
lacunosus

T. senticosus
reticulatus
loricatus
pectunculoides
pectunculus
radiatus
vulgaris, var. α.
sufflatus
bicanaliculatus
bisuffarcinatus
lateralis
nucleatus
vicinalis
marsupialis
æquirostris
substriatus
radiatus
lagenalis
gigantea
dissimilis
Gryphites dilatatus
spiratus
Mytilites gryphoides
elongatiformis
rostratus
pseudocardium, (Lias?)
Echinites conoideus *or* istriacus
helveticus
depressus
coronatus
globulatus
miliaris
varians
ellipticus
tessellatus
orificiatus
paradoxus
rosaceus
digitatus
cruciatus
campanulatus
Pentacrinites ramosus
major
echinatus
mespiliformis
phytolites
Fungites infundibuliformis
rugosus
Hippurites turbinatus
α radiatus
Madreporites exesus
limbatus
muricatus
punctatus
cavernosus
meandrinus
filatus
astroides
truncatus

Milleporites punctatus
Tubiporites stalactiticus
Spongites alcyonatus
pertusus
Alcyonites manatus
clavatus
asterulatus
rugosus
globatus
stellatus
boletiformis
madreporatus

Upper part of the Jura Limestone.

Didelphous animals
Ornitholite
Fishes of the genera
Clupea
Esox
Pœcilia
Stromateus, &c.
Monitor
Macrourites tipularius
pseudoscyllaris
propinquus,
arctiformis
fuciformis
pusillus
minutus
mysticus
modestiformis
longimanatus
Brachyurites antiquus
Sphinx
Cerambyx
Ichneumon
Vermiculites
Tellinites problematicus
solenoides } perhaps not shells.
cardissæformis
Asteriacites pannulatus
Ophiurites filiformis
octofilatus
decemfilatus
pennatus.

Iron and Green Sand, and Chloritic Chalk.

Mastodon, &c. at Vienna.
Fragments of fishes, especially teeth of Squalus, Raja, &c.
Crawfish
Brachyurites hispidiformis
Hamites

Lenticulites ephippium
(nummulites) reticularis
variolaris
denarius
mamillaris
stellaris
Ammonites planulatus
laevis, &c.
Belemnites giganteus
cingulatus
Nautilites aperturatus
cingulatus
bisiphilis
Helicites deperditus
Patellites vetustus
Buccinites vulpeculus
cingulatus ?
limatus ?
Strombites pugnans
Volutites
Conilites
Turbinites
Trochilites cementricus
Neritites
Muricites
Porcellanites
Pholadites amygdalinus ?
Myacites margaritiferaeformis ?
asserculatus ?
Solenites diluvialis
tellinarius ?
cultratus ?
Venulites approximatus
borealiformis.
islandicus
Tellinites politus
corbularius
Bucardites cardissaeformis
liniatus ?
Donax subtrigonius
Chamites anceps
Plagiostoma spinosum (*Bt.*)
Ostracites crista-galli
complicatus
Pectinites aculeatus
Terebratulites vulgaris, var. α
acuminatus
Gryphites chamaeformis
spiratus, (columba Brongt.)
Mytilites rugosus ?
Arcacites
Asteriacites patellaris
Lignite
Carpolites abietinus
Carpolites hispidus
avellanaeformis
piniarius.

Chalk.

Fishes in fragments
Zeus auratus
Carcharias verus
Squalus, &c.
Teeth of fishes, squalus, &c.
Raja pastinaca
Monitor, &c.
Trionyx or Emydes
Brachyurites australis
rugosus
Macrourites cancer gammarus
Belemnites paxillosus
macronatus
Chrysoura hercinina (Mont.)
Orthoceratites vertebralis or Baculites
Turrilites turbinatus
Orthoceratites annulatus
raphanoides
Ellipsolites funatus (Mont.)
Nautilites danicus
Lenticulites scabrosus
nautiloides
Dentalites cingulatus
nodulosus
Serpulites contorquatus
Helicites ampullaceus
Patellites limbatus
cornucopiaeformis
Lepas anatiferaeformis
Myacites asserculatus
Venulites flexuosiformis
Ostracites lineatus
oblongus
Chamites tellinoides
Pectinites gigas
liniatus
operculatus
asper
chamiticus
limbatus
Ostracites subchamatus
haliotideus
crista-galli cingulatus
urogalli
vaginatus
hastellatus
difformis
O. crista-gali, cristaecomplicatus
Ganiolites brattenburgicus
Terebratulites biforatus
decoratus
tegulatus
gracilis
crenatus
chrysalis
vermicularis
communis
β latris
γ orbiculatus
vulgaris
approximatus
giganteus
regularis
Gryphites truncatus
rugosus
ungulatus
suborbiculatus
Mytilites ostracinus
problematicus
Pinnites ungulatus
substriatus
Echinites radiatus
scutatus major
minor
sinuatus
corculum
quaternatus
variolatus
corallatus
amygdaliformis
avellanarius
stellatus
vulgaris
pustulosus
galeatus
echinometritis
cruciatus
rosaceus
Encrinites calycularis
testudinarius
Corallinites
Escharites cingulatus
coriaceus
celleporatus
membranaceus, &c
Fungites
Porpites echinatus
globulatus
Hippurites rotula
elongatus
Madreporites
α crispus
astroites, var.
filatus, var.
porcatus
Milleporites cellulosus

Milleporites clavatus
polymorphus
Tubiporites stalactiticus
Alcyonites boletiformis.

First Tertiary Sandstone, or Plastic Clay.

Bones of Elephas jubatus, Equus, &c.
Mustela putorius ?
Mus porcellus ?
avellanarius ?
Ornitholite of the genus Fulica
Fishes of the genus Cyprinus ?
Muraena auguilla ?
Cottus Gobio ?
Perca fluviatilis ?
Silurus glanis ?
Salmo Fario ?
Esox Lucius ?
Tinca ?
Gobio ?
Corassius ?
Cephalus ?
Brama ?
Rutilus ?
Nasus ?
Alburnus ?
Phoxinus bipunctatus
Grislagine ?
Monitor ?
Salamandra ?
Lacerta palustris ?
L. aquatica
Testudo orbicularis ?
Bufo calamita ?
Rana temporaria ?
Coluber natrix ?
Insects
coleopterous
dipterous
hemipterous
Cimex
Blatta
Tenthredo
Cynips
Ichneumon
Termes
Tipula
Culex
Erupis
Musca
Lepisma
Phalangium
Aranea
Hydrophilus
The above genera of Insects are found in Amber.
Helicites viviparoides
Neritites fluviatilis
Muricites carbonarius
Cerithium
Tellinites corneæformis ?
T. carbonarius
Lithoxylites similar to
Oak
Beech
Walnut
Fir
Willow, &c.
Lithanthracites
Lignites
Bibliolites of
Populus
Acer
Salix, &c.
Anthotypolites
Carpolites execaeformis
pistaciæformis
amygdalaeformis
pisiformis
rostratus
Palmacites flabellatus
Lycopodiolites caespitosus
Algacites crispiformis.

First Tertiary Limestone.

Fishes (all those of Bolca)
Teeth of Fishes
Turtle
Brachyurites porcellanus
carniolaris
gibbosus
hispidiformis
monadius
Macrourites astaciformis
Lenticulites phasiticus
planulatus
Dentalites elephantinus
D. radularis
striatus
Serpulites muricinus
nummularius
Helicites glabratus
roncanus
ampullarius
gregarius
paludinarius
Neritites cochleatus
Patellites peltatus
calyptræformis
cingulatus
fissuratus
Cypraecites inflatus
bullarius } or in the
spiratus } chalk.
Bullacites elegans
ovulatus
Bullacites nodulatus
cylindricus
volutinus
Volutites anomalus
nodosus
marginellus
linearis
Conilites cingulatus
stromboideus
subsimilis
Buccinites nitidulus
cingulatus
scalatus
decussatus
terebratus
vulpeculus
pyrulatus
laevis
plicatus
cinctus
orbiculatus
Muricites striatuliformis
noachius
substriatus
hispidus
fistulatus
subgranulatus
plicatiformis
elegans
cognatus
gracilis
pyrastriformis
aciculatiformis
pygmaeus
aculeatus
vulcanicus
pentagonatus
turritellatus
melaniaeformis
subcanaliculatus
granulatus
incrustatus
costellatus
costatus
mamillatus
melanoides
aluciformis
trapeziformis
auriculatus
radulaeformis
torrilosiformis
Strombites speciosus
Trochilites depressus
pentagonatus
pseudozizyphinus
Turbinites cingulatus
terebratus
laevissimus
Turbinites unguliniformis
Balatina patellæformis

Lepadites sulcatus
tintinabuliformis
plicatus
Myacites affinis
solenoides
Solenites vaginatus
Tellinites cingulatus
glabratus
glaberrimus
margaritaceus
Venulites octogonius
sinuatus
Islandicus
Arcacites rhombiformis
pectunculatus
lineatus
venericardius
orbiculatus
circularis
Pectinites regularis
gryphæatus
fragilis
hispidus
excentricus
Ostracites ventricosus
fossula
chamæformis
orbiculatus ?
crista-galli planulatus ?
parasiticus
cornucopiæformis
Gryphites spiratus
Mytilites pernatus
neritoideus
recens
terebratus
antiquus
Lunulites
Fungites
Hippurites areolatus
turbinolatus
var. α.
renovatus
Madreporites sessilis
Tubiporites tubulariæformis
Milleporites polymorphus
Lithoxylite or wood-opal
Zosterites.

Lower Fresh-water Deposit.

Bones of Hippopotamus
Paleotherium magnum
medium
crassum
curtum
minus
Anoplotherium commune
secundarium
medium
minus
minimum
Sus
Canis parisiensis
Didelphis parisiensis
Viverra parisiensis
Ornitholites and Fishes
Planorbis alba
Helicites sylvestrinus
agricolus
pseudo-ammonius
viviparoides
palustris
buccinatiformis
cylindricus
Volutites helicinus
Cypris.

Second Tertiary Sand and Limestone.

Turbo duplicatus
Bullacites ficoides
Nerilites radiatus
rotulatus
Volutites breccinoides
Buccinites elongatus
pseudo-vulgatus
cinctus
Trochilites ellipticus
Arcacites pectinatus
Tellinites scobinatus
Ostrea gryphoides.

Upper Fresh-water Deposit.

Helicites globositicus
putrinus
sylvestrinus
rotundatus
Fishes.

Alluvial Formations.

Remains of Elephas primigenus
Rhinoceros antiquitatis
Mastodon
Megatherium
Tapir
Bos Urus priscus
cæsaris
Cervus Elaphus primordialis
Alce gigantea
Ovis
Antilope
Equus adamiticus
Sus proavitus
Leo diluvianus
Canis crocatus
vulpes
Jaguar
Castor trogontherium
Whale
Cachalong
Sea-Dog, &c.
Caverns with Bones of the
Bear
Tiger
Lion
Hyena
Wolf
Jaguar, &c.
Calcareous Breccia, with Bones of the
Antilope
Asinus
Equus
Bos
Ovis
Lepus
Mus
Lagomys alpinus
Birds
Coluber natrix,
and with fluviatile and marine shells.

Calcareous Tufa.

Anthropolite ?
Elphas jubatus
Bos Urus priscus
Cervus Elaphus primordialis
Equus adamiticus
Antilope
Tigris
Talpa
Lepus timidus
Mustela vulgaris
Sorex
Strix bubo
Gallus communis
Rana
Bibliolites of the
Quercus robur
Tilia europæa
Betula alnus
fruticosa
Salix capræa
Acer pseudoplatanus
Chara vulgaris
hispida
Confervæ.

According to Hausmann, the fossils of the Muschelkalk and Lias of the north of Germany, are distributed in the following manner:

In the under part of the Muschel-kalk, alternating with Marls and Slate-clay.

Bones of Delphinus and Fishes
Terebratulites lacunosus
vulgaris
Belemnites paxillosus
Ammonites angulatus
capricornis
Gryphites suillus
Pentacrinites vulgaris

In the Middle Part of the Muschelkalk.

Terebratulites vulgaris
Encrinites liliiformis
Ammonites nodosus
Nautilites bidorsatus
Donacites trigonellus
Chamites striatus
Ostrea
Pleuronectes laevigatus
Mytilites socialis
Myacites musculoides
Bones

In the Upper Part of the Muschelkalk.

In Limestone.
Ammonites nodosus
Nautilites bidorsatus
Donax trigonellus
Chamites striatus
Mytilites socialis
Pentacrinites vulgaris
Glossoptera

In Slate Clay.
Ammonites angulatus

In Marls and Slates.
Belemnites paxillosus
Ammonites Capricornus
bipunctatus
Gryphites arcuatus
Terebratulites lacunosus
bicanaliculatus
vulgaris

In the Undermost Marls of Lias with Sandstones.

Ammonites Capricornus
hircinus

In the Black Marl of the Lias.

Belemnites giganteus
canaliculatus
Ammonites costatus
angulatus
Gryphites arcuatus
Pentacrinites subangulatus

In the Lias Limestone.

Ammonites angulatus
Capricornus
Gryphites pectiniformis
arcuatus

Serpulites

In the Ferruginous Marl Concretions.

Ammonites macrocephalus
planulatus
costatus
angulatus
Donax hemicardius.

In the Sandstone Bed of the Lias.

Lignite
Pholadites
Mytilites diluvianus
Venulites donacinus.

In the Clay with Iron Ore.

Belemnites giganteus
Ammonites Amaltheus
ornatus
radians
Muriacites strombiformis (Cerithium Lam.)
Venulites donacinus
Terebratulites vulgaris
lacunosus
bicanaliculatus

In the south-western part of Germany, the following is the distribution of the Fossil Remains in the Lias, according to Professor Schubler of Tubingen.

In the Lias itself.

Ammonites arietis
colubratus
Belemnites paxillosus
Gryphites cymbium
Myacites musculoides
Pleuronectes discites
Venulites islandicus
Bucardites hemicardiiformis
Terebratulites ostiolatus
alatus
Mytilites modiolatus
Pinnites diluvianus
Pentacrinites vulgaris

In the Bituminous Marl Slate of the Lias.

Belemnites paxillosus
Pentacrinites subangularis
Ammonites Amaltheus
annularis
ornatus
laevigatus
cristatus

Turbinites trochiformis
Algacites granulatus
Fishes
Amphibious animals

In the Ferruginous Sandstone and Iron Ore of the Lias.

Ammonites bifurcatus
Pleuronectes laevigatus
Arcacites corbularis
Terebratulites sufflatus
Small Tellinites

Belemnites
Nautilites.

In the Upper Clay of the Lias immediately under the Jura Limestone.

Ammonites coronatus
Ammonites noricus
macrocephalus
Belemnites canaliculatus
giganteus
Serpulites lumbricalis
gordialis
Ostracites crista-galli
complicatus
Ostracites pectiniformis
eduliformis
Donacites trigonius
costatus.

It may not, perhaps, be out of place to observe here, that, to complete this list of petrifactions of the different formations of Europe, it would be necessary, in the first place, to consult the general works on fossils, such as Knorr's great and fundamental work, the Encyclopedie Methodique, Burtin, Lister, the Geological Transactions, Parkinson, &c., and then to have recourse, for the different formations, in particular, to the following works: For the Transition Deposit, to Miller's Encrinites, Sowerby's Mineral Conchology, Wahlenberg's Memoir on the Orthoceratites, Brongniart's on the Trilobites, and the Description of the Fossils of the Mountain Limestone of the United States, in Silliman's Journal. For the Coal formation, a synonymy might easily be established between the works of Schlotheim (Flora der Urwelt), Sternberg, Nau, Martius, (Memoirs of the Munich Academy), Rhode, (4 Fasciculi of Fossil Vegetables, Breslau,) and Brongniart's Memoirs. This latter gentleman will commence, in spring, the publication of his great work on this subject, so that no department of organic remains will be so well known. For the lias and Jura limestone, Sowerby and some Parisian memoirs would, in particular, require to be examined. For the upper Jura limestone, and the chalk formation, the same authors, together with Mantell's work, Faujas on Mont St Pierre, Brongniart's work on Paris, Desmarest's on the Crustacea, would furnish ample materials. The fossils of the plastic clay would be found in Brongniart's work on Paris, in Sowerby and Ferrussac; those of the first tertiary limestone, and the other tertiary deposits, in Lamarck, Brocchi, Brongniart on Paris and on the Vicentin, in Sowerby, in M. Deshaye's work already commenced, in Borson's Memoir on Piedmont, (Memoirs of the Turin Academy), in a work which is soon to be published by M. Basterot on the fossils of Bourdeaux and Dax, and in Fichtel's Transylvania. Lastly, Cuvier would furnish a complete list of all the animal remains of the alluvial formations; and Blainville a catalogue of the greater number of known petrified fishes.

To establish a perfect synonymy between so many authors, would be of so much advantage to geologists, that some scientific society ought to propose such an attempt as the subject of a prize.

Art. X.—*An Account of a Series of Experiments, made to determine the Local Attraction of his Majesty's Steam-Vessel Comet.* By P. Barlow, Esq. F. R. S., Professor Royal Military Academy.

No experiments having yet been made on the local attraction of a steam-vessel, and the iron in these cases being very differently distributed to what it is in vessels of the usual construction; and, moreover, as the above steam-boat was going down the coast of Norway for certain observations connected with the determination of the longitude, &c. it was thought desirable to ascertain the effect of her iron-works on the compass before she left the River; and I therefore received directions from my Lords Commissioners of the Admiralty, and from the Navy Board, to take with me the six gentlemen who had been ordered to attend me for instruction *, and make such observations and experiments as might seem desirable in this novel case.

I had been before requested to give my opinion as to the probable effect which the projected hollow iron-masts in men-of-war might have on the compass; and I stated, that I thought it probable so great a surface carried above the deck would have a counteracting effect on the usual iron of the vessel, by bringing the common centre of attraction of all the iron nearly into a horizontal plane with the compass, and therefore, in these latitudes, nearly into the plane of no attraction, so as to leave it doubtful whether the actual effect would be the same as, or the reverse of, what happens in the usual cases. If the power of the mast prevailed over the other iron, the effect would be reversed; but

* These gentlemen, Messrs Reid, Parsons, Watts, Bennet, Williams, and Cutfield, had been educated in the Royal Naval Architectural College at Portsmouth, and were, in every respect, highly competent to, and interested in, the duty assigned to them by the Admiralty.

if, on the other hand, it did not amount to so much, then the effect would remain the same in quality, but would be diminished in quantity.

Steam-vessels present nearly a similar arrangement; the iron-chimney standing in place of the mast, and the boiler and engine in lieu of the usual iron-tanks, ballast, and guns. There was also here another question. I had determined, by a long series of experiments, that iron, when hot, had a much greater power than when it was cold, in many cases more than three times; and it might therefore be presumed, that as, in a steam-vessel, most of the iron is kept under a considerable degree of heat, the power of this on the compass would be much more strong than in ships of the usual kind.

The following are the principal dimensions of the vessel, &c. as they relate to the following experiments:

	Ft.	In.
Length of the vessel, - -	115	0
Greatest breadth, - -	21	0
Burden, - - -	237 tons.	
Length of boilers, - -	15	0
Mean breadth, - -	15	0
Depth, - - -	8	6
Thickness of metal, - -	0	$0\frac{3}{8}$
Height of the smoke-chimney, -	36	0
Diameter of do. for 3 feet 3 inches,	2	9
Do. do. for 32 feet 9 inches,	1	6
Thickness, - - -	0	$0\frac{1}{16}$
Height of steam-chimney, -	25	6
Diameter do. - - -	0	6
Thickness, - - -	0	$0\frac{1}{4}$

The three compass stations are thus distinguished: Binnacle compass A, standard compass B, the compass fixed forwards C.

Compass A near the wheel.

	Ft.	In.
From A to B was - - -	7 ft.	8 in.
From B to C, - - -	20	6
From C to edge of boiler, - -	9	0
From C to large chimney, - -	15	8

The vessel was ready for the experiment on the 26th of June, and Mr Lecount, Admiralty midshipman, author of a highly ingenious work on the "Polarisation of Iron," having been ordered to go out in her to assist Dr Tiarks in his experiments, had already provided a pedestal or stand for the standard compass B, in a proper place in the vessel; and, at a little past six o'clock in the morning, the Comet was swung round a buoy off Woolwich Dock-yard. The observations were made by two persons, one on shore, and the other on board, each having one of Gilbert's patent azimuth compasses. At certain signals made on board, each took the magnetic bearing of the other, while the head of the vessel was successively directed to the several points of the compass; and the difference in these bearings gave the local attraction at each point, at least as far as the tide would admit of her head being warped about the buoy.

In this course of experiments, the counteracting power of the chimney was rendered very obvious, the local attraction having been found very inconsiderable, and just such as might have been predicted from the circumstance of elevating the common centre of attraction, as in the case of the iron-mast above mentioned.

These observations having been made at low water, we descended the river to North Fleet, and there lay by to repeat another set at high water. We now fixed up a second azimuth compass 9 feet abaft the boiler, and 15 feet 8 inches from the chimney, where it might be supposed the boiler would have a much greater effect than the chimney, and thereby bring the centre of attraction below the plane of no-attraction; and, having thus engaged both our compasses, we made use of a theodolite on shore for taking the bearing of the stations on board, the zero of the fixed plate having been first carefully adjusted to the magnetic north.

The vessel being now swung by the tide, with the usual arrangement of warps, &c., the following observations and results were obtained.

Local Attraction of His Majesty's Steam-Vessel Comet, on two Compasses placed in the Fore and Aft Line of the Vessel, at the Stations stated above.

Local Attraction at Fore-Compass.				Local Attraction at After-Compass.			
Bearing of Ship's Head by Fore-Compass.	Bearing of Shore-Station, from Fore-Compass.	Bearing of Fore-Compass, from Shore-Station.	Local Attraction, Fore-Compass.	Bearing of Ship's Head by After-Compass.	Bearing of Shore-Station from After-Compass.	Bearing of After-Compass from Shore-Station.	Local Attraction from After-Compass.
E NE	S 27° 40′ W	N 40° 46′ E	— 13° 6′	N E	S 41° 0′ W	N 42° 20′	— 1 20
N E	31 0	43 1	— 12 1	N E	41 20	42 10	— 0 50
do.	30 40	42 56	— 12 16	N E	41 20	42 21	— 1 1
do.	32 0	44 31	— 12 31	NE by N	46 1	47 17	— 1 16
NE by N	38 10	48 40	— 10 30	NN E	49 50	50 17	— 0 27
N NE	42 0	50 12	— 8 12	N by E	50 40	51 41	— 1 1
N by E	44 20	51 20	— 7 0	N by E	53 0	53 25	— 0 25
do.	47 20	54 41	— 7 21	North	54 40	54 58	— 0 18
Nor. ½ E	51 0	53 59	— 3 59	do.	55 40	55 50	— 0 10
do. ¼ E	53 10	54 33	— 1 23	do.	57 0	56 57	+ 0 3
N by W	54 40	55 1	— 0 21	do.	56 40	56 46	— 0 6
do.	54 40	55 12	— 0 32	do.	56 20	56 45	— 0 25
do.	54 0	55 19	— 1 19	do.	57 40	57 30	+ 0 10
do.	56 20	55 56	+ 0 24	N by W	58 20	58 6	+ 0 14
do.	56 20	56 32	— 0 12	N by W	58 30	58 5	+ 0 25
do. ½ W	59 0	56 18	+ 2 24	E SE	54 0	53 58	+ 0 2
SE by E	45 20	54 30	— 9 10	E SE	52 0	51 15	+ 0 45
E by S	43 0	52 58	— 9 58	SE by E	54 0	53 17	+ 0 43
E SE	45 40	54 34	— 8 54	E SE	55 0	54 48	+ 0 12
E by S	46 20	56 24	— 10 4	E SE	55 0	54 43	+ 0 7
E by S	46 40	56 17	— 10 47				

As the state of the tide would not admit of the vessel being warped to the other points, we again descended the River, and, the weather being very favourable, we were enabled to determine the difference in the bearing of these two compasses by an observer at each, keeping the other compass in the line of his sights, while the vessel was put about with her head to different points. In this way the following observations were made; and, as the after-compass, from the preceding table, appears to have very little local attraction, the difference in the bearing of the two instruments may be principally attributed to the fore-compass.

Observations on the reciprocal bearings of the Compasses marked B *and* C.

Bearing of Fore-Compass, & Ship's Head from After-Compass. B.	Bearing of After-Compass from Fore-Compass. C.	Difference or Local Attraction at Fore-Compass.	Bearing of Fore-Compass, & Ship's Head from After-Compass. B.	Bearing of After-Compass from Fore-Compass. C.	Difference or Local Attraction at Fore-Compass.
North.	South.	0° 0′	South.		
N 14° 10′ W.	S 16° 20′ E.	+ 2 10	S 15° 40′ E.	N 16° 40′ W.	— 1° 0′
31 10	23 30	+ 7 40	30 10	36 50	— 6 40
46 0	38 0	+ 8 0	53 0	61 0	— 8 0
60 0	50 20	+ 9 40	55 30	63 40	— 8 10
75 30	59 40	+15 50	70 10	84 20	—14 10
West	74 16	+15 44	N 85 0 E	S 70 0 W.	—15 0
S 75° 40′ W.	89 30	+14 50	70 40	57 30	—13 10
60 0	N 72 10 E.	+12 10	55 0	44 10	—10 50
44 10	54 40	+10 30	35 30	27 6	— 8 24
30 0	36 44	+ 6 44	20 0	14 30	— 5 30
15 0	17 50	+ 2 50	10 30	9 8	— 0 22

From these results, it appears that the local attraction at the fore-compass amounted, towards the east and west, to more than 15°; and as it appears that the north end of the needle was drawn forwards, it follows that the action of the iron *below*, viz. the boilers and engine, had in this place a greater effect than the chimneys.

At the place selected for the standard-compass, the action of the iron below was exactly or nearly balanced by that of the chimneys, so as to leave the compass nearly correct in its bearing; and it only remained to examine the effect of the two bodies upon the steering-compass. With this view, a similar set of observations to the last, were made upon the standard-compass, and the other azimuth set up in the place where the binnacle or steering-compass stood. These results are exhibited in the following table:

Observations on the Reciprocal Bearings of the Compasses marked A *and* B.

Direction of Ship's Head, by Observation from After-Compass A to Compass B.	Bearing of After-Compass B from Compass A.	Difference or Local Attraction at Compass A.	Direction of Ship's Head, by Observation from After-Compass A to Compass B.	Bearing of After-Compass A from Compass B.	Difference or Local Attraction at Compass A.
N. 3° 0′ E.	S. 3° 0′ W.	0° 0′	S. 0° 20′ W.	N. 0° 10′ E.	—0° 10′
8 0	7 40	+0 20	14 0	15 5	—1 5
21 0	18 40	+2 20	19 0	21 40	—2 40
31 40	29 20	+2 20	40 0	41 30	—1 30
39 25	38 0	+1 25			
50 40	48 0	+2 40			
66 30	62 40	+3 50			
74 20	70 40	+3 40	74 0	77 20	—3 20
82 40	8 0	+2 40	80 40	84 0	—3 20
S. 85 45 E.	N. 89 40 W.	+3 55	N. 86 0 W.	S. 83 10 E.	—2 50
79 40	83 30	+3 50	80 20	77 0	—3 20
69 25	73 10	+3 45	71 0	68 0	—3 0
63 1	65 10	+2 9	61 0	58 40	—2 20
48 0	51 10	+3 10	53 0	50 0	—3 0
			41 20	39 40	—1 40
31 30	34 20	+2 50	32 40	31 40	—1 0
17 30	18 40	+1 10	22 40	22 0	—0 40
10 0	9 40	+0 20	9 40	9 0	—0 40

Here, as in the preceding case, the compass B was known to have little or no attraction from the iron; therefore the above errors are principally due to the steering-compass A, or rather to its situation, for, as has been observed, the steering-compass was removed during these experiments, and one of the azimuths set up in its place.

On examining the above Table, it will appear, that, with the ship's head to the east, the north end was repelled to the west, and with the head to the west, the north end passed to the east of its true bearing, which shows that the result was either due to the superior action of the chimney, or to some iron abaft the wheel, being directly the reverse of what generally takes place in the usual order of vessels in these latitudes. Whether this is the case in all steam-vessels with iron chimneys, may be worth the inquiry of those engaged in the navigation of them, particularly in those intended for sea-voyages.

Art. XI.—*A Memoir on the Bag or Bladder occasionally protruded from the Mouth of the Dromedary.* By Dr Paolo Savi, Professor of Natural History in the University of Pisa. (Concluded from p. 137.)

The large canine teeth of the camel, and the incisive teeth in the upper jaw, which distinguish it from other ruminants, are well known to all naturalists; and the excessive hardness of the gums and palate, by which it can feed, with impunity, on the most thorny and sapless plants, are equally noted. I shall, therefore, not treat of those parts, since none of them are connected with the immediate subject of this memoir, but pass directly to describe the posterior part of the mouth.

From the point where the last molar teeth are placed, spring the anterior arches of the palate; from these the posterior arches are distant five inches, which cannot be seen on merely opening the mouth of the dromedary, without exposing entirely the cavity of the fauces. The space comprised between the anterior and posterior arches is occupied by the *velum pendulum palati*, or soft palate, from the middle of the free or posterior margin of which, in Man, and also in all the other mammalia, hangs the *uvula*. It is not so in the adult dromedary. In it the uvula does not hang from the free margin of the soft palate, but from its anterior or adherent margin; that is, from the crown of the anterior arches; and, as this uvula is extremely large, having usually a length of 14 or 15 inches, it occupies, with its base, not only the entire crown of that palatal arch, but also the upper third of the internal margin of the two *crura* or pillars of the posterior arch; and descending in front of the *velum pendulum palati*, shuts up, like a curtain, the opening into the fauces. Its anterior margin is free; but the posterior is united to the whole middle longitudinal portion of the *velum pendulum palati*, by means of a membranous fold, forming a sort of *frænulum*. This fold or frænulum, which, on one side, reaches to the extremity of the uvula, and on the other to the free extremity of the soft palate, that is, to the point where the uvula is usually found, divides longitudinally in two portions, the cavity comprehended between the anterior and posterior palatal arches.

Behind the uvula is found, as I have remarked above, the *velum pendulum palati*, which, being very large, and touching the base of the tongue with its extremity or free margin, just before the *epiglottis*, in the quiescent state, forces the air which escapes from the larynx to pass by the nasal canal.

In the upper part of the back of the nose is a *strait*, formed by a semilunar reduplicature of the nasal membrane. This kind of partition is so placed, as to cover the larynx by its inclination; and, consequently, it forms with that part, and the superior wall of the nasal canal, a *cul de sac*, the use of which we shall see in the sequel.

The excessive size of this uvula in the dromedary, and its attachment to the adhering or anterior margin of the *velum pendulum palati*, and not to the free or posterior margin, as in the other mammalia, might make some imagine that I have improperly termed it the *Uvula*, and that it might be a different organ. But, on examining its external and internal structure, its form and situation in dromedaries of different ages and sexes, the justness of my opinion is apparent. A thick whitish epidermis covers the mucous tunic, of a yellowish colour, in which are scattered numerous little glands. Under this tunic there is a cellular tissue, extremely loose, which serves to unite one of the parietes of the organ with the other; in this cellular tissue run large bloodvessels, and buried in it are numerous small glands, the excretory ducts of which, traversing the intervening substance, open upon the surface of the uvula. Now, of these very same parts, is formed the membrane of the palate, of which the uvula, as every one knows, is but a continuation. The *azygos* muscle, in all the mammalia, is the principal mover of the uvula; and the azygos muscle in the dromedary, which is thick and strong, distributes all its fibres into the interior of that organ which I call the uvula, and retracts and elevates it at the pleasure of the animal.

The uvula of the dromedary, then, is very similar in structure to that of man and other mammalia, differing merely in size and situation. Every difficulty respecting its position vanishes, on examining the mouths of the young, and of the female dromedary; for, in them, where the uvula is much shorter, and less developed, it is placed much more toward the free margin of the soft palate, or towards the usual site of the uvula; and in thus forming, by its position, if we may be allowed the expression, a connecting link between the uvula of the dromedary and that of other mammalia, it banishes the peculiarity which seemed to distinguish them.

And, finally, in regard to its great size, it is evident that this cannot be considered as a sufficient character to regard it as no true uvula, since the greater or less development of an organ can never change its nature.

This is all that seems to me necessary to be said respecting the structure of the mouth of the male dromedary, as far at least as concerns the guttural sac, the appearance of which we shall now explain.

When an animal in heat intends to project the sac, he raises the *velum pendulum palati*, and thus approximates it to that partition, in the superior part of the nasal cavity of which I have already spoken, at the same time driving out the air from his chest with some force. As, in this case, the *velum pendulum* is raised up, the passage into the posterior part of the nose is much straitened, while the air expelled serves to shut it up entirely, by entering into the *cul de sac* formed by the above mentioned partition; which being thus distended, and applied to the soft palate now elevated, performs the office of a true valve, and entirely shuts up the ordinary passage for the air. The air, no longer able to escape by the nostrils, seeks a passage by the mouth, and enters the fauces; but here a new obstacle presents itself to the free egress of the air in the uvula, which hangs before the *isthmus faucium*, and lies on the tongue, touching with its sides the posterior face of the anterior crura of the palate.

Hence it happens, that the air must force its way through one of two passages; that of the nasal canal is impervious, because the soft palate and the nasal sac shut up the passage more securely the greater the force of aerial current; that of the fauces may be forced through with difficulty, provided the impetus of the air be sufficiently strong. The air is thus made to act on the back part of the uvula, and strives to force it forward; but, as all the anterior extremity of that organ lies on the tongue, and its sides are applied to the crura of the palate, the air can only act on that small portion of the uvula situated between the arches, and near its attachment to the palate, where it is impeded by no obstacle. There the main force of the stream of air is concentrated, by which all the middle part of the uvula sliding on itself, projects beyond the *isthmus faucium;* and as soon as its margins come in contact with either, with the tongue below, or laterally with the palatal arches, it will form a sort of *sac*, inflated and distended, which is the substance that appears under the form of a bladder. If the action of the air continue, and the uvula be impelled forward, and the sac be inflated and increase, some portions of the margins of the uvula will be at length detached from the arches of the palate and the tongue; and hence the air will find a free exit; the bladder already formed, and until that moment most turgid, will instantly empty itself, and be converted into a membranous body, wrinkled and reddish, which the dromedary, as we have already stated, retracts within his fauces.

It is only during the rutting season that the dromedary projects the bladder. At other seasons of the year, by irritating him much and making him neigh, one may perceive in the interior of his mouth the swollen uvula rise up; but at that period it never distends itself sufficiently to appear externally. At that time the uvula is corrugated and shorter, and does not hang loose and relaxed on the base of the tongue; probably by reason of a contraction of the *azygos* muscle, and perhaps of some fibres of the *levatores palati mollis* that are distributed over it. Even in the season of love, it is only, as I have hinted above, in the moment of the venereal furor that the enormous uvula issues from the mouth, probably because it is only at that moment that the uvula is wholly relaxed, and becomes capable of entirely shutting up the space between the anterior arches of the palate.

It may be readily believed, that the uvula could remain in that state but temporarily, and for a short time, when it is considered, that, even in the rutting season, the dromedary ruminates; and that it is absolutely impossible for food to pass into the throat, as long as the uvula, relaxed and pendulous, closes up the entrance.

We see, then, that there exists in the dromedary an intimate connection between the organs of generation and the uvula; and we have a more direct evidence of it, on finding that, in the female and in the young male, there is never an appearance of the bladder. The females and young males have uvulæ proportionally larger than those of any other mammalia, but, as already remarked, they bear no proportion to that of the adult male. This intimate connection between the organs of the throat and those of generation, must be allowed to be remarkable; but it is well known to physiologists, and therefore nothing new. Various maladies that attack the genitals attack also the throat; a change of voice is very frequently observed in the season of love, and the instantaneous and notable change of voice in men at the age of puberty, is familiar to all. In not a few species of birds, the organs of voice in the male are absolutely different from those in the female; in others, the interior of the mouth and throat in the male acquires, when they are in heat, a very different colour to what they have at other periods, and to what is always found in the female: and many similar examples may be collected in glancing over the history of the various tribes of animals. But the cause of this *consent*, of this *sympathy*, is still unknown, and if there be a way of detecting it, it will probably be by accurate observation and attention to the anatomy, and the phenomena which those animals present, in whom this sympathy is chiefly conspicuous.

The presence of this uvula so long and flaccid, causes that *rattling* in the throat of the adult male dromedary which gives so odd a sound to its voice. It is easily comprehended how the air, in passing from the larynx, by meeting with a soft and flaccid body, like the uvula, and constrained to pass below it, and among its duplicatures, would produce a *gurgling*, as in passing through a liquid; and it is one proof of my assertion that the females and young males, in which the uvula is little pendulous, never produce so distinct and decided a *gurgling*; but their cry is more like the bleating of goats.

I shall terminate this memoir by the remark, that, in dromedaries, the uvula, velum pendulum palati, and all the membranes that line the mouth and the upper part of the alimentary canal, are often the seat of severe diseases, from which they are with difficulty saved, at least such is the case in the herd of Pisa. Every year some of the very young dromedaries are seized with ulcers,

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Fig. 2.

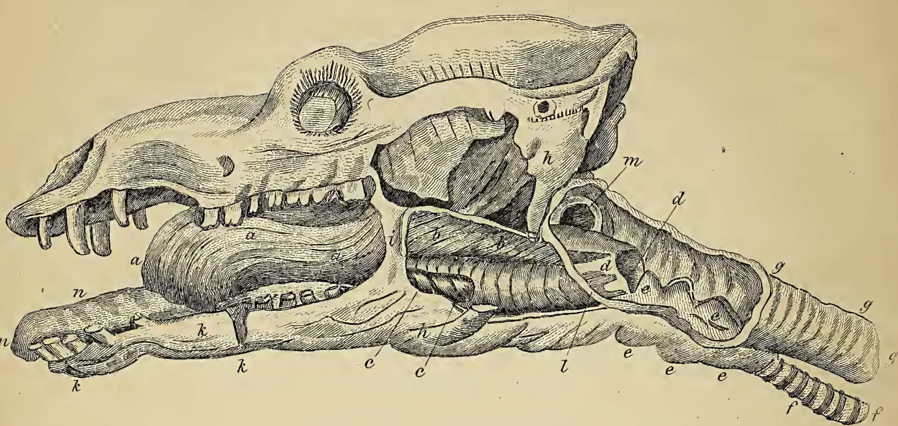


Fig. 1.

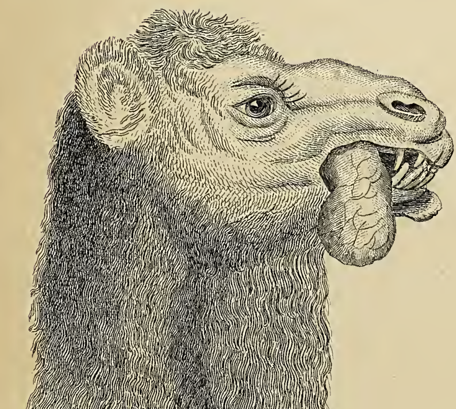
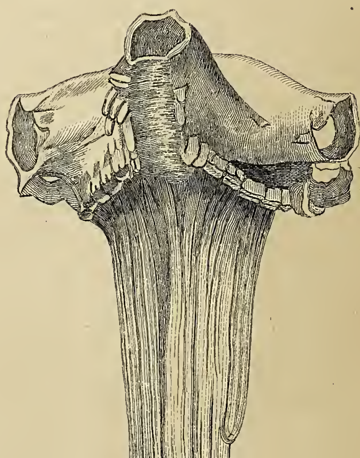


Fig. 3.



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which attack these parts, and spread with such rapidity as speedily to produce distress; and finally, by totally hindering the young animal to suck, cause its death from pain and inanition. In the adult dromedary, and especially in the male, toward the rutting season, these same parts frequently inflame, and I have seen two males destroyed by such a malady.

Explanation of Plate X.

Fig. 1. Head of the Male Dromedary, represented at the moment that the sac hangs out of his mouth.

Fig. 2. The Head flayed, and in part denuded of its flesh, to shew the manner in which the bladder is produced.

a, a, a, The Uvula, a little inflated, and directed toward the opening of the mouth.

b, b, Its reduplicature, or Frænulum, which is united to the free margin of the soft palate.

c, c, The extremity of the Uvula, which still remains within the anterior palatal arch.

i, i, The anterior Arch.

l, l, The posterior Arch.

m, Partition of the nasal Canal.

e, e, e, The Larynx.

f, f, The Trachea.

g, g, The Œsophagus, &c.

h, h, Portion of the Os Hyoides, cut in order to shew the interior of the mouth.

n, n, The Tongue.

k, k, The lower Jaw, of which one portion is removed.

Fig. 3. Head of the male Dromedary, deprived of the lower jaw, in which is seen a front view of the uvula when pendent.

Art. XII.—*Summary of Observations for Ten Years, from 1815 to 1824, containing the Mean of Thermometer and Barometer, number of Days of prevailing Winds, Snow, and Rain, Fall of Rain, &c. at Alderley Rectory, near Knutsford, Cheshire.* By the Rev. E. Stanley.

In the annexed columns, from January to December, is given under the head of Thermometer, the mean for each month during ten years, calculated from the mean of each month, according to observations taken at the times marked at the top, viz. 8 a. m., 2 p. m., 10 p. m. The maximum and minimum of the thermometer and barometer, shew the highest and lowest temperature and atmospheric pressure of any month during the year mentioned. The mean of the Barometer is taken only at 2 p. m., the variations from those taken at 8 a. m. and 10 p. m. being inconsiderable. The sums of the days of prevailing Winds, variable, snow and rain, are given under the respective columns, also the quantity of Rain fallen during each of those months, with the sums total.

		Thermometer.			*Ther.*		*Barometer.*	*Barometer.*		Prevailing Winds, N° of days of each.				Variable.	Snow or Rain.	Fall of Rain.
		8 A. M.	2 P. M.	10 P. M.	Max.	Min.	2 P. M.	Max.	Min.	N.	E.	S.	W			
January,	1815,	30.90	35.06	30.70	42	17	29.62	30.30	28.70	11	5	15	0	0	13	.42
	1816,	36.09	40.64	36.25	49	25	29.35	30.15	28.60	6	4	14	7	0	12	2.40
	1817,	37.67	41.77	38.19	53	22	29.46	30.25	28.25	6	0	22	3	0	12	1.17
	1818,	36.45	40.70	37.54	54	22	29.43	30.10	28.60	1	1	22	7	0	23	3.17
	1819,	37.45	42.09	37.83	52	29	29.25	30.05	28.45	3	2	24	2	0	19	3.31
	1820,	26.32	33.45	28.00	50	5	29.48	30.40	28.20	6	7	17	1	0	10	1.68
	1821,	35.25	40.45	36.80	54	12	29.43	30.35	28.10	2	10	17	2	0	8	1.19
	1822,	37.03	41.09	37.06	49	21	29.69	29.95	28.95	13	0	6	10	2	18	1.14
	1823,	27.18	33.51	28.87	47	4	29.31	29.85	28.60	5	13	13	0	0	12	2.05
	1824,	36.09	41.80	36.96	52	24	29.60	30.25	28.35	7	0	16	7	1	11	1.33
		34.04	39.05	34.82	54	4	29.46	30.40	28.10	60	42	166	39	3	13.8	17.86
February,	1815,	42.14	47.46	41.21	54	32	29.49	30.20	29.05	1	1	21	5	0	17	1.84
	1816,	33.37	40.27	33.69	51	14	29.60	30.15	28.85	10	0	14	4	1	13	1.52
	1817,	40.21	44.50	41.07	52	32	29.64	30.30	29.10	5	0	11	12	0	16	3.44
	1818,	32.60	38.35	34.92	52	23	29.37	29.95	28.75	2	0	20	6	0	15	2.50
	1819,	36.32	41.71	37.64	49	25	29.16	29.65	28.55	6	0	17	5	0	20	3.44
	1820,	33.51	41.34	33.48	54	16	29.55	29.90	29.05	7	0	21	1	0	12	1.49
	1821,	34.17	39.08	33.20	51	15	29.83	30.25	28.85	6	8	11	3	0	6	0.57
	1822,	37.85	45.50	38.14	58	24	29.55	30.20	28.60	0	0	23	2	3	13	1.63
	1823,	32.32	38.22	32.14	45	14	28.98	29.95	28.30	7	3	12	6	0	21	3.96
	1824,	36.48	42.65	37.24	53	28	29.38	30.10	28.60	6	7	13	2	1	12	0.86
		35.89	41.90	36.27	58	14	29.45	30.30	28.30	50	19	163	46	5	145	21.25

	Thermometer.			Ther.		Barometer.	Barometer.		Prevailing Winds, N° of days of each.				Variable.	Snow or Rain.	Fall of Rain.
	8 A.M.	2 P.M.	10 P.M.	Max.	Min.	2 P.M.	Max.	Min.	N.	E.	S.	W			
MARCH, 1815,	41.12	53.06	43.16	71	31	29.44	30.10	28.95	0	0	19	10	2	21	3.96
1816,	37.00	43.25	36.51	51	25	29.46	30.10	28.65	3	5	18	5	0	14	1.36
1817,	37.07	44.61	39.07	54	18	29.52	30.20	28.65	5	0	14	10	2	20	2.34
1818,	36.19	42.41	37.45	52	28	29.13	29.95	27.75	6	0	17	8	0	23	3.98
1819,	40.19	47.16	41.16	61	28	29.45	29.85	28.85	11	4	11	5	0	13	1.68
1820,	34.87	44.19	34.35	58	16	29.47	30.00	28.60	12	2	13	3	1	11	1.99
1821,	37.19	46.32	39.87	57	21	29.18	29.90	28.60	3	2	16	10	0	22	3.40
1822,	42.35	49.48	42.90	62	27	29.50	30.05	28.90	2	0	17	11	1	16	3.48
1823,	36.41	44.25	35.58	57	19	29.36	30.05	28.55	8	2	15	6	0	17	3.10
1824,	37.83	43.70	36.40	62	22	29.38	29.90	28.50	11	1	10	7	2	22	3.14
	38.00	45.84	38.64	71	16	29.38	30.20	27.75	61	16	150	75	8	179	28.43
APRIL, 1815,	46.13	54.73	44.26	72	31	29.66	30.15	28.85	9	9	5	6	1	13	1.25
1816,	41.06	52.20	42.23	68	28	29.44	29.90	28.85	8	6	12	3	1	14	2.28
1817,	41.00	50.66	42.43	61	26	30.02	30.35	29.50	17	3	6	2	2	7	0.28
1818,	41.03	49.16	41.60	63	27	29.26	30.25	28.75	3	12	14	1	0	15	4.25
1819,	44.50	53.23	43.76	68	32	29.33	29.75	28.55	5	6	13	5	1	11	1.77
1820,	44.80	53.50	40.16	66	26	29.50	30.15	28.85	9	2	11	7	1	14	2.16
1821,	45.70	54.76	43.83	67	26	29.19	29.65	28.70	7	3	14	5	1	18	2.98
1822,	43.06	52.16	41.03	75	27	29.49	30.00	28.80	13	3	11	3	0	20	1.99
1823,	39.53	48.46	37.23	57	24	29.44	30.00	28.65	9	6	8	5	2	13	1.76
1824,	41.46	51.93	41.10	64	24	29.45	30.10	28.80	7	5	11	4	3	14	2.24
	42.82	52.07	41.76	75	24	29.47	30.35	28.55	87	55	105	41	12	139	20.96
MAY, 1815,	53.62	61.32	52.45	75	40	29.64	30.10	29.20	4	2	18	4	2	18	3.21
1816,	47.74	55.45	47.51	70	32	29.54	29.85	28.90	5	5	11	8	2	18	2.80
1817,	45.32	53.61	45.67	63	31	29.45	30.05	29.05	12	4	4	3	8	20	2.85
1818,	50.41	60.33	53.22	69	38	29.39	29.90	28.80	7	6	16	1	1	12	1.56
1819,	50.80	59.03	50.22	70	31	29.44	29.70	29.10	6	9	10	4	2	14	1.92
1820,	50.55	56.64	45.71	73	25	29.33	29.90	28.75	2	2	21	4	2	19	5.51
1821,	44.77	53.06	42.16	66	26	29.43	29.80	28.70	6	5	6	14	0	17	3.18
1822,	51.45	62.03	50.74	75	33	29.56	29.90	29.00	10	11	7	2	1	7	1.16
1823,	51.45	59.22	47.03	70	32	29.45	30.00	29.00	7	0	18	5	1	17	2.07
1824,	48.83	55.77	45.25	78	28	29.54	30.15	29.20	13	3	7	6	2	15	1.33
	49.49	57.64	47.99	78	25	29.47	30.15	28.70	72	47	118	51	21	157	25.59
JUNE, 1815,	58.00	60.40	56.03	72	46	29.60	30.10	29.30	10	0	16	2	2	13	2.20
1816,	53.30	60.56	50.33	78	36	29.63	29.82	29.15	11	0	9	10	0	17	2.54
1817,	56.36	63.60	57.20	81	43	29.56	30.15	28.80	3	3	15	8	1	20	4.00
1818,	57.73	67.03	59.16	81	42	29.50	29.85	29.05	4	4	14	5	1	7	1.29
1819,	53.63	60.05	54.43	70	43	29.42	29.80	29.00	3	1	16	10	0	21	3.58
1820,	52.00	59.66	51.23	84	32	29.49	29.95	29.00	15	1	5	7	2	15	2.83
1821,	51.63	58.40	46.61	71	33	29.66	29.95	29.25	21	5	1	3	0	10	1.38
1822,	58.28	67.23	59.10	80	44	29.62	29.80	29.30	3	7	11	8	1	8	2.90
1823,	52.16	58.30	46.90	70	34	29.47	29.90	28.90	14	1	8	3	4	16	2.70
1824,	55.66	61.63	54.23	78	42	29.47	29.95	28.85	9	7	8	2	4	14	4.00
	54.87	61.68	53.52	84	32	29.54	30.15	28.80	93	29	103	58	15	141	27.42

		Thermometer.			*Ther.*		*Barometer.*	*Barometer.*		Prevailing Winds, N° of days of each.				Variable.	Snow or Rain.	Fall of Rain.
		8 A. M.	2 P. M.	10 P. M.	Max.	Min.	2 P. M.	Max.	Min.	N.	E.	S.	W.			
JULY,	1815,	59.80	64.58	56.03	77	44	29.81	30.00	29.40	11	2	6	9	3	14	2.48
	1816,	54.41	61.19	53.45	75	42	29.38	29.62	28.95	4	0	15	10	2	29	5.10
	1817,	54.67	60.80	55.00	67	47	29.49	29.75	28.95	6	3	17	5	0	21	5.10
	1818,	58.64	66.64	58.50	82	45	29.54	29.80	29.20	6	0	12	10	3	11	1.38
	1819,	58.54	65.22	59.41	80	45	29.52	29.80	28.90	11	4	10	5	1	17	2.77
	1820,	57.74	64.38	55.48	75	36	29.49	29.80	28.90	8	2	10	9	2	10	2.84
	1821,	54.22	59.19	50.12	67	35	29.45	29.85	29.00	9	1	14	6	1	16	2.05
	1822,	56.87	61.54	56.09	70	45	29.31	29.75	28.95	7	2	13	7	2	23	7.81
	1823,	54.51	59.45	53.93	68	44	29.33	29.70	28.95	3	0	15	10	3	22	4.22
	1824,	58.16	65.12	57.45	77	45	29.55	30.05	29.05	5	2	15	8	1	8	0.93
		56.75	62.81	55.54	82	35	29.48	30.05	28.90	70	16	127	79	18	171	34.68
AUGUST,	1815,	58.96	64.29	56.96	72	43	29.65	30.05	29.20	5	0	11	14	1	18	3.97
	1816,	53.54	59.74	53.96	72	43	29.64	29.95	29.00	5	0	10	15	1	18	1.55
	1817,	55.71	60.32	51.64	67	37	29.40	29.85	28.80	3	2	16	7	3	18	4.80
	1818,	54.03	62.32	54.64	82	41	29.57	29.75	29.20	9	5	10	5	2	10	0.86
	1819,	59.48	68.00	60.80	80	46	29.54	29.85	28.70	8	6	10	5	2	9	2.03
	1820,	56.12	63.35	52.22	74	34	29.38	29.80	28.95	3	2	16	7	3	20	2.79
	1821,	55.32	62.22	52.48	74	42	29.45	29.75	28.95	2	6	17	6	0	18	4.46
	1822,	56.03	61.38	55.06	74	45	29.42	29.80	28.90	1	1	14	14	1	20	3.54
	1823,	54.06	59.61	54.29	68	44	29.39	29.75	28.90	0	2	17	8	4	24	4.83
	1824,	56.09	62.83	56.03	73	43	29.49	29.95	29.15	4	4	16	5	2	19	2.70
		55.93	62.40	54.80	82	34	29.59	30.05	28.70	40	28	137	86	19	174	31.53
SEPTEMBER,	1815,	55.56	65.03	52.66	80	36	29.68	30.00	29.20	1	0	21	8	0	13	2.55
	1816,	50.10	59.20	51.40	71	37	29.57	29.95	28.90	4	1	20	3	2	19	2.05
	1817,	52.78	60.46	53.15	75	34	29.66	29.95	28.80	3	6	17	3	0	11	0.70
	1818,	53.00	59.00	52.50	71	40	29.56	29.75	29.00	5	6	7	11	1	13	1.10
	1819,	52.01	60.70	53.33	73	40	29.48	30.05	28.95	4	2	17	6	1	14	1.59
	1820,	51.90	59.73	49.10	75	32	29.51	29.85	29.00	4	0	15	6	5	12	2.85
	1821,	52.93	59.20	50.30	69	37	29.37	29.75	28.85	0	2	16	12	0	24	6.06
	1822,	51.40	57.80	51.06	68	36	29.52	29.85	29.00	5	11	8	6	0	13	1.32
	1823,	50.20	58.56	51.23	71	35	29.50	29.90	28.70	3	2	14	10	1	16	3.36
	1824,	53.96	59.76	54.00	76	35	29.44	29.80	28.85	7	0	15	7	1	19	4.07
		52.38	59.94	51.87	80	32	29.52	30.05	28.70	36	30	150	72	11	154	25.65
OCTOBER,	1815,	48.06	55.51	48.38	64	37	29.55	30.10	28.85	5	3	20	3	0	15	2.56
	1816,	48.45	54.20	48.45	66	35	29.53	29.90	29.05	3	6	14	7	1	19	4.00
	1817,	41.48	48.64	43.06	55	32	29.67	30.05	28.80	15	7	5	2	2	14	0.63
	1818,	50.00	56.96	51.41	65	40	29.36	29.85	28.80	0	4	23	3	1	11	2.42
	1819,	45.32	52.35	46.87	70	28	29.38	29.90	28.95	15	0	10	6	0	19	2.85
	1820,	41.41	50.10	41.32	59	28	29.17	30.15	28.15	5	6	12	5	3	21	3.66
	1821,	44.16	50.67	42.16	65	31	29.42	29.95	28.50	3	2	18	8	0	17	2.76
	1822,	48.19	53.41	48.41	63	31	29.19	29.60	28.80	4	3	22	2	0	15	3.39
	1823,	44.22	50.61	43.90	62	30	29.28	30.00	28.45	4	7	17	1	2	20	2.38
	1824,	46.64	51.03	41.74	56	25	29.20	29.75	28.60	6	6	10	7	2	22	6.60
		45.79	52.34	45.57	70	25	29.37	30.15	28.15	60	44	151	44	11	173	31.25

		Thermometer.			*Ther.* Max.	*Ther.* Min.	*Barometer.* 2 P. M.	*Barometer.* Max.	*Barometer.* Min.	Prevailing Winds, N° of days of each. N.	E.	S.	W.	Variable.	Snow or Rain.	Fall of Rain.
		8 A. M.	2 P. M.	10 P. M.												
NOVEMBER,	1815,	38.83	45.36	38.73	59	23	29.71	30.40	28.55	10	5	12	4	0	12	1.92
	1816,	36.60	41.16	36.80	52	21	29.47	30.50	28.45	7	1	18	3	1	17	3.71
	1817,	45.86	49.93	47.13	57	34	29.60	30.25	28.95	2	0	21	7	0	15	2.89
	1818,	42.80	51.11	47.06	58	32	29.33	29.80	28.90	1	4	23	2	0	13	2.55
	1819,	35.19	42.04	36.96	53	18	29.30	29.75	28.70	12	2	14	2	0	15	2.43
	1820,	37.10	44.04	37.10	58	19	29.42	29.90	29.00	5	6	15	4	0	9	1.96
	1821,	42.16	46.96	41.84	58	23	29.32	29.85	28.55	2	1	17	10	0	23	5.49
	1822,	43.10	47.66	44.13	58	32	29.21	29.75	28.55	1	0	28	1	0	22	3.24
	1823,	41.50	46.90	41.60	56	22	29.67	30.20	28.80	4	5	15	4	2	12	2.10
	1824,	41.70	46.20	41.40	56	26	29.14	29.70	27.75	3	0	18	9	0	24	5.76
		40.48	46.13	41.27	59	18	29.41	30.50	27.75	47	24	181	46	3	162	32.05
DECEMBER,	1815,	36.38	40.00	36.96	52	22	29.50	30.25	28.55	6	2	19	4	0	18	3.00
	1816,	34.58	38.00	36.12	48	23	29.37	30.45	28.40	3	1	23	4	0	18	2.64
	1817,	33.48	37.51	34.77	52	22	29.29	29.80	28.35	6	3	20	2	0	14	3.81
	1818,	35.21	40.51	36.38	51	18	29.59	30.20	28.85	6	3	21	1	0	8	0.52
	1819,	31.48	36.19	32.83	51	1	29.30	29.75	28.80	6	5	14	5	1	17	4.25
	1820,	37.09	40.51	38.90	54	18	29.52	29.90	29.10	2	11	12	6	0	10	1.80
	1821,	36.61	42.54	39.03	55	27	28.97	29.80	27.85	2	0	20	7	2	19	5.52
	1822,	31.06	36.16	31.74	46	14	29.66	30.20	28.30	2	7	20	2	0	10	1.81
	1823,	37.32	41.32	37.90	49	23	29.27	30.05	28.20	3	0	21	7	0	21	4.49
	1824,	36.93	41.06	37.06	52	20	29.35	30.00	28.25	3	0	20	7	1	18	4.54
		35.01	39.38	36.16	55	1	29.48	30.45	27.85	39	32	190	45	4	153	32.38

Thermometer, Maximum,...June 25. 1820,...84° in the shade.

.... Minimum, ...Dec. 31. 1819,... 1°.

Barometer, Maximum,...Nov. 30. 1816,...30.50.

.... Minimum, ..Mar. 4. 1818 & Nov. 23. 1824,...27.75.

Fall of Rain,
- 1815,......29.36
- 1816,......31.95
- 1817,......32.01
- 1818,......25.58
- 1819,......31.62
- 1820,......31.56
- 1821,......39.04
- 1822,......33.41
- 1823,......37.02
- 1824,......37.5[illegible]

Mean of 10 years,...32.90 inches.

TABLE, shewing the Annual Mean for 10 *Years, calculated from the preceding Tables. Thus,* 45.12 *is the Mean Temperature at* 8 A. M. *for the last* 10 *Years.*

	Thermometer, Mean of, from preceding Tables.			*Barometer,* Mean from preceding Tables,	Prevailing Winds, and No. of days of each.				Variable.	Snow or Rain.	Fall of Rain.
	8 A. M.	2 P. M.	10 P. M.	2 P. M.	N.	E.	S.	W.			
January, ...	34.04	39.05	34.82	29.46	60	42	166	39	3	138	17.86
February,	35.89	41.90	36.27	29.45	50	19	163	46	5	145	21.25
March,......	38.00	45.84	38.64	29.38	61	16	150	75	8	179	28.43
April, ...	42.82	52.07	41.76	29.47	87	55	105	41	12	139	20.96
May, ...	49.49	57.64	47.99	29.47	72	47	118	51	21	157	25.59
June, ...	54.87	61.68	53.52	29.54	93	29	103	58	15	141	27.42
July, ...	56.75	62.81	55.54	29.48	70	16	127	79	18	171	34.68
August, ...	55.93	62.40	54.80	29.59	40	28	137	86	19	174	31.53
September,	52.38	59.94	51.87	29.52	36	30	150	72	11	154	25.65
October, ...	45.79	52.34	45.57	29.37	60	44	151	44	11	173	31.25
November,	40.48	46.13	41.27	29.41	47	24	181	46	3	162	32.05
December,	35.01	39.38	36.16	29.48	39	32	190	45	4	153	32.38
	45.12	51.76	44.83	29.46	715	382	1741	682	130	1886	32.905

ART. XIII.—Professor Buckland's *Reply to some observations in Dr Fleming's Remarks on the Distribution of British Animals.* In a Letter to Professor Jameson, dated Oxford, December 16. 1824.

DEAR SIR,

ALLOW me, through the medium of your Journal, to express my obligations to Dr Fleming, for the handsome manner in which he has spoken of my *Reliquiæ Diluvianæ* in your last Number; and for the mild and gentlemanly tone he has maintained, whilst expressing his opinions on certain points whereon he differs from me.

I perfectly coincide with that eminent naturalist, as to the expediency and the necessity of illustrating the history of the Fossil World, by the analogies afforded by the structure and habits of living plants and animals, and the operations of nature now passing before us; but I see not how the charge of neglecting all these things can, with propriety, be advanced by him, against the present cultivators of the science of geology, whose foundation-stone (as far as relates to the history of fossil animals) is laid by Cuvier on the most accurate analysis of the structure of recent skeletons, from which he argues most rigidly, as to that of the fossil species*; nor am I aware, that the imputation of ignorance of modern botany, can be fairly laid to such illustrious names as those of Sternberg, Schlotheim, Brongniart and Rhöde, from whose labours the subject of fossil botany is now receiving illustrations; and with respect to the history of the formation of peat-bogs, sand, and marl-beds, which Dr Fleming specifies as points which have hitherto been too much neglected by geologists, I need only appeal to the accurate and able observations of Professor Jameson and Dr Macculloch, —to the copious, and, on these subjects, most judicious pages of Deluc,—to the voluminous folios of the Irish Bog Reports,—and to the numerous papers that occur in the Philosophical Transactions,—to shew, that the history of peat, sand, and marl, which Dr Fleming states "to have been neglected as too recent for inquiry or speculation," has received its due share of attention from the most eminent writers that have yet occupied themselves with the study of the physical structure of the Earth.

With respect to the matters at issue between Dr Fleming and myself, as it appears to me that his objections arise chiefly from a mistaken or imperfect view of the facts on which his arguments are founded, I beg to submit to his consideration, and that of the readers of your Journal, the following points, on which I consider his ideas to be erroneous; forbearing to enter into the arguments he has derived from them, since, if the facts are misconceived, his conclusions will, of course, follow the fate of the premises from which they are deduced.

1. Dr Fleming objects, that the distinctions I have drawn between Post-diluvian and Diluvian deposits,—or, in other words, between local deposits, which can be referred to existing causes, and those more extensive collections of water-worn detritus, which have resulted from some single, and transient, and uni-

* J'ai donc dû me préparer à ces recherches, par des recherches bien plus longues sur les animaux existans; une revue presque générale de la creation actuelle pouvoit seule donner un caractère de démonstration à mes résultats sur cette creation ancienne.—*Cuvier, Recherches sur les Ossemens Fossiles*, Discours Preliminaire, 1821, vol. i. p. 1.

versal inundation of the surface of our planet,—are not sufficiently established. And,

2. He thinks the remains of animals that occur in what I consider the deposits of this inundation, may be referred to genera and species that have gradually perished by local accidents, or been extirpated by man.

To the first of these points I shall offer no other reply than to refer him to the distinctions between *alluvium* and *diluvium*, as stated by Cuvier in the Introduction to his History of the Pachydermata, tom. 1.; the slightest perusal of which cannot, I think, fail to convince the reader that it is utterly impossible to explain the phenomena which I have called Diluvial, by any causes at present in operation.

I would also refer to the luminous paper of Sir James Hall, in the Edinburgh Philosophical Transactions, 1813, on the evidences of an inundation afforded by the Corstorphine Hills, and other summits, in the neighbourhood of Edinburgh ; and to the accurate and practical distinctions drawn by Mr Bald, in the third volume of the Wernerian Memoirs, p. 123, and fourth volume, p. 58., between the old and the new alluvial covers along the east coast, and in other parts of Scotland ; and have only to add, that my own observations in that district, during the last summer, enable me to bear testimony to the fidelity of description both these gentlemen have maintained in the publications alluded to. It is needless here to repeat the evidences of diluvial action afforded by deposits of loam and gravel, in situations to which no river could have ever brought them, which I have collected in the chapter following p. 185. of the first edition of my Reliquiæ Diluvianæ. I shall deem it sufficient to subjoin the following extract from a foreign scientific journal, which shews that the distinctions I am contending for, are generally admitted by the best observers of the present time.

" We believe the best geologists of the day agree in limiting the term *alluvial*, to those deposits which result from causes now in action, and in appropriating the term *diluvium*, to those universal deposits of gravel and loam, to the production of which no cause at present is adequate, and which can only be referred to the waters of a sudden and transient deluge. This gravel and loam are always confusedly mixed together, and are thus distinguished from the older deposits of sand and gravel which occur in regular alternating beds. The ablest writers in Europe now adopt these distinctions, and would no more think of confounding them, than to describe, under the same name, gypsum and limestone *."

With regard to the second proposition, I think that, to a certain point, Dr Fleming's opinions and observations are correct. I fully coincide with him in believing, that the beaver and the wolf, like the roebuck, probably the bear, and the Irish elk, have gradually disappeared, together with the various species of birds, whose expulsion or extirpation he so ably describes, before the arrows of the hunter, and the snares of the agriculturist; but when he proceeds to apply the same explanation to the bones of quadrupeds, imbedded often many fathoms deep in masses of drifted clay and gravel, in situations at or near which no such deposits are at present taking place, or in caves and fissures which have been wholly closed, and whose interior has been often filled with the detritus of rocks introduced by the same sudden and transient inundation, to which alone the existence of the superficial deposits in question can be referred, I feel obliged to object to the application of the principle of gradual extirpation to this part of the subject, and appeal to the entire body of phenomena detailed in my Reliquiæ Diluvianæ, in support of my opinion.

But while I thus contend that there is evidence of a sudden and general destruction of animals by a transient inundation of the Earth's surface, I, at the same time, proceed most willingly with Dr Fleming to apply his method of illustration, to the animals inhabiting the earth antecedently to this great aqueous revolution; to explain the phenomena of the den at Kirkdale by the habits of living hyænas, and to argue on the probable history of fossil elephants and hippopotami, from the known habits of those which at present inhabit the banks of the Ganges or the Niger; and without this practice of illustrating the history of the fossil dead by the study of their living representatives, I could never have arrived at the conclusions I have founded on the evidence of the den at Kirkdale.

* Review of Reliquiæ Diluvianæ in Silliman's American Journal of Science, vol, viii, No. 2. p. 326.

I proceed, therefore, to examine, in the order in which he has stated them, some of the propositions advanced by Dr Fleming.

Case I.—*Peat-Bogs.*

I agree with Dr Fleming in considering the bones discovered in our peat-bogs; in mud and silt at the mouths of rivers, or within the level of their floods; and in ponds or lakes, and other situations at or near which the formation of aqueous deposits is still going on, to prove that the horse, the ox, the boar, the beaver, and several species of deer, have existed as wild animals in this country since the formation of post-diluvian silt and peat began, and have been gradually extirpated, or domesticated, by man; and I admit this on evidence independent of the documents of history, or the voice of tradition, viz. the fact, that the bones of these animals occur imbedded in the deposits in question.

Case II.—*Fresh-Water Marl-Beds under Peat-Bogs.*

Deposits of this kind, formed at the bottom of shallow lakes and ponds, accumulate, until they arrive so near the surface of the waters, that the growth of peat commences, and often continues so far, that the hollow, which was once a shallow lake, becomes entirely filled up; the basis of the marl-bed, beneath this peat, is sometimes solid rock, and sometimes a bed of that ancient detritus of gravel, clay, or sand, which I have called Diluvium. The animal remains which occur in this fresh-water marl are of post-diluvian origin. Now, with respect to the Irish elk, if the common accounts should prove correct, that it is found in this shell-marl, immediately below the peat, or in the lower regions of the peat itself, it will only add another species to the list of animals that have repeopled this country, since the formation of the diluvium, and which, like our beavers and wild boars, have been extirpated by man; and the high state of preservation of its horns and bones from the bogs of Ireland, when compared with the usually decayed condition of bones from the diluvium, inclines me to favour this opinion. This animal, however, should it prove to be thus recent, will, like the ox and horse, and other species of deer, be common to our diluvial deposits, with those that are post-diluvial; it occurs with elephants and hippopotami in the diluvium, at Walton in Essex, and in the diluvial gravel of Germany, France, &c. * The evidence to prove its more recent existence, should, therefore, be carefully attended to, and forms an interesting subject of inquiry.

Case III.—*Horns of Rhinoceros in Scotland.*

Dr Fleming states, p. 297, "that a specimen of the horn of the fossil rhinoceros, found in one of the marl-pits at the Loch of Forfar †, exists at present in the Edinburgh Museum, and we have been informed by Professor Jameson, that two other examples have occurred in Blair-Drummond moss on the banks of the Forth. It is to be hoped, he adds, that the skulls will yet be procured."

Could the above cases be established, they would be decisive in favour of the theory maintained by Dr Fleming. In my Reliquiæ Diluvianæ, p. 33, I have expressed an opposite opinion, that the horns of the rhinoceros neither have nor are likely to be ever found in a fossil state, unless when preserved in ice. I made it my business, therefore, whilst at Edinburgh, carefully to investigate the cases here alleged to have existed in that neighbourhood, and the following are the results.

Mr David Don informs me that the horn in the Edinburgh Museum was presented by himself and his brother, on the death of their father in the year 1814, to a museum then existing at Dundee, which was shortly after broken up and the contents sold by auction; and that the story of its having been found in the Loch at Forfar, must have been invented either by the auctioneer or the person who bought it of him, and sold it again to the Museum at Edinburgh, at a price proportionate to the increased value that would justly have been attached to it, if it had really been a Scotch fossil ‡. Mr Don, however, affixed no

* A detailed description of the remarkable Skeleton of the Fossil Elk, discovered in the Isle of Man, and now preserved in the Museum at Edinburgh, will be given, by Professor Jameson, in a future Number of this Journal.

† Vide Wern. Mem. vol. iv. p. 582.

‡ In the recent sale at Fonthill, the public were, in a similar manner, informed, that a vase of rock crystal, submitted to the hammer, was a real topaz; and the authority of Professor Buckland, who had never seen or heard of the gem in question, was advanced in confirmation of the alleged fact.

such history to it when he gave it to the museum at Dundee. In his letter to me on this subject, he says, " It had a long time been in possession of my father, who, I am inclined to believe, obtained it from some friend, whilst he was Superintendant of the Royal Botanic Garden at Edinburgh." He adds, " Had it been found in the lake at Forfar, it is not probable that so remarkable a circumstance should have remained unknown to me, or any of my family." The story of the other two horns of the rhinoceros, said to have been found in the moss of Blair-Drummond, and of which Dr Fleming is anxious, as he well may be, to discover the skulls from whence they were derived, I found to originate in another mistake of a similar kind. Professor Jameson had been informed of the supposed discovery of these horns by a gentleman of Stirling, who is factor to the estate of Blair-Drummond. I proceeded to Stirling, and found this gentleman to be a man of accurate observation as to the geological structure of this district, and particularly of the peat and alluvial deposits in which these horns were said to have been discovered. But he informed me that he had no personal knowledge of the finding of them; that the discovery was made many years ago by some of his father's workmen, who, together with his father, are now dead; but that he believed the horns were still existing in the House of Blair-Drummond. I applied forthwith to Mr Drummond for further information, and learnt from him that there were some years ago two horns of a rhinoceros somewhere about his house, and that they have since been removed to that of his mother in Edinburgh *. He further adds, " I know nothing of their history but what my factor tells me, and he seems uncertain whether his father had seen them dug up, or had only been told by some person that they were found at some former time. As to the question about

* Professor Jameson has lately examined these horns, and informs me, " that they differ not in shape from those of the living two-horned rhinoceros; that the fibres at their base exhibit the usual transparency of recent horns, and that the base of one of them is perforated with round sinuous holes, like those made in timber by the Teredo, but smaller." Holes of this kind are not uncommon in recent horns of this animal; they occur in a specimen in the Oxford Museum, and still retain within them the husk or sheath of some parasitic worms resembling maggots, by which they were produced.

their having been found at Blair-Drummond, I can only answer with safety, in the terms of a verdict peculiar to our criminal courts, "Not Proven."

The evidence then before us amounts to nothing more than this,—that there exist two horns of a rhinoceros, which at some unknown former time were found in some unknown place, by some unknown person, and preserved in some unknown room in the mansion of Blair-Drummond, from which they have since been removed to Edinburgh: Until, therefore, the bones or teeth of these animals shall be found in the moss of Blair-Drummond, or the loch of Forfar, or the skulls procured, which Dr Fleming hopes to find, we remain without the slightest evidence of the rhinoceros having been a postdiluvial inhabitant of Scotland.

Case IV.—*Fossil Hippopotami.*

A hippopotamus is recorded by Lee, in his Natural History of Lancashire, as having been found *under* a peat-bog in that county.

This evidence is unfortunately too imperfect to be of use in a disputed point. We simply learn from it that the bones were not in the peat but under it; but whether the foundation on which this peat-bog lay was a bed of postdiluvian shell marl, or of diluvial clay or gravel, we are not informed. The analogy of the other localities in which the hippopotamus has been found in England, leads to the latter hypothesis.

Dr Fleming concludes, "These animals, formerly inhabitants of this country, have their remains preserved, not only in peat-bogs and marl-beds, but likewise in the silt of our great rivers; in the valley of the Thames, for example, they occur in the regular stratified clay, sand, gravel, and peat." As this conclusion is founded chiefly on the cases I have already discussed, it must stand or fall with them. He proceeds to support it further, by stating, on the misinterpreted authority of Mr Trimmer's paper in the Philosophical Transactions, that the hippopotamus and elephant occur in the valley of the Thames, in the regular stratified clay, sand, gravel, and peat. In reply to this, I venture to assert, that no remains of this kind have ever been found in the peat-bogs of any part of the valley of the Thames, and still less in the regular stratified clay, that is, the London Clay. The case described by Mr Trimmer is that of the brick-earth-pits at Brentford, which I visited last week, and where there is not the smallest trace of any kind of peat-bog to be seen. The patches of peat mentioned by Mr Trimmer in his paper, as being only two or three inches thick, and of small extent, were portions of drifted peat, or other vegetable matter that became lodged and entangled in the sand and gravel, at the same time with the bones in question. Their extent must have been very small, for not a particle of peat is now visible, although a larger section is open than existed at the time when Mr Trimmer made his observations.

But even admitting all the facts which Dr Fleming contends for as to this point, and supposing it proved that the elephant, rhinoceros, hippopotamus, hyæna, and other lost animals, have existed recently in Europe, and been extirpated by man, and that we found their remains in postdiluvian deposits of peat, and silt, and fresh-water marl; they would only be in the same predicament with the horse, the ox, the fox, the wolf, the boar, the beaver, and others, whose bones are common to these postdiluvian formations, as well as to antediluvian caves and fissures, and to beds of diluvial gravel: still every atom of the evidence contained in my *Reliquiæ Diluvianæ* would remain unaffected by this discovery, and the great and universal phenomena of diluvial deposits would still be equally inexplicable, without appealing to the agency of a transient and general inundation of the Earth *.

* Dr Fleming, speaking of the gradual extirpation of certain well known animals in this country and on the continent, says, "These changes have all taken place in the course of the last six or eight centuries; in ages that have preceded, the same causes must have been in more or less active operation," &c. In short, by the theory of gradual extirpation, he would explain the extinction of the lost species of elephant, rhinoceros, hippopotamus, hyæna, &c. over Europe. Is it not incumbent on him first, to show at what period such animals as these, much too formidable to be overlooked, were ever known to have existed? Can he give any reason why hyænas should have been extirpated at a more early period than wolves, had they ever existed in postdiluvian Britain? Or is it probable, that the savage hordes which inhabited Germany before its occupation by the Romans, should have utterly destroyed such powerful animals as the elephant and rhinoceros, as well as the hyæna, from the impenetrable fastnesses of the great Hercynian forest,

Dr Fleming, however, at page 299, speaking of what Mr Bald denominates the "old alluvial cover," and many English mineralogists "diluvium," concludes, that "The partial occurrence of these strata,—their limited extent,—great difference of character in neighbouring districts,—the presence of remains of terrestrial animals,—and the absence of marine exuviæ,—demonstrate that a universal flood, possessing the velocity some have assigned to it, had no share in this formation." Here again we are obliged to differ from Dr Fleming as to matters of fact.

1. With respect to the asserted "partial occurrence of these strata, and their limited extent, I know not what may have been his opportunities of locomotion and observation; but I dare assert, that, in the whole course of my own geological travels, from Cornwall to Caithness, from Calais to the Carpathians, in Ireland or in Italy, I have scarcely ever gone a mile, without finding a perpetual succession of deposits of gravel, sand, or loam, in situations that cannot be referred to the action of modern torrents, rivers, or lakes, or any other existing causes; and with respect to the still more striking diluvial phenomena of drifted masses of rocks; the greater part of the northern hemisphere, from Moscow to the Missisippi, is described by various geological travellers as strewed, on its hills as well as valleys, with blocks of granite and other rocks of enormous magnitude, which have been drifted (mostly in a direction from north to south) a distance sometimes of many hundred miles from their native bed, across mountains and valleys, lakes and seas, by a force of water, which must have possessed a velocity to which nothing that occurs in the actual state of the globe affords the slightest parallel. I must therefore deny, that the occurrence of these deposits is partial, or their extent limited.

2. That their character is different in neighbouring districts I readily concede; for it often differs in the same field, and even in the same pit or quarry; as well it may do, considering the

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when animals of the same kind have not yet ceased to abound in the woods of India and the wilds of Africa, in spite of a farther persecution of nearly two thousand years? Surely the theory of their extinction by the savage natives, preceding the Roman invasion of these countries, is a matter of the highest improbability; their existence at that time, and subsequent extirpation, is, in the utter silence of Cæsar and Tacitus, and all later historians, and even of tradition, a moral impossibility.

turbulent condition induced on the Earth, by the inundation of which it is the wreck and rubbish.

3. The presence of the remains of terrestrial animals, simply shews that they had perished; but whether they were drifted from other countries to those in which we now find them, or how far they may have been floated backwards and forwards, by the flux and reflux of the mighty currents then in motion, before the carcasses became putrid, and the bones fell piecemeal into the gravel, as the agitation was subsiding, we have no means to judge; and, without the evidence afforded us by the interior of caves and fissures, we should have been unable to prove that the elephant, rhinoceros, hippopotamus, and hyæna, had ever inhabited Europe; as it might have been argued, that these animals were all drifted from the tropical regions now occupied by such genera, by the waters of the same inundation that produced the superficial deposits of gravel, loam, and sand, in which alone their bones had been discovered before the investigations that have been made into the contents of caves and fissures.

4. The absence of "marine exuviæ" is another case of misstated facts. Had Dr Fleming ever examined the diluvial clay which forms the cliffs more than sixty feet high at the brick-kilns on the south of Peterhead, he might have found (as I did last summer), marine shells imbedded in it, similar to those which now live in the adjacent seas; and had he further examined the shells found in diluvium not many years ago in the bed of the Paisley Canal, three miles from Glasgow, and of which a list was published by Captain Laskey*, whilst a very perfect collection of them is preserved in the cabinet of Dr Browne of Glasgow; or, had he ever seen or heard of the thousands of acres of marine shells of existing species, which cover more than one-fourth part of the counties of Norfolk and Suffolk, so as to form an integral part of their gravel pits, and to be mixed in every possible proportion with ordinary diluvial gravel, sand, and clay, and with the bones of elephants and other land animals;—he would never have advanced such arguments as these to "demonstrate," that a *universal* flood had no share in the for-

* See Annals of Philosophy, Feb. 1814, vol. iii. p. 150; and Wern. Soc. Mem. vol. iv. p. 568.

mation of what many English mineralogists have called *diluvium.*

I considered it needless when I was at Edinburgh, to investigate the fact asserted by Dr Fleming at page 298, that a copper battle-axe was found in digging the Union Canal at Bonnington, in the same kind of clay or till with the tusk of an elephant, as its accuracy is questioned by Professor Jameson himself, in a note subjoined to the passage in question; but I here adduce it as another of the mistakes that cannot but arise from neglecting or denying the distinction between Alluvium and Diluvium.

It remains only to notice a few more errors into which Dr Fleming has fallen, in his Observations on my History of Bones discovered in Caves and Fissures.

With respect to the habits of modern hyænas, I have to offer him my thanks for the manner in which he has disposed of the evidence of Dr Knox, in the fourth volume of the Wernerian Memoirs, p. 385, as inapplicable, on the ground of difference of species between the Fossil and Cape Hyæna. But I am surprised he should characterise as *valuable* the notices of any writer who argues, that, because lions and tigers do not devour bones, therefore hyænas also do not eat them; or that, because he himself has never seen an hyæna in the act of dragging off its prey, therefore they never do so. Is the positive evidence, then, which I have quoted from Brown, Sparman, and Busbequius, who assert the fact, that hyænas do drag off their prey, to be set aside by the negative fact that Dr Knox has never seen them in the act of doing it? Since the publication of my last edition, I have seen an officer from India, Captain Sykes, who has often hunted hyænas in the vicinity of Bombay; and from him I learn that he has not only seen heaps of bones accumulated at the mouths of their dens, but that, in digging one from its hole, he observed large quantities of bones flung out with the dirt and rubbish from the interior of the den.

Dr Fleming, at page 301, gives his opinion, that the "bones at Plymouth were washed by some *land*-flood from an open fissure, and deposited in confusion in the neighbouring caverns." Is he then ready to maintain, that the bones in the caves and fissures, and the gravel that occurs on the summit of the rock at Gibraltar, were deposited also by what he calls a land-flood?

—and that many hundred other caves and fissures along the coast and islands of the Mediterranean, and the Adriatic, in Dalmatia, and in Germany, at various elevations from 2 to 2000 feet above the level of the sea, were all so similarly affected by partial land-floods, that there is not a tittle of difference in the effects produced on each and every one of them by such numerous and independent inundations? Or is he prepared to shew, how a land-flood could cover the summit of the insulated rock of Gibraltar, at the height of 1439 feet above the sea, without inundating at the same time at least nine-tenths of Europe, and to point out the source from whence the waters of such a land-flood could be derived? Unless he is so, it is in vain to say a partial land-flood may have risen a hundred feet at Plymouth, and have moved the bones, and carried the mud and pebbles into the caves at Oreston; for this is but one of many hundred analogous cases of such bones imbedded in similar mud and pebbles that must be accounted for, and for which the only sufficient cause that has ever been proposed, is an universal and transient deluge.

Again, at page 301. Dr Fleming contends, that these bones found thus universally in fissures, and caverns connected with them, cannot have been drifted into their present position by the waters of a general flood, and there surrounded by them with mud; because, in the solitary instance of the large cavern of Wokey Hole, there is a river now running through it, and depositing mud and sand upon human bones or urns, or any thing else that may now, or at any modern period of time, have been deposited within the level of its winter floods. Surely it is at least incumbent on him to shew that there is, or may have been, a river running through every cave, and every fissure in the world, in which bones and bony breccias are found imbedded in mud, before he can establish a conclusion like this. His present argument is stated thus: "A subterranean river runs through the cave at Wokey, which may have deposited mud during its highest floods. But why may not the mud in the Kirkdale cave have been deposited by a similar agent?" The answer is, because there is no river there to deposit it; and, because it is impossible that now, or at any past period of time, any river should flow, or ever have flowed there. The cave at Wokey is a connected series of large and lofty vaults, with two apertures near its floor, by which a subterranean river at this moment runs in and out continually; whilst that at Kirkdale is a small hole, (seldom larger than a large gutter hole), not five feet square at its mouth, and branching internally into smaller ramifications, which finally terminate in a close end, or *cul de sac;* so that by no possibility could any river now, or at any past time, have found a passage through it.

I fully agree with the observation quoted from Mr Young, that the cave at Kirkdale is not a fissure in the rock, and that it has a number of rounded hollows or depressions in the sides and roofs, (and possibly on the floor, though I have never seen them there), resembling such water-worn hollows as we see in rocks, in the beds of rivers, or on the shores of the ocean; but I must add, that the appearance of such hollows is a feature common to the cave of Kirkdale, with every other cave in limestone rocks that I have ever examined; and in every case there is decided evidence that the hollows have not been produced by friction from moving water, in the fact, that, though not unlike in shape, they are never smooth and polished like the holes worn in the beds of rivers, and on the sea-shores, but are constantly rough and studded over internally, like a corroded preparation, with thousands of small and delicate points, projecting in high relief over these surfaces, and which would inevitably have been destroyed, had friction or any kind of violence been employed in producing the cavities in question.

In reply to the note at page 300, in which the authority of Professor Goldfuss, is quoted by the editor to support an opinion, that the elk and hyæna are the animals intended by the terms *schelch* and *halb-wolf* in the romance of the Niebelungen written in the 13th century, and enumerated among the beasts slain in a hunt a few hundred years before that time, in Germany; I have only to observe, that the authority of the same romance, would equally establish the actual existence of giants, dwarfs, and pigmies, of magic tarn caps, the using of which would make the wearer become invisible; and of fire-dragons, whose blood rendered the skin of him who bathed in it of a horny consistence, which no sword or other weapon could penetrate *.

Dr Fleming will, I am sure, excuse me if I suggest to him, that the tone of levity in which he speaks of the facts established by the evidence of the den at Kirkdale, as a parallel case to the fables of travellers who have pretended to discover the decayed timbers of the Ark, is not the most appropriate to a discussion of the nature now before us.

Appendix.—Since this article was sent to the editor, Dr Fleming has published a second paper, in No. XXIII. of this Journal, in which he proposes to explain the universal dispersion of diluvial deposits by the bursting, at different periods, of an almost universal series of lakes. Had such lakes ever existed, it may fairly be asked, Where are the traces of their ancient locality? It is evident from the terraces, or parallel roads, in the valleys of Glen Roy, Glen Gloy, and Glen Spean, and some three or four more, which are all that have hitherto been noticed on the surface of the whole earth, that wherever such lakes have burst their ancient barriers, they have left behind them, in these terraces, evidence that shews the amount of their former extent and successive depressions. Even river-floods, of any magnitude, produce a similar effect, and form terraces in the adjacent gravel-beds that mark the line of their highest inundations, as I have stated, in a note at page 217, first edition, of my ***Reliquiæ Diluvianæ***. Is it not, then, utterly impossible that such an universal system of lakes as Dr Fleming's hypothesis assumes, could ever have existed, without leaving on their banks similar terraces to those of Glen Roy, Glen Gloy, and Glen Spean? Not one example, however, of such a terrace occurs in England, a country that is half covered with diluvial gravel. Neither, I believe, are there any other lacustrine terraces in Scotland, but those just mentioned, although river terraces are very common. Until, therefore, such lacustrine terraces are found to be of nearly universal occurrence on the sides of upland valleys, we remain without a particle of evidence that such lakes have either

* Vide Weber's Northern Romances, p. 172.

existed or become extinct, and must consider the assumption of Dr Fleming respecting them to be altogether gratuitous.

In this same second memoir, p. 294 and 295, I find Dr Fleming advances facts, in direct contradiction to the *demonstration* in his former paper, that a universal flood had no share in the formation of our diluvium, which, in part at least, he founded, on the asserted "*absence of marine exuviæ*" in diluvial deposits, viz. those I have stated, that marine shells of existing species occur in the diluvium of the neighbourhood of Peterhead, and in the Paisley Canal, near Glasgow. He also quotes other cases of the same kind, *e. g.* that of recent marine shells, discovered by Mr Adamson on the banks of Loch Lomond, &c.; but he makes no allusion to his denial, in his former paper, of the existence of such deposits, and I presume could not have been aware of facts which so materially affect his argument, at the time of his writing the paper in question. At any rate, it would have been more candid to acknowledge his error, than to leave to me the task of pointing it out, and applying it to my advantage in the matter at issue between us.

I forbear at present to offer any farther remarks on Dr Fleming's second memoir, as I should be drawn to greater length than the patience of your readers would tolerate, or the limits of a Journal, destined to be the vehicle of original communications, rather than of controversial discussions, could with propriety admit.

Postscript.—I have just been informed by Mr Weaver, that he has established, beyond all doubt, the fact of the elk having existed as a postdiluvial animal in Ireland. Its bones and horns, he says, occur in the Bog of Kilmegan near Dundrum, in the county of Down; they lie at the bottom of the peat between it and a bed of shell-marl, resting upon, or being merely impressed in the marl, which is composed of a bed of fresh-water shells, from one to five feet thick, and must have been formed while the bog was a shallow lake. In this and other similar lakes and swamps, Mr Weaver imagines these animals fled for refuge from their enemies, and were drowned in the waters, or swallowed up in the morass.

Art. XIV.—*On Fossil Organic Remains as a means of distinguishing Rock-formations.* *

The relative position of rocks can alone furnish the essential characters for recognising and distinguishing the different formations of mineral masses which constitute the solid crust of the globe, and afford us data for judging of their identity and relative age. Their structure, the minerals of which they are composed, and the organic bodies which several of them contain, should only be considered by the geologist as accessory, and in a manner subordinate, characters, however important the aids which they afford him in his inquiries.

The observations of M. de Buch and M. Hausmann, with regard to the syenite of Norway; those which have been made upon a similar deposit by M. Brongniart in the Cotentin; those which M. Brochant has made upon the transition formation of the Tarentaire; and those of M. de Bonnard upon the same formation in the Hartz, sufficiently prove, that neither the structure nor the composition of rocks, taken by themselves, can afford certain indications with respect to the relative age and identity of the different formations. The Pyrenees present similar facts, as will be presently seen.

The presence of organised bodies is, it is true, the most essential character according to which we may pronounce that a rock belongs to the class of secondary, or to that of transition, formations. But, as each of these classes contains several sorts of deposits, it is necessary to determine the one to which the rock in question is to be referred; and, for this purpose, we must previously have distinguished these particular deposits from each other with accuracy, fixed their number, which is perhaps greater than has hitherto been supposed, and determined their relative age, as well as found means to recognise their identity in the different countries in which they are observed. Now, it is for this important inquiry, which, in some measure, constitutes one of the chief objects of geognosy, that the knowledge of the organised bodies which these deposits contain, does not appear to me to be sufficient.

* From Charpentier's Essay on the Pyrenees.

In fact, when we pretend to be able to distinguish the different secondary formations from one another, and to determine their identity in all parts of the globe, by the petrifactions which they contain, we suppose that each formation contains certain species of organised bodies which are peculiar to it, and which do not occur in another ; consequently, it must be admitted, that the same formation contains, in all countries, the same organised beings,—a hypothesis which does not seem to me to be founded upon a sufficient number of observations ; because the researches which have hitherto been made have been limited to a very small number of countries, which are not even sufficiently distant from one another to admit the deduction of general conclusions. Thus it is very possible, that the same formation contains all over France, perhaps throughout the whole of Europe, the same petrifactions ; but we could not thence conclude, that these organic bodies must be equally the same in the analogous formation in Asia, in Africa, or in any part of the globe whatever at a distance from Europe. Judging from the present distribution of living beings over the earth, it does not appear probable, nor even possible, that any animal or vegetable species could ever have existed at the same time in every part of the vast ocean, which, before the formation of the secondary rocks, must have covered the surface of the globe.

The identity or difference of fossils cannot therefore serve, in a general manner, for pronouncing upon the identity or difference of the various formations. They are, in my opinion, equally insufficient for determining their relative age ; because we should previously be acquainted with the relative age or period of existence of these organic bodies, which we could only determine with precision by the relative age of the rocks which contain them. It is then impossible for us to draw a conclusion in the inverse sense, and we are therefore reduced to observe the position of rocks, in order to determine their relative age.

I may add, that we are equally ignorant if a genus or species of organised bodies may not become extinct and be reproduced again at intervals. It is without doubt very probable that this has not taken place ; but, nevertheless, we are not certain, and it can only be by purely geognostical researches that we can eventually come to determine this fact.

Art. XV.—*Discourse on the History and Progress of Geology, delivered by Professor* Necker *at the Meeting of the Magistrates and Teachers which takes place annually at Geneva, on the occasion of distributing the Literary Prizes to the successful Candidates* *.

Gentlemen,—Called to address you upon a subject relating to one of the branches of Natural History, the teaching of which the Academy has done me the honour to confide to me, I have thought that a rapid view of the general progress which the physical examination of the globe which we inhabit has made, and still continues to make, might not be without interest. Geology is still a young and new science, and, viewing it in this light, the history of the successes and failings, of the trials felicitous or unfortunate, which have accelerated or retarded its progress; the inspection of those oscillations around the true path, which, in the more advanced sciences, have preceded their fixed and regular march, may present to the contemplation of enlightened men some interesting perceptions with relation to the study of the human mind. Besides, the country of the Saussures and De Lucs, and this Academy, which has seen all that is positive and accurate in geology springing from its bosom, could not remain indifferent to the progress of a science to which they have so largely contributed. It can only, however, be a very general sketch of the progressive developments of Geology that I can venture to trace here. And, in the first place, we may divide the picture into two very distinct portions: the first, a period the longest in time, but the poorest in useful results, commencing with the birth of the science, and leading it to the middle of the last century; the period of cosmogonies and geogonies, in which geology, placed in the rank of vain speculations, presents nothing but fanciful hypotheses, and systems without foundation: the second, in which it really becomes a science, includes but a short space, of from sixty to seventy years, but is distinguished by the constantly increasing extent of solid and useful observations, and by the abandonment of idle geogonical discussions.

* A copy of this Memoir was communicated by our former pupil Professor Necker for this Journal.

I shall scarcely dwell upon the long period with which the review ought to commence, as it presents but the history of the wanderings of intellect, and hardly affords any result worthy of being preserved. All the nations of antiquity, however, have had their cosmogonies, which, associating themselves with their mythological systems, connected the first origin of things with the history and the greatest interests of the human race. The Jews, and this is a very remarkable fact, were the only nation of antiquity, which, on certain particular points of the history of the earth, have possessed ideas, the accuracy of which has been demonstrated by the most recent observations of the most improved geology.

The order of succession of organised beings at the surface of the globe, which, in Sacred History, corresponds with the order of their creation, and the comparative recentness of the human race, are indications of a supernatural light thrown in the midst of the profound obscurity and absolute ignorance of the people of primeval times. And the sublime picture of the successive development of organisation upon the Earth, had already existed inscribed at the head of our Sacred Books, many ages before the diligent and scrupulous investigations of geologists and naturalists had attained to the demonstration of its counter proof in the bosom of the solid strata of the rocks and mountains.

To search in the writings of the Hebrew Lawgiver for other data regarding the origin of the world, than those which attribute creation to its true and eternal Author; to hope to find documents respecting the different revolutions which our globe had undergone before the last catastrophe which has left the surface in its present state, and has rendered it susceptible of becoming the abode of man; to wish to discover in a book devoted to man, considered as a moral being, to his duties, and the knowledge of his sublime destination, statements in respect to the physical sciences,—all this may have originated from a respectable source, and from sentiments which cannot be too much praised; but experience has apprised us, that those who, with the purest intentions, have become interpreters of the Sacred Text, in order to find, and have found in it, the confirmation of their own systematic views, have misunderstood its true object, and have benefited neither religion nor science. On the other hand, how culpable are those who have sought, although without success, in the study of the revolutions of the Earth, for weapons to destroy the foundation of the hopes and consolations of the whole human race?

Such are the reflections which naturally arise in the mind of him who is obliged to dig among the philosophico-romantic rubbish of speculative geology, upon reading the numerous Theories of the Earth, those productions of an unrestrained imagination, and an utter ignorance of facts. We shall not fatigue you, gentlemen, with an analysis of the systems of Burnet, Whiston, Woodward, Lazaro-Moro, and so many other more modern authors, whom we see at their pleasure creating inundations and abysses, raising the seas from their beds, calling comets to their assistance, and all to form a fantastic world, utterly different from that which exists. We would more willingly fix our attention upon the first wakening of the spirit of observation, upon that dawn of true science, the first glimmerings of which began to appear at the commencement of the 16th century, when Agricola, a Saxon miner, laid the foundations of mineralogy and the art of mining; when Bernard de Palissy, a mere potter, announced to the Academy of France that the fossil shells were really the work and the abode of animals; when, at a later period, Steno in Tuscany established the distinction between the primitive mountains and the secondary formations.

But I hasten to arrive at the second epoch of the science, that in which the empty knowledge of cosmogonies was superseded by physical geography and mineralogical geology; that in which the principles of the immortal Bacon alone directed a study which had so long been perverted from the true path by imagination and speculative mania.

It was at Geneva that this change was produced; it was De Saussure who first discovered, that the method hitherto followed was not that which conducts to truth, and who proved, by his example, that the natural history of the Earth, studied according to the same principles as the other physical sciences, would furnish itself alone and independently of every foreign idea, results sufficiently numerous and important to merit the particular attention of correct and enlightened minds.

It is not before you, gentlemen, several of whom have heard those great truths developed, in this very place, and upon days like the present, by the philosopher himself of whom I am speaking; it is not to those whom the remembrance of this illustrious man disposes perhaps at this moment to listen with more indulgence to his grandson, that I shall offer excuses for dwelling with a lively satisfaction upon the services which he has rendered to science.

To form a correct estimate of what Saussure has done for geology, we must see what it was when he first entered upon its study,—the spirit which directed him in its pursuit,—the state in which he left it,—and the impulse which his writings have given to those who have come after him. Without entering into details, we shall yet remark, that, at the period at which he commenced his labours, mineralogy and chemistry were still in their infancy; that the study of rocks scarcely existed; that, of the small number of facts in physical geography related in former works, which might have served as a guide to him, he quickly discovered that several had been too much generalized, and that others were entirely erroneous. The topography of the districts over which he travelled, and which are now the resort of all Europe, was less known than is at the present day that of the Cordilleras or the Himalaya Mountains. There existed no charts of the Alps, and if he had not, on this occasion, as on many others, derived the most important aids from his friend, our learned colleague Mr Pictet, he must have renounced the advantage, indispensable in our day, of giving a graphic representation of the places which he described. Thus, on all hands, he met with nothing but obstacles; he had to make for himself, by dint of labour, a path into those fearful deserts, as into the domain of a science whose vast unexplored extent presented itself before him.

Persuaded, as he says himself, that physical geography, or the description of our globe, can alone serve as a basis for geology, he proposed to investigate, first the mountains which surround us, and afterwards those of more remote countries. He commenced with a profound examination of the minerals which our soil produces; he classed them according to a method so philosophical, so independent of every idea foreign to their nature, of all hypothesis of origin, and of every consideration of position; he described them with so much clearness, that, notwithstanding the changes effected in the nomenclature, we still, at the present day, easily recognise, by means of his descriptions, the rocks even the most difficult to distinguish.

Embracing the study of the Earth in its most extended acceptation, to the examination of minerals, and the stratification of rocks, he added that of the physical structure of mountain chains, of the form, direction, and probable origin of valleys; he sought, in the present arrangement of strata, and in the disposition of the fissures by which they are traversed, data for determining their original position; he recognised, in the action of external agents, the operation by which they daily eat, by little and little, into those rocks, so hard and apparently so indestructible. It was this which led him to observations upon the glaciers, the snows accumulated, from time immemorial, upon the declivities of our Alps; and it was still his desire of advancing physical geography, that gave rise to his labours in physics, and, in particular, to his Treatise on Hygrometry. Thus, with him, every thing converged toward one object,—that of collecting materials for the history of the globe.

In proportion to the avidity with which he sought for facts, was the care with which he avoided vain speculations. If he sometimes advances a hypothesis, it is with a reserve justly admired, although rarely imitated, and only when the facts seem imperiously to command it. When new facts come in opposition to his former opinions, he abandons or modifies them without regret.

He has even carried this wise restraint so far, that that comprehensiveness of mind which, in the immensity of science, attaches itself still more to what is to do, than to what has been done, may have been taken for a too great timidity in generalising his observations. But, if Saussure, after forty years of assiduous study, in the part of the Alps comprised between the Tyrol and the Mediterranean, during which he attached himself particularly to the central part of the chain, the most difficult to explore, and the most extensive,—if Saussure, in exposing the general results of his observations, has not been led to discover that regular succession of formations which the German geologists were the first to detect; if he avows, that the countries which he has explored have presented only infinite varieties in the mineralogical order of the rocks, with relation to the physical structure of the chain; all this finds a ready explanation (and those who are acquainted with the mineralogical geography of Europe will be convinced of it), in the circumstance, that there is no country less adapted for the regular study of formations than the chain in our neighbourhood, and which is itself only a small portion of the vast geognostical system which may be denominated the Chain of the Alps.

An inconsiderable number of different formations occupy there a prodigious space; the strata of which they are composed present gigantic masses, and their structure assumes such a degree of development, that mere subordinate beds cover a much greater surface than elsewhere whole independent formations.

Add to this, the irregularity in the position of the strata, their numerous and enormous contortions, the absolute want of relation between the mineralogical and the physical structure of this portion of the chain, and say if it was possible, for even the greatest genius left to itself, to discover that regularity in the order of succession of formations which has been traced in other countries, in characters so clear and so easily accessible; since, even at the present moment, with all the perfection to which geology has attained, and, notwithstanding the great number of expert observers who have travelled among the Alps, we have not yet discovered the key of the enigmatic arrangement of the formations of which they are composed.

But, if we consider the list of *agenda* which concludes his works, we shall there see exposed, under the form of questions, all the most important positive or negative results to which the study of the Earth should lead. Without doubt, the great improvements which have been made in the science, would require the addition of a considerable number of questions; without doubt, also, several of these problems have been resolved by the illustrious author, or by his successors; but the greater number still require to be answered; and these agenda, although published thirty years ago, should still, at the present day, form an indispensable guide to him whose object is to pursue the study of geology in its full extent. They have marked out all the routes which should be travelled by him who wishes to embrace that study in its most comprehensive acceptation. The means of observation may be ameliorated, the result simplified or generalised, but every where in the fundamental questions do we find the impress of the steps of Saussure upon the path of truth. It is not, therefore, so much the number, or even the importance of the detailed observations; it is the spirit which has guided him in the whole of his career, the spirit with which he has animated Dolomieu, Spallanzani, Palassou, and those who have immediately followed his traces in the purely philosophical investigation of nature; it is that spirit which he has excited, which renders him worthy of being considered as the illustrious representative of the new era of geology.

(To be continued.)

Art. XVI.—*On the Number and Situation of the Magnetic Poles of the Earth.* By Professor Hansteen *.

That the magnet attracts iron was known to the naturalists of Greece and Rome. If we strew iron-filings upon it, these cling with peculiar fastness to the two opposite ends, in which the greatest power thus seems to reside. If we hang up a magnet by a thread, or allow it to swim in quicksilver, or place it on a small bit of wood floating in water, we shall find that it will never come to a state of rest, till the one end point to the north, and the other to the south. This quality of the magnet of pointing, when it is left to move at perfect liberty, towards the north and south, the poles of the earth, is called its polarity; and the two stronger ends its poles. On this polarity is founded the construction of the mariner's compass, the needle or index of which is nothing else than a prismatic piece of tempered steel, which, by being rubbed on a magnet, has acquired the magnetic powers, and which is placed on a pivot, on which it is at liberty to turn itself in all directions.

When this remarkable quality of the magnet became known to Europeans, is a matter hid in darkness. About the end of the 12th century, we find evident traces of the use of the compass. It is beyond doubt, that the Chinese were acquainted with it long before this period; and it is highly probable, that

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* From the Christiania Journal of Natural Science.

the Venetians, in their commerce on the Red Sea, brought the knowledge of it with them from the East. That our Norwegian ancestors in this, were not behind the inhabitants of the south, may be seen from the 1st part of the Landnama Book, chap. 2. sect. 7., where it is related that the famous Pirate Floké Vilgerdarson, the third discoverer of Iceland, when, about the year 860, he went out from Rogaland in Norway, to search for Gardarsholm, (the old name of Iceland), took with him three ravens to serve him as guides. When on the open sea, he let go one of these birds, and if it returned to the ship, this was a sign that it saw no land. If, on the contrary, it flew off and returned not, they followed its flight, in hopes of reaching the land to which it bent its course. At Smörsund where his ship lay ready for sailing, Floké had proclaimed a great premium for training ravens to this service; since says the Landnama Book, the seaman had no magnet in our northern lands in those days. As this book was written about the end of the 11th century, the polarity of the magnet must then have been known in the north here, though the proper compass is not expressly mentioned.

It soon became, of course, a matter of question, what is the cause that the magnet, when at perfect liberty to move, always arranges itself with its poles towards the north and south. The following remarks seem to lead to a satisfactory answer. Place two magnets in such a situation, that, by this free motion, their north and south poles may be distinguished, it will be always found, that, on bringing them near one another, the north pole of the one repels the north pole of the other; and, in like manner, that the south pole of the one, repels the south pole of the other: On the contrary, the north pole of the one, attracts the south pole of the other. This law may be more briefly expressed. *Similar poles repel, dissimilar poles attract, one another.* From this we conclude, that the globe of the Earth itself must be a large magnet, which, in the north, somewhere in the neighbourhood of the pole of its revolution, the geographical pole, has a magnetic pole of the same sort with that of the magnetic needle which points to the south, and in the neighbourhood of the southern geographical pole, a magnetic pole of the same sort with that of the magnetic needle which points to the north. The north end of the magnetic needle is attracted to the north, by the north pole of the earth, the south magnetic pole ; and repelled from the south by the earth's south pole, the north magnetic. The reverse of this takes place with regard to the southern half of the needle. The position of the needle thus depends on this double attraction and repulsion. If, over the whole surface of the globe, the magnetic needle pointed due north and south, we should at once conclude that the earth's magnetic poles coincided with its geographical. But, after men had been acquainted with the use of the compass for 200 years, it was found by more accurate observation, that the direction of the needle declines from the meridian, which declination is called the Variation of the Compass*. It was farther observed, that this variation was different, at different parts of the earth ; in one place to the east ; in another to the west ; and, at last, at a later period, that, at the very same place, this variation was not the same at different times. This remarkable phenomenon can be explained in no other way, than by supposing, that the magnetic poles are situated at a considerable distance from the poles of the earth's revolution ; and that these poles, from one year to another, are changing their position. But as there are natural magnets which have four poles, two of each name, it is not impossible, that the earth may be found to be such an anomalous magnet. Here, then, arise the two following questions to be solved. Are two magnetic poles sufficient to explain all the phenomena of the variation of the compass, or are we under the necessity of assuming more? What are the position and motions of these poles?

It may be asserted, without any extravagance, that the inven-

* The first discovery of the variation of the compass is commonly ascribed to Columbus, who, among other perplexities he had to suffer from his mutinous crew, was questioned by them whether, at such a distance from the parts of the earth hitherto known, the compass might not point to quite other directions than north and south, and thus mislead, instead of guiding their course. To satisfy them on this matter, he observed the setting of the sun, and found that the needle actually deviated two degrees from the meridian. It was half a century after this before the exact amount of the variation was known. That it was so lately discovered in Europe, and not at all known in China, where the compass had been longer known, may be accounted for from this,—that in Europe it was at that time very small, and in China, for these 200 or 300 years, in some places nothing, and nowhere exceeded 2°.

tion of the compass, more than any other discovery, has given us possession of the whole circle of the earth. Without its guidance, navigation must have been confined to sailing along the sea-coast, without losing sight of land. By aid of the compass, the seaman can always steer his ship in a certain direction, ascertaining what angle her course makes with the meridian. By means of the log he measures how many miles he has sailed. From his course thus and his distance, he has simple geometrical principles by which he can calculate how far he has advanced south or north, east or west. He thus always knows, too, where he is. To steer by the stars was a thing very difficult, since the heavens were always revolving: when they were covered with clouds, it was altogether impossible. It was the compass which shewed to Columbus a path over the Atlantic Sea to America, which guided Vasco de Gama round the Cape of Good Hope, and the undaunted Hernando Magellan round the globe. In the tract of these heroes followed enterprising seamen, who, from the hope of gain, were continually endeavouring to extend their discoveries in all directions, till the whole surface of the earth now lies open to us, from the ice-bound coasts of North America to the southern Thule. In the South Sea, at Otaheite and the Sandwich Isles, arise Christian states, where, with Christianity, the mind is awakened to a more intellectual animation. In the tract of commerce slowly follows the higher cultivation of Europe, which shall at last encircle the whole earth; so that different races, endued with different talents, shall in the end unite in rearing the temple of wisdom, which now stands before our sight as an ideal vision. But what reaction has this discovery occasioned in our own part of the world? The gold of America has flowed in streams to Europe. States have risen and sunk as the tide of commerce was in their favour or against them. Envy and emulation awakened men's passions, and excited the most bloody wars and revolutions. New wants were introduced, and with them new activities. The sciences themselves felt a mighty excitement to progress. Long dangerous voyages made it necessary to discover more certain methods of determining a ship's place at sea, than were formerly known; for the log is attended with certain unavoidable mistakes, which, during a voyage of several months, rise to a considerable amount.

Artists applied their ingenuity to invent new and more accurate instruments and time-pieces, by which astronomical observations were to be made on ship-board. Astronomers were called on to make more accurate determinations of the places of the fixed stars, and the motions of the sun, moon, and planets *. Mathematics, the foundation of astronomy, had to be formed anew, and, in the hands of Newton and Leibnitz, acquired an enlargement, by which it first became possible to give an account of the many irregularities in the motions of the heavenly bodies, which, before, could neither be explained nor calculated. New and hitherto unknown natural curiosities were brought home, which more than doubled the extent of our museums. It may be asserted, at the same time, that, if the compass had not been invented, the Incas, the children of the sun, would have still sat on the throne of Peru, and tribes, whom avarice and fanaticism have extirpated from the face of the earth, would have still lived happy in their native lands. The mightiest naval powers of Europe would, in that case, too, have acted but an inconsiderable part in the annals of history, and the whole of Europe would have been farther from the period of its maturity, and, therefore, from the period of its decline. But the friend of humanity would, at the same time, have wanted this precious consolation, that, if ever base degeneracy, or the contentions of selfish interests, should force the muses to fly from Europe, they will find certain and ample refuge in the New World of Columbus †.

Besides the interest which a more accurate knowledge of the magnetic powers of the earth thus derives from its importance

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* The famous astronomical Observatory at Greenwich was erected for this express purpose, in the year 1675; for, in the Royal Edict, concerning it, the Directors were commanded, " That they should apply themselves, with the utmost care and diligence, to rectify the tables of the motions of the heavens, and the places of the fixed stars, in order to find out the so-much desired longitude at sea, for the perfection of the art of navigation." And a series of men, of distinguished talents, provided with the finest instruments, have, for a century and a half, faithfully endeavoured to accomplish this purpose, and have delivered to us an uninterrupted series of accurate observations, on which the whole newer determinations of astronomy are founded.

† Science has no alternate growth and decline. Why should we think her most likely to depart from that residence where she is most firmly established?—T.

to navigation, it acquires a still higher from the light which it is probable it will yet throw over the whole of science. The interior structure of the earth, it is beyond our power to examine with the bodily eye. The greatest depths to which we are able to descend beneath its surface, are almost nothing compared with the diameter of the earth. In the mean time, the operation of the powers of nature on the surface of the earth, discover its interior. Thus, the deviation of the plummet from a vertical line in the neighbourhood of high mountains, from the attraction of the mountain to the plummet, shews, that the mass of the earth, taken as a whole, is about five times heavier than water, heavier also than most species of stones, and in all probability, therefore, the greater part of it composed of metallic substance. In the same manner, the yearly and daily periodic motions of the magnetic needle, are a mute language, revealing to us what is going on in the bosom of the earth. The aurora borealis, too, is probably the result of a struggle of powers put in activity by the variously constituted substances composing the mass of the earth, which we may thus perhaps one day learn to know; for, to advance from effects to causes, is the natural progress of science.

Although the answer of the questions on this subject seems thus to have both a theoretical and a practical interest, it is not every one's affair to engage in extensive mathematical investigations. I have therefore thought that I might perform a task acceptable to a number of the readers of this Journal, in giving, in as popular a manner as possible, a statement of the most important results of my researches with regard to the Magnetism of the Earth.

The two charts which accompany this paper *, are two segments of the surface of the earth, from the poles to latitude 50°. The longitudes are reckoned from the meridian of the Observatory of Greenwich, as most of the sea observations were made by English navigators, who count from that meridian. The arrows scattered over the charts give the direction of the magnetic needle; the end next the poles marks the place of observation, the angle which the meridian forms with the arrow,

* These will be given in a future Number.—Edit.

gives the variation of the compass as it was found by observation. The observations marked on the southern chart, are all taken from Captain Cooke, and fall between the years 1772 and 1777. The observations on the northern segment, are from Captain Cooke, Captain Phipps, afterwards Lord Mulgrave, Commander, now Admiral, Lövenörn, Captain Billings and others, and fall about the same time. With some older and later observations the date is given. The most important observations made during the two last English expeditions to the North Pole (1818–1820), are marked by a star. As there was so short an interval between these two series of observations, they are given as belonging to one period, and may be considered as representing the magnetic state of the globe for the last quarter of the foregoing century.

Over the whole of Europe the variation of the compass, at the present time, is westerly. If we cross, from east to west, over the Atlantic sea towards Greenland, it increases as we approach nearer the southern promontory of Greenland. Thus at Petersburgh, it is about 8° west; at Stockholm, 15°$\frac{1}{2}$; at Christiania, 20°; at London, 24°$\frac{1}{3}$; on the north coast of Iceland, it is above 40°; and at the colony of Good Hope, in Greenland, it is above 51°. From the west coast of Greenland to Hudson's Bay, it decreases again a few degrees; but in Hudson's Bay this decrease is so great, that, in the year 1769, at Prince of Wales's Fort, on the west side of the bay, it was found only 9° 41′. Farther in on the Continent, it vanishes altogether, becoming afterwards easterly; and increasing in this direction so much towards the west coast of America, that, in the year 1778, it was found, by Captain Cook, at Nootka Sound, to be 19° 51′ east; and at Behring's Straits, the same year, 35° 37′. If we lengthen the arrows from Nootka Sound, and Hudson's Bay and Straits, it will be found, that they meet in a point which lies about 20° from the pole, and 259° east from the meridian of Greenwich.

(To be continued.)

Art. XVII.—*On the Natural History of the Salmon, and on the Salmon-Fisheries, as stated in the "Report from the Select Committee on the Salmon-Fisheries of the United Kingdom, ordered by the House of Commons to be printed, 17th June* 1824;" *with Remarks.* By a Correspondent.

The attention of the country has long been directed to the Salmon-fisheries, in consequence of the numerous discussions which have taken place in our courts of law, respecting the rights of different proprietors, and the legality of certain engines or modes of fishing. In the river Tay, and its estuary, litigations on this subject were, at one period, carried to a very great extent; and the heritors having fishings in the river, succeeded in establishing the coble-net as the only legal engine of fishing in the estuary, and suppressing all fixed apparatus, such as stake-nets. Two years ago, these victorious upper heritors brought in a bill to the House of Commons, for the ostensible purpose of promoting the interest of the fisheries in the river; but the under heritors succeeded in convincing the House, that the end could not be gained by a change of a *few days* in close time, nor by the police regulations proposed; and the bill was thrown out. Last year, the attempt was renewed, to introduce a similar bill, and with no better success. The House, however, having the subject thus pressed upon their notice, and aware of its national importance, resolved to examine it in all its relations. A Committee was accordingly appointed, and the evidence taken constitutes the Report to which we now propose to direct the attention of our readers. With the exception of one witness, "Henry Home Drummond, Esq. a Member," all those examined are individuals actually engaged as salmon-fishers, and practically acquainted with the subject. Among these, some seem acquainted only with coble-net fishing; others appear equally well skilled in stake-net as in coble-net. There is a paper added to the Report, which was delivered in to the Committee by Sir Humphry Davy, on the Salmon-Fisheries, in which the principal statements are at variance with the testimony of those witnesses who are the most extensive salmon-fishers in the United Kingdom.

In order to enable our readers to perceive the evils which exist in our salmon-fishing practices, and the principles by which the Legislature should be guided in framing new regulations to remove them, we shall consider the facts brought to light, or established in this Report, relating to the habits of the fish; then inquire into the nature of the alleged grievances by which the fisheries are injured, and proceed to the consideration of the remedies proposed. Without quoting in every instance the words of the witnesses, we shall refer to the number of the page of the Report. It would have been more convenient had the questions, with the answers, been numbered, as the references could have been made with greater distinctness.

HABITS OF THE FISH.

In the course of the examinations which are here recorded, the Committee seem to have been anxious to determine the different *species* of fish usually found in the salmon rivers, or captured in the nets. This is an object of considerable importance, with the view of regulating the size of the meshes of the nets.

I. Salmon.—All the witnesses are of the same opinion with regard to this species; but they differ greatly as to this question, "Whether the salmon of one river can be distinguished from those of another by any definite characters." Mr Halliday has "compared them in Ireland, England, and Scotland, many times," and says, "I cannot make out the distinction of one river's fish from that of another;" p. 87. Mr James Bell states, "I have a little guess; not altogether;" p. 22. J. Proudfoot considers the Tweed fish as smaller than those of the Tay, and those of the River Isla as smaller than those of the River Tay; but, when asked if upon meeting with an Isla fish and a Tay fish in the frith, he would know the one from the other, he replies "No; I would not;' p. 25. On the other side of the question, Mr James Wilson, in reference to the North and South Esks at Montrose, declares, that "the species of salmon is quite different in these two rivers;" and adds, "One is a large coarse scaly fish, and the other is a smaller and a finer fish;" p. 14. Mr James Bell states, that the "Aberdeen fish is quite different from the Tay, different in the scale;" p. 28. Geo. Little, Esq. states, that the salmon in the Shannon "grow to a large size;" and adds, "We have three fishings that fall all into one bay in Ireland, the Bush, the Bann, and the Foyle, and we can easily distinguish the fish of all the different rivers when we take them. The salmon in the Bush is a long-bodied round salmon, nearly as thick at the head as he is at the middle. The salmon that we kill at the Bann, is what I call a very neat made fish, very broad at the shoulders, and the back fin tapering away towards the tail, and quite a different shaped fish from the Bush fish. The Foyle is a river that we seldom get any large salmon in." p. 112.

A considerable degree of importance seems to be attached to this branch of the inquiry, with the view of determining the question, Whether the fish bred in a particular river always return to their birth-place, and to no other river. Sir Humphry Davy *assumes* that " salmon, and salmon-trout, belong, in fact, to the river in which they were spawned," and that " each variety of salmon or salmon-trout affects a particular river, and always returns to it;" p. 145. The other witnesses seem generally to entertain the same *opinion*. Mr Little has been *told* of evidence on this subject, p. 112.; but no *facts* are communicated. Indeed, Mr Halliday *asserts*, that " they do not all come to the same river in which they were bred;" and as a *proof* of this he states, " I found the different rivers vary from one year to another; but when one is protected and another unprotected, the unprotected river keeps up its quantity as well as the protected one;" p. 87. Judging from analogy, we should consider it probable, that, in the absence of deranging circumstances, the fish bred in a river would generally return to it; but not a few, under the influence of those feelings on which depend the peopling of the globe, would wander into other rivers. And when we consider the *persecutions* from seals, grampuses and sharks, to which salmon are exposed in the sea, in connection with their social or *gregarious disposition*, it is impossible to avoid drawing the inference, that the *tribes* belonging to different rivers must be frequently *dispersed* and *mixed*, and have their future movements controlled by other circumstances than the localities of their birth. In point of fact, salmon, so far from belonging to the *rivers* in which they were *bred*, belong to the *sea*, the place of their *ordinary residence*, where they *grow* and *feed*. The ordinary laws of citizenship, therefore, are not applicable to salmon.

II. Grilse.—Sir H. Davy and Mr John Wilson consider this fish as a young salmon; other witnesses, as Messrs Little, Johnstone and Halliday, entertain a different opinion, viewing it as *a distinct species*. They found this opinion of its claim to rank as a species on the circumstances, of its being found full of milt or of roe, and of its spawning and return to the sea as a *kelt* or spawned fish. But fish spawn long before they attain maturity, consequently this test is of little value. But other proofs are offered. Mr Johnstone says, " The grilse is a much less fish in general; it is much smaller at the tail in proportion, and it has a much more swallow tail, much more forked; it is smaller at the head, sharper at the point of the nose, and generally the grilse is more bright in the scales than the salmon;" p. 38. Mr Halliday states, that " a grilse's tail is very much forked, like that of a swallow; a salmon's tail is not forked like that of a grilse, and the chowk fins (pectorals) of a grilse are much more blue in their colour than a salmon's; a grilse is much smaller at the head and immediately above the tail than a salmon is; it seems to be a different fish in shape every way; besides, it goes up full of spawn in the end of the year, and does not come down till the spring, when it is a kelt grilse, while the young salmon are coming up the rivers in numbers of at least fifty young salmon for every kelt grilse that returns to the sea;" p. 63. Mr Little, who entertains a similar opinion to the two preceding witnesses, states, that grilses enter rivers in June, seldom in May, p. 112., (confirmed by Mr Halliday, p. 53.); and adds, " We do not find in some rivers the same proportion of grilses as salmon as we do in others; for instance, in our fishing at the Foyle, it consists almost entirely of grilse;" p. 110. When they first appear in the rivers, they are from 1½ to 3 lb. in weight, "and they increase gradually every week during the time we kill them." At the end of the season they weigh "8, 9, or 10 lb." He likewise states, "Our water keepers tell me that they very seldom see a *salmon and grilse breeding together*, but they have seen it occasionally, but not generally; very seldom;" p. 113. There can be little doubt, that the term *Grilse* is used in general to denote a young salmon, though the same epithet is probably bestowed upon a distinct species of the genus Salmo, with which it seems to be confounded.

III. Trout.—Sir H. Davy considers Salmon-peal, Sewen, and Bull-trout, as constituting one species, the Salmo Eriox of Linnæus, the most correct appellation of which is *Sea-trout.* The Salmo *Trutta* of Linnæus, however, has been *universally* regarded by British systematical writers as the common *Sea-trout;* and the Salmo Eriox is a very different species. The term *Eriox*, as first employed by Albertus Magnus in the thirteenth, and by Cuba in the fifteenth century, was considered by Artedi as referring to the Common Salmon! Linnæus afterwards employed the term as a trivial name to the "S. maculis cinereis, cauda extremo æquali" of Artedi, and the *Gray* of Willughby and Ray. De Lacepede continues the term in its Linnean sense; and, we may add for the information of the learned chemist, that S. Trutta and S. Eriox are both well characterised species and natives of Great Britain. Let him count the rays of the gill-flap if he doubts. Mr Johnston says, "Although in some friths and rivers, where there are a great many salmon, there are also great numbers of trout; yet in others, where there are a great many salmon, there are very few trout;" p. 38. Mr Halliday states, "In the Annan I have known us get more sea-trouts in one day, than we shall get in the Tay in a whole year;" p. 64. Mr Little declares, "that the sea-trout are not found in all salmon rivers. We do not see any thing like the Spey trout, or like the trout that is caught in the Solway Frith, or like the trout that is caught in the Tweed, in any of our fishings in Ireland. They do not breed, nor are they to be seen there;" p. 111. Sir H. Davy states, that "the different habits of the salmon and sea-trout are well demonstrated in the Moy, near Ballena in Ireland," on which there is a large pile near the town, and which, below the fall, is joined by a considerable stream. "The salmon leap this fall; the sea-trout almost all spawn in the smaller stream, a few miles from the sea;" p. 144. There is some strange blunder here. Mr Little, the tenant of the fishings on the Moy, says, there are trout, "but not the trout called the Sea-trout;" and with regard to the *pile* or fall which obstructs the progress of the trout, and over which the salmon leap, he adds, "They can go over it at tide-time, without leaping; after the tide rises they can go over it;" p. 134. He likewise observes, "A trout goes very far up the river to spawn."—"The smaller the fish is, they go the higher up into the little streams to deposit the spawn; but the trout in the Moy are quite a different kind of trout from what we call in Scotland the salmon or sea trout;" p. 134.

IV. Whitling.—Sir H. Davy considers this fish as a young salmon, and states, that they are "without *visible ova or spermatic secretion;* are found in salmon rivers, a mile or two from the sea, and which return to the sea, without attempting a farther migration;" p. 145. Mr Little, who knows this fish by different names in different rivers, as hirlings, whiteings, or finnocks, declares, "We never see such a fish in Ireland, in the rivers we are concerned with." In the rivers that run into the Solway Frith and in the Tweed, and in some other rivers, they are found; but in a great number of rivers they are not. They are only found in those rivers where they breed. There are a few in the river Tay, shaped, and headed, and tailed like a salmon. They are from 12 to 15 inches in length. Some of them will cut up red, but they are mostly white.—We frequently do not find them in rivers where salmon are: there are many rivers where there are salmon, where no such fish are known; we see them going down *kelt* in the same way as we see a large salmon going down after spawning;" p. 110. Mr Halliday states, "that in Carlisle they call them whitings: in Annan hirlings, and in the north finnocks. I never saw any in the Tay; but I have taken 100 dozen in the Annan at one draught. It is about 12 inches long. The tail of the hirling is straighter than that of the salmon or grilse, and it is quite a short-headed fish; neither does the head of the hirling shoot like that of the salmon when he is going to spawn. The largest I ever saw was about ¾ths of a pound. My reasons for believing that they are not the young salmon, are, that when "they go up the rivers, they are as *full of spawn* for their size as the salmon is; and when they come down in the spring of the year kelts, we are getting the young salmon;" p. 63. Mr Johnstone agrees with the preceding witnesses, in asserting the ordinary presence of ova and spermatic secretion, and in considering this fish as a distinct species. "They are called hirlings on the Scotch side of the Solway, whitings on the English side; hirlings, whitings or whitlings at Berwick; whitelings in the Tay; and finnocks in the north of Scotland;" p. 37.

V. Par.—Mr Little is the only witness who is questioned in reference to this fish. "I have seen them; but I consider them merely a fresh-water fish, or a species of fish by themselves, unconnected with our salmon-fisheries altogether;" p. 113.

It is probable, that some species of migratory trouts have not been noticed at all. The river fishers are better acquainted with the trouts than the frith fishers.—But we return to the Habits of the Salmon, as furnishing materials for regulating the legislative enactments of this kingdom.

Before entering upon this branch of the subject, it may be proper to state, that the present legal time for beginning the salmon-fishing varies in different rivers, from the 10th December (in the Tay) to the 12th March (in the Solway); and that the fishing-season legally ends, according to the rivers, from the 12th August (Ireland generally) to the 4th December (in the Teign). How far these terms are suitable or improper will presently appear.

In the more important actions of the salmon, viz. migration and spawning, there is a *season* during which these are executed by the greatest number of individuals, occupying, however, a range of some months. But there are individuals, executing these operations irregularly, at other periods. Mr Little says, "There are some rivers in which you will get some good salmon all the year round;" p. 114. In the *spring months*, few fish enter rivers; they rapidly increase in numbers as the summer advances, and in autumn again they begin to decrease, leaving the winter months, as to the ascending migration, to constitute a dead season.

The *condition of rivers* in the spring influences the movements of the salmon. J. Proudfoot states, that, "in the spring of the year the fish always occupy the north side of the Tay (*i. e.* the sunny side of the river). The north side fishing kills far more fish than the south side;" p. 28. Mr Little states, that in "the river Shannon the salmon fishery is nearly over by the middle of May," p. 114.; and that he does "not get many fish in the Foyle of any kind till the end of May;" p. 112. When the great differences existing between different rivers, in the quantity, temperature, and contents of their waters, are duly considered, we need not wonder at the influence these circumstances may exert on the motions of salmon; but if we make a difference in the *close season* between *one river and another*, we must, with equal propriety, establish a similar distinction between the *south side and the north side of every river*.

In rivers, during the early spring months, the fisheries are seldom productive: even Lord Gray's fishings on the sunny side of the Tay, according to J. Gillies, "taking the average from the 10th December till the end of January, will not, one season with another, pay the expences or little more. There are some very good fishings in the month of February; perhaps in the month of February there will be ten days of those fishings, and scarcely take one fish." The same witness adds, in reference to the kind of fish taken at those periods in the Tay, "You will get *ten foul* fish till the middle of February for *one clean* one;" p. 139. As the season advances, the salmon appear on the shores, in the estuaries, and enter rivers in greater numbers. The stake-nets, in such places, according to Mr Halliday, "are seldom productive but in May, June and July;" p. 68. "The fishings fall materially off about the middle of August, and to the end of it;" p. 69. & 84. "In September they catch almost nothing;" p. 84. These conditions vary much with the season. The salmon are most abundant in dry seasons on the shore, and in estuaries. In rivers, they abound most in wet seasons. Mr Halliday on this subject offers some very pertinent remarks: "Because the stake-nets take the salmon at that season of the year when they would not go into the rivers; the rivers are not in a state to receive them, they become so heated; the rivers likewise become so very small, and the water gets so hot at that season of the year, when salmon is most plentiful on the coasts of Scotland, that they will not enter the rivers, the rivers being then not in a fit state to receive them; it is by the stake-nets that the fish at that season of the year can be taken in the greatest quantity; it is at that time too that they are in the greatest perfection; very few would be taken except by the stake-nets; and if they were not so taken, they would generally be lost altogether; a great part of these fish that the stake-nets do take, are taken going out to sea: even in the friths and estuaries, the fish do not go far up in the warm months. In the course of my practice in the Tay, I have carefully observed the upper stake-nets in comparison with the lower: when the seasons were dry, the upper stake-nets took very few fish in comparison at a particular time of the year; in one season, when the season was very dry and warm, the fish in the neap-tides did not even approach the highest stake-net, namely, Seaside and Birkhill; when the spring-tides became high, the fish came up to these nets, and were taken; but when the tide fell off again, the nets on the lower parts of the frith, on Mr Dalgliesh and Mr Maule's properties, caught a great deal more fish at that particular time of the tide, when the fish did not float up so high as the upper stake-nets;" p. 72. In conformity with this statement, J. Proudfoot declares, that, "in rainy seasons, in heavy speats, the upper fisheries (in the river) give more fish in proportion when the river is high than when it is little;" p. 26.

The fish which enter rivers in the spring and summer months, have roe, but in May, for example, it is very small. As the season advances, the roe and milt are found in a riper state, until the time of spawning; but in these respects, there are individual differences. Now, since salmon enter rivers months before they be ready for spawning, Do they remain in the river until that period, or do they occasionally return to the sea? On this subject the Committee seem to have bestowed considerable attention. The opinions of the witnesses, however, are at variance. In reference to the fish on the shore and in estuaries, Mr Wilson declares, "I believe they all go up those rivers; they are upon the shore, and get up the river if they can;" p. 14. Several of the other witnesses give it as their opinion, that salmon, before the spawning season, enter the rivers, and return again to the sea, influenced by very different instincts from those of spawning. The following proofs are offered.

1. It is asserted that *salmon remaining a short time in fresh-water, become weak, and return to the sea to be recruited.*—It is stated by some of the witnesses, that salmon are fattest at a particular season. Mr Little says, "In the month of May I consider they are as good and as perfect as at any one season of the year. From the month of May, they are gradually growing worse till they begin to deposit their spawn in the month of November;" p. 114. Mr Wilson reckons "salmon is at its best at midsummer, and falls greatly off after about the middle of July;" p. 12. Mr Johnstone considers "May and June as the period of their greatest perfection;" but he adds, "there may be equal to three months difference between the quality of fish;" p. 56. Mr Bell, on the other hand, declares, "that the fish is full as good on the 10th December in the Tay as at any other time of the year;" and "the Tweed fish is good in August; that is their best season;" p. 21. Mr P. J. Proudfoot says, in reference to the Tay, "there is a great deal of good fish killed by the time we commence the season," (on 10th December); p. 27. These opinions are of less value than those now to be stated respecting the relative qualities of sea and river fish. Mr Wilson decidedly declares, that there is no difference in the quality of salmon taken at different parts of the same river, or in the tideway, or in the sea adjoining, during the proper season; p. 13. On the other hand, Mr Johnstone says, "the salmon caught in the sea, and nearest to the sea, are generally the richest." When they have been some days in the water, "they lose their bright colour,"—"their firm state; the fish gets longer in proportion to its thickness, and loses its weight."—"If he is not *many days* in the water, if he is caught immediately out of the sea, I do not see he can be any worse;" p. 50. "A few weeks would make him a great deal worse;" p. 53. Mr Halliday states, that those that had been long in fresh water "were very much

exhausted, quite changed in the colour, as if they had *hung in a smoky chimney* for some time; others were very *red* in the skin, by having been in the fresh water for some time." "When they are in the fresh waters they turn as slippery as an eel;" p. 61. "The salmon becomes unsound after it has been detained in fresh-water at any season;" p. 79. Mr Little not only states, "if he remains any length of time in a fresh river, he becomes worse," but even limits the period to a week or ten days; p. 126. This supposed deterioration in fresh water, we consider to be *visionary*, and for this reason,—if it took place, how could the fish suffer under its influence for months, while exerting themselves in ascending to the spawning-ground,—while in the protracted act of spawning,—during their residence in the neighbourhood after parturition,—and in their subsequent descent to the sea?

2. *Salmon remaining in fresh water have their gills covered and eaten by worms, which fall off upon their return to the sea.*—Mr Johnstone declares, "They get infested with worms or maggots in the gills if they remain long in the fresh water, which I think would kill them in the end, if they did not go back to the sea to get clear of these worms or maggots;" p. 35. Mr Halliday says of fish in a bad condition, "Some of those we took had their gills almost eaten through with maggot worms, by being so long up the river;" p. 61. Mr Little declares, "I have seen their gills *entirely eaten off them* by the worms in fresh water; at least the thin and red parts *entirely* eat away," (*i. e.* all their organs of respiration!) "I do not believe they are ever found in that state except in fresh water, and it is necessary for them to leave the fresh water to get clear of the vermin which fasten upon them while there;" p. 108. The worm referred to, is the *Lernæa salmonea* of Linnæus, the *Entomoda salmonea* of Lamarck. We still ask the question, If the fresh water be so very exhausting, and the attacks of the maggot so very troublesome and destructive, how can the spawning fish survive during their residence for months in a river? It is to be regretted that the season of the year, and the condition of the fish as to spawning, had not been determined, as, trusting to the declarations of experienced river fishers, we consider that these worms only appear on the *kelt fish*, or such as have spawned, and which are consequently on their return to the sea.

3. *Salmon are caught in the rivers and estuaries on their way out to sea.*—In proof of this, Mr Halliday states, "I fished the Annan for many years; and there is one pool in particular, namely the Sand Pool; although we had fished this pool quite clean of fish before the rain came, yet, whenever the rain did come on, we then continued fishing constantly, until the water rose so high that we could not manage it, and we got the salmon and grilses coming down the river all the time into the pool. Some of those we took coming down the water of Annan were what we call *Moffatmen*, a term used for exhausted fish which had been at the head of the water;" p. 61. But the fish may have come up the water to this pool; or, if they came down with the flood, they may have been kelts,—their gills were infested with maggots. This is the only proof in the report of the descent of salmon in rivers before spawning, and it refers to a length of course from the sea not exceeding a salmon day's journey. The point in question can only be determined at *salmon leaps*. Do fish ever recross these before they have become kelts? The proof in the estuary and sea is still more defective. Mr Johnstone declares "the fish seldom

go against the tide;" p. 44. "They run backwards and forwards with the tide in all directions;" p. 45. Mr Halliday admits that it is common "for salmon to ebb and flow with the reflux of the tide;" p. 91. With these admissions, the two last witnesses consider the salmon taken in stake-nets, with an ebb court for taking fish with the ebb tide, were such as had been in the river or estuary, and were leaving it for the sea. But if the salmon were *inactive*, the motions of the ebb-tide would carry them into the nets, in the same manner as the flood-tide carried them past. The fish do not enter rivers until the water is in a state to receive them, and they are in a condition to enter. Hence, on the shore and in estuaries, when not inclined to migrate, the motions of the tide will control them, and the ebb-nets, will, from their very nature, be most likely to secure them. Even in the driest seasons, when the fish were not entering the river, Mr Halliday states that the ebb-nets were most successful; p. 72. Could they be other fish than such as passed by with the flood?

If fresh waters be so exhausting to salmon, and promote the growth of parasitical maggots so rapidly, how comes it to pass that they ever leave the sea, unless for the necessary purposes of spawning? The three witnesses, who consider that salmon run out of rivers to get rid of the worms which infest their gills, have a similar hypothesis for explaining their leaving the sea. Mr Johnstone says, in reference to their visits to rivers, "One evident object is to get clear of the vermin termed the *sea-louse*, which infests them sometimes when in the sea, and which leave them when they get into fresh-water;" and he admits, that when the salmon are subject to this insect in the sea, they are in the highest condition; p. 35. In reference to the length of time the sea-louse remains upon fish after leaving the sea, he observes, "I do not think it remains many days; for when they are in the fresh-water, we soon observe them to go off; they do not go off all at once, they go off by degrees;" p. 53. Mr Halliday says, "They visit rivers to clean themselves of the sea-louse, an insect that fastens to them in the sea, and with which they are infested when they come out of the ocean, but which die in the fresh water;" p. 61. Mr Little says, "It is instinct which induces them to return to the rivers, and, as I consider, for the purpose of getting rid of a vermin which gets upon them, called sea-lice;" p. 108. The animal here referred to is the *Monoculus piscinus* of Linnæus, and the *Caligus curtus* (mixed probably with *C. productus*) of Müller, but usually confounded with the *Lernæa salmonea* of Linnæus, by a blunder of Mr Pennant. This animal is common to the salmon, whiting, cod, and flounder. The three last do not enter rivers to escape from its attacks. The salmon, when *most infested by it*, is in the *fattest and healthiest condition*; but still, in order to have it removed, this fish, in the opinion of these witnesses, enters rivers, where it is certain of being exhausted in a week or ten days, and where it is in danger of having its organs of respiration entirely devoured by the entomoda or maggot. Another reason assigned by the same witnesses for salmon entering rivers, is searching for *food*. Of this, however, no proof is offered. But, in reference to estuaries, Mr Halliday has taken a great many salmon, "with worms passing through them; such worms as are to be seen on the banks;" p. 61. "I have had thousands of them dissected, when I have seen small sea-fish in their stomachs;" p. 90.

At what season do salmon enter rivers for the purpose of spawning?—We have already seen, that the milt and roe make their appearance in a very obvious manner so early as the month of May; p. 35. Mr Johnstone states, "that some are getting full of spawn in July;" p. 56. In August, "the great proportion of them are gettting full of roe and milt; they always get full as they get near spawning;" p. 40. Mr Wilson states, that "in August they get considerably advanced with spawn; and in the end of August and beginning of September they get very full of spawn;" p. 12. Wm. Bell, in reference to the Tay, states, that eight or ten days before the fishing-season closes, they are "very full of roe;" p. 32. J. Proudfoot says, "I have seen the fish, particularly the female, beginning to get very large by the 25th August;" p. 27. In September and October, they are so full of roe and milt as to be unmarketable. Mr Halliday says, "Last year some of the fish sent from Montrose before the 10th October were seeded, and condemned in the London market as being unfit for use; and I have seen them frequently take them by the 1st October that I considered were very unwholesome and improper fish to be taken;" p. 83. Even in February and March last year (1824), in the North Esk, "I caught them upon the spawning-beds in the night-time;" p. 84. Mr Little declares, in August, September, and October, in general, they get large in the belly, and full of roe and milt; and he adds, that, for the purpose of spawning, "they begin to ascend in the months of August and September, and continue to the end of the year;" p. 107. In January, February, and even March, some of the fish are unspawned. Mr Little states, that "last season my tenant commenced fishing at my fishery in the Nith on the 11th March. He then killed, as I am informed, upwards of 200 salmon, some of them positively not spawned;" p. 116.

Fish ready to spawn seem to enter the rivers directly, and in the friths to keep the depth of the stream: hence, neither shore stake-nets nor estuary stake-nets are successful in capturing *red fish*. Even Mr Bell, a witness obviously hostile to stake-nets, declares, in reference to the capture of red fish in the estuary, that "none" are caught, and qualifies his assertion by saying, "there may be one accidentally in a year or two;" p. 23. In ascending the river, Mr Halliday declares, "the fish run most in the morning and evening;" p. 86. The *general time* of spawning, according to all the witnesses, is during the months of November, December, and January; pp. 61. 108.: though stragglers may be found in March.

The *interruptions* which salmon at present experience in ascending rivers for the purpose of spawning, chiefly arise from *mill-dams*. The walls of these, in many cases, are built in so close a manner, that for months there will not be enough of water to permit any fish to ascend. It is only in very great floods that they can successfully overcome the barrier. *Noxious matter*, from tan-pits, the steeping of flax, and gas washings, expel salmon from a river; p. 133. 67. In reference to noxious matter, however, Mr Drummond makes an exception in favour of peat-moss floated into the Forth from Blair-Drummond: "I believe it to be troublesome to the nets in fishing; but certainly there is nothing noxious in the nature of moss to the fish;" p. 141.

Fish ready to spawn are sought after by poachers for the sake of the *roe*. Mr Little says, "It is potted. The gentlemen going to fish in the lakes of

Cumberland, buy it for the purpose of using it as *bait* in fishing upon those lakes;" p. 119.

With regard to the *mode of spawning*, it is gratifying to peruse the testimony of *eye witnesses*. Mr Halliday, after having stated that "they generally spawn in the running water, at the foots of fords and the tops of fords, where the gravel is fine, and low down in the foot of pools where the water begins to run, so as to assist the salmon in removing the gravel," (p. 60.), thus describes the process: "When they proceed to the shallow waters, which is generally in the morning, or at twilight in the evening, they play round the ground, two of them together. When they begin to make the furrow, they work up the gravel rather against the stream, as a salmon cannot work with his head down the stream, for the water going into his gills the wrong way drowns him; and when they have made a furrow, they go a little distance, the one to one side and the other to the other side of the furrow, and throw themselves on their sides when they come together, and, rubbing against each other, they shed their spawn both into the furrow at once."—"I have seen three pair upon a spawning-bed at a time in the Annan; I have stood and looked at them, both while making the furrow and laying the spawn."—"They do not lay it all at once. It requires from about eight to twelve days for them to lay their spawn."—"I have often taken a number of these kelts with the skin rubbed off below the jaws, just between the *chowk* fins (pectorals), almost the size of a half crown, with rubbing up the gravel, and making the holes for the spawn."—"A male fish's head is always larger in proportion to his size than a female's, and it begins to shoot smaller at the point;" p. 62. "The spawning-bed is easily known by the thrown-up gravel; when I took my foot off the hard gravel, and put it on the spawning bed, it was quite soft;" p. 65. In reference to grilses, he adds, "They spawn the same as the salmon."—"I have frequently seen them spawning in the autumn;" p. 64. Mr Little speaks in an equally decided manner. "I have frequently looked at the salmon spawning."—"When they begin their bed first, it is like one furrow; they make a furrow in the shallow part or current of the water, where they begin their spawn, and they continue working against the stream, until they have formed a bed of perhaps twelve feet by eight or ten,"—"for one pair of salmon."—"In the instance I was alluding to, when I saw these salmon first, the bed was very little, but it increased every day. I observed the salmon go very leisurely down the side of the bed, and go just round where they have thrown up the gravel, and come back to the same point next the stream; as soon as they came up to this place, they threw themselves on their sides, and worked one against the other, at the same time rubbing their noses against the gravel, till they came to the other corner of the bed, and then they fell leisurely round until they came to the same place again, at the top of the bed next the stream, where they went through the same process; they continued in this way for many days, working; and if it so happened that they were frightened, they would run away, and in a little time return to it again."—"It takes them some considerable time before they get all their spawn deposited; several days; and I have known them, when they have been frightened away, go and leave their spawning-beds, and begin at other places."—"The bed is covered as they go along."—"Both assist in it, and while in the act of depositing their spawn." He adds, that the male gets a very long hard bill on his under jaw, which *decreases* as the spawning season passes;" p. 108. Sir H. Davy asserts (but whether from having seen the operation is not stated), that "the female fish, in spawning, deposits her eggs slowly *on gravel;* the male sheds a white seminal liquid *upon them;* and both fish cover the eggs with gravel. The male is most active in this operation, which hardens the extremity of the mouth, and *bends it into the form of a hook;*" p. 145. The opinion here expressed, that the female first deposits her roe, and then the male sheds the milt upon them, stands contradicted by the preceding eye-witness; and, we may add, that it is not the extremity of the *mouth* or nose, but the extremity of the *lower jaw*, which is bent up; and were this bending produced by the resistance of the gravel in the act of covering up the spawn, then the lower jaw in males, before they had spawned, should be much longer than the upper, which the witness will find not to be the case; and the gravel we should think, would be rather apt to enter the mouth. This bending is in a great measure characteristic of the male; but the peculiarities of its form and position demonstrate that it could not be produced by mechanical means.

The quantity of eggs deposited by a single female, has been variously stated by different authors. Mr Johnstone says, "I have counted them (eggs in the roe) repeatedly; they are from 18,000 to 20,000 on an average;" p. 36. Mr Halliday says, "They are not all exactly of the same number; I have found them of different numbers, from 17,000 to 20,000;" p. 62.

It may be proper here to inquire, whether, according to the present fishing season, the salmon are ever disturbed on their spawning-beds? Alas, but too frequently! James Gillies declares, that, in reference to the year 1819 in the Tay, "we took eighteen at one haul, in the month of December, of fish spawning on the spawning-beds;" p. 138.

Leaving for a little the spawning-beds, let us attend to the character and motions of the spawned fish, or *kelts*, as they are termed. In this state, says Mr Wilson, "when the spawn is just leaving the fish, it is merely just two pieces of skin, just like a cow in calf;" p. 13. Mr Johnstone adds, "By a kelt is meant a fish which has recently spawned; it is very thin; it gets very much discoloured; it is very long in comparison with its thickness; the head is very large; the fish is quite out of season; the fish then cuts white in general;" p. 37. Mr Wilson declares, from six or eight years experience in the North Esk, in Forfarshire; the Dee and the Don, in Aberdeenshire; the Beauly and Lochy, in Inverness-shire, "in fact, fishing those fisheries before the first of February, you would catch nothing but black fish (kelts)," p. 13. When the process of spawning is finished, according to Mr Halliday, "they go into a pool to *recruit* themselves (*recruiting* in fresh water, so *exhausting* to fish!); and, in about a fortnight or three weeks thereafter, then the *male* fish begins to seek his way down the river. The female fish remains longer about the spawning ground; and I have very often found some of the mother fish going down a kelt as late as when the first of the fry began to come down the river."—"In the end of April and beginning of May, I have taken five at one haul in the river Annan," p. 62. He says, in February and March, "*immense nnmbers* are caught;" and, "in the upper parts of the Tay, there must be thousands taken annually," p. 83. James Gillies has formerly stated the number of foul fish (kelts) in February. He adds, "You could not commence before the month of March, without taking the foul fish, because the most part of the *she fish* come down in the month of March from the high lands. You will see them go down in shoals. The *he fish* always seeks his way down immediately after he spawns; but you will scarcely get a *she kelt* early in the season. You will get the *she fish* coming down in the months of March and April, *great numbers* of them; and you will scarcely get one he fish so late as that month; all the *he's* are coming down chiefly in the month of February," p. 139. Mr Johnstone declares, that the kelts " are found during the months of January, February, March, and April; and I believe some are found in May, but they get very scarce then," p. 36. Mr Little says, that, after spawning, " they remain a little time near the place, and then return again to the sea." With regard to the time they remain, he says, " that depends a good deal upon the season, whether it is a dry or a wet season: if it is dry weather they remain longer; but if it is wet weather, they soon go down to the sea," p. 108.

In the course of their descent to the sea, they experience *interruptions* from cruives and dam-dikes; but, when arrived at the place where the tide meets the river, they seem to pursue the deepest part of the channel or stream, and escape all the coble-nets and stake-nets of the *estuaries* and *sea-shore*. In reference to the stake-nets capturing kelts, Mr Bell declares they do not," p. 29. Mr Johnstone says of the stake-nets, " very few were ever caught in them;" and gives as the reason, " the kelts in the river are in a much narrower compass, and so are more subject to capture: they are seeking their way down to the sea, and generally prefer deep water; the water on the banks on which the stake-nets stood was very shallow; and generally by the time the fish came down so far from the river, the banks were getting dry by the tide leaving them. When the fish meet the flowing tide, they generally stop, the current being strong; the surf or agitation of the water, in the shallow waters on the banks of the friths, must also keep a weak, unhealthy fish like a kelt, from venturing on the banks; when it has not strength like a sound fish; the deep water is more suitable. I have often found them driven on shore dead, when they ventured on the banks; they were thus very seldom caught in the stake-nets, because they were seldom within reach; whereas in the river they had no means of escape," p. 43. Mr Halliday, in reference to the stake-nets of the Tay, declares, " I have fished some seasons, and have not seen above two kelts the whole season in the stake-nets."—I have not seen a single kelt in them all some seasons."—" Kelts do not generally resort to that particular part of the shore," p. 69. Mr Shepherd declares, that, during his survey of the river fishing in 1809, during the stake-net process in the Tay, he has seen foul fish taken in April, in the river fishings, but in the stake-nets " never but one," p. 102.

The station in the sea to which the kelts resort, yet remains to be discovered. Sir H. Davy says, " Salmon do not go far out to sea;" p. 145. How he has gained this information does not appear. Not surely from the proprietors of stake-nets on the sea-shore, for salmon seldom enter there, but from May to September;—not surely from cod and haddock fishers, for the bait which allures these fish tempts not the salmon. William Bell thinks that the fish that enter rivers from the sea " come from the north," (p. 33.); the very place, we may add, whence the older naturalists brought the herrings.

To return to the *spawning-bed*, we are compelled to record the injuries which it must sustain by the present practice of fishing. Mr Halliday, in reference to the coble-net (for the spawning-beds are remote from the stake-net grounds) as used in the winter and spring, says, "We have very strong ropes made of old nets, and with round circles of heavy rope lashed to the ground-rope of the net to keep it down; sometimes we tie stones to it to keep it to the bottom, and sometimes we put two cast-metal sinkers. It is generally in the spring that we require the heaviest weights at the bottom of the coble-nets, on account of the river being heavier or more full of water at that season. If thousands of fish should breed in the river, it would be impossible for spawn to come to perfection, where we are constantly fishing over them all the twenty-four hours with coble-nets."—"They usually fish the whole fords in the river from top to bottom at pleasure, with ground-ropes trailed along them;" p. 65. He has seen this process performed on the very places where "they use winches and capstans in the Tay; by which means they can add more weight to the bottom if they like." Though he never examined the river to determine whether the eggs were actually removed, yet he declares, "I have seen the under rope of the net level down the spawning-bed;" and he adds, with force, "You might just as soon have a bed of onions to come to perfection (as a spawning-bed), if a coble-net and rope was dragged over it, tearing up the mould twenty times a-day; I would take my chance of the one as soon as the other;" p. 66.

The *period* when the spawn evolves the fry, is stated by Mr Little to be when the natural warmth comes into the water in the month of March; "and they continue going down from that time until the first of May: sometimes I have observed them going down till the month of June; I have ssen some of them in the month of June, but they principally are out of the river early in May. The spawn does not come into life I consider till March;" p. 115. Even with regard to the time of the fish rising from the gravel, he says, "I have observed, when we have early warm weather, the fry come early; and when we have a late spring, it is later before the fry rise from the gravel; of course a great deal depends upon the season, but generally they begin to rise about the beginning of March, and they end about the middle of April in rising from the bed;" p. 109. Mr Halliday says, "I think they generally come into life the end of March, or from about the middle of March to the end of it; but I do not think they come all into life exactly at one time, but nearly so. Some of the fry appear to be much larger than others, and I do not see the young fish so plentiful at the sides of the water at the first as after some time;" p. 62. Sir H. Davy says, "It is stated that the eggs produce young ones in about six weeks," p. 145.;—an opinion rendered nugatory by viewing in connection the general period of the spawning and the general period of the appearance of the fry.

There is very little satisfactory information respecting the appearance of the fry at the time of their evolution. Mr Little says, "I never saw them in that state, but I have often conversed with other water-keepers on the subject, who are placed upon the upper branch of the rivers, and they describe them very much in the same way that Mr William Scott did when he was examined in the Tay case, that they rise from these gravel-beds like a crop of oats or thick breard of grain, rising up all round the stones in very great numbers. The tail comes up first, and they will come from these beds with a part of the pea about their heads;" p. 109. At such a period, the destruction occasioned by the heavy ground rope of the coble-nets must be truly great.

The progress of the fry from their birth-place to the sea, is given in detail by several witnesses, all of whom agree in the particulars. The fry, freed from the spawn, and now termed *smouts* or smolts, betake themselves to pools, and afterwards proceed, according to circumstances, in myriads along the easy water at the margin of the river, with their heads against the stream, until they reach the frith where the tide ebbs and flows, where, like the kelts, which frequently go down at the same time, they retire to the deepest part of the channel, and disappear in the sea. These facts were established upon oath by two competent witnesses in the Tay case, and their evidence is recorded in the Report, p. 92. The flooded state of the river is most favourable for their descent, by supplying depths of water on the shallows or fords. Mr Little says, " The Coleraine or Bann is a late fishery; and, in the year 1820, in the spring of that year, I considered we lost nearly all the fry; the dry spring did not allow them to come down the small rivers; they were collected into little pools, and the people in the country destroyed them; and in the end of that season of 1820 the fishing fell off to 42 tons;" p. 127.

The smouts descend during the months of March, April, May, and June. Mr Halliday states, " From the first time that I have observed them, about the end of March or beginning of April, they come down until about the 10th or 12th of May. I have seen them in the middle of May, and as late as June, in a particularly dry season, when the river had not been flooded;" p. 63. Mr Wilson says, " I think they commence going down about the end of April, and finish going down about May;" p. 10. James Sime, in his deposition in the Tay case, " believes that the fry goes down the river in the month of April;" p. 93. Mr Little declares, that "they are principally out of the river early in May;" p. 115. Mr Johnstone says, " They have generally reached the sea in the month of May. Some reach it in June; a few;" p. 36. While the fry are in the act of descending to the sea, they are exposed to many *enemies*, of which the following are the most destructive.

A. *Coble-nets.*—As these engines, according to the present practice, are in active operation during the period of the descent of the fry to the sea, we may expect such statements as the following. Mr Johnstone says, that smouts cannot pass through the coble-net, " if there be much dirt in it; and sometimes, particularly when there is a number of them, they get *broadside on;* in particular when there is salmon in the net, they prevent the fry from going through so easily; and the net is loose and not extended, more especially when near the edge of the water;" p. 40. Mr Halliday says, " I have dragged a number of them on shore with the coble-nets." " I have dragged them ashore at the Howe's Pool, on the River Annan; in the Bridge Pool at the Bridge of Annan, when the boys used to gather them up; and at the Old Mill Pool I have hauled out a good many;" p. 66.

B. *Angling.*—At first sight, one might suppose that the angler was an enemy of but feeble destructive powers. But it appears to be otherwise in fact. Mr Wilson says, " I have seen from my own window upwards of seventy or eighty people angling within the distance of half a mile on the Tweed;" p. 15. Mr Halliday declares, " I have killed above twenty dozen with the rod in one day;" p. 62. Mr Little says, "I have killed twenty or thirty dozen of fry, when coming from the school at Annan to Newby, in half an hour, with a rod in an afternoon," p. 121.; and he adds, "I have known even boys and children go and kill, in the course of an afternoon, twenty, thirty or forty dozen;" p. 132.

C. *Mill-races.*—Mr Jonhstone says, "I have seen hundreds of them lying dead at the bottom of a mill-race, killed by the wheel."—"I have seen them in thousands and tens of thousands, in the water in the mill-leads, seeking to go down, but prevented by the dike across the river, which they could not get over;" p. 40–41. Mr Halliday states, "I have seen the miller taking out his creel in the morning at the Newby mill, and taking baskets-full out of it; and I have seen great quantities lying dead in the dam behind the mill-wheel in the morning; I have also known the miller to put in a heck in the small side-sluice, by which means great quantities are destroyed in the night time, when they set the water of the wheel, through the side-sluice; there have been so many taken on some of the mills on the Annan, that sometimes they have fed their pigs with them; p. 67. The dam-dikes conduct the fry, when coming down the water, into the mill-dam, and when night comes on they do not see, and they seek their way down the dam, and so they go into the miller's heck or basket, and are all taken;" p. 67. Mr Little adds, "They are very destructive to the fry when they come down the river; they take amazing quantities as the fry go down; in dry seasons, when the waters are little, there is no other way for the fry to get down the little rivers than by going down the mill-lead; in fact, they can take all the fry that there are in the river at those mills. I have seen the water black in these mill-leads with fry, seeking down to the sea." "I know they take the fry in Ireland, and cure them like herrings;" p. 118.

D. *Eel-weirs.*—Mr Little says, "In Ireland the eel-fishery is very hurtful to the salmon fisheries. The eels are caught by weirs, set in the river for taking the eels going down to the sea; the eel-weirs are made of stake and wicker work, drawn together towards the centre, and the net, which is like a bag, is hung at the centre; the proper season of the eel-fishery is in the months of September, October, and November, *when the eels are going down to the sea to spawn;* but those who have eel-weirs place their nets in the river at the time the salmon-fry are going down: they do this under the pretence of catching eels, but really to catch the salmon-fry, which they catch and salt in some places in great quantities;" p. 118.

It has been alleged that stake-nets in estuaries and on the sea-shore are destructive to the salmon fry, and various questions are proposed by the Committee, with the view of eliciting the truth. The answers and documents produced, however, demonstrate that there is not even a vestige of foundation for the charge. The meshes of the stake-nets are too large to detain a smout, as, according to Mr Halliday, they are "about three inches from knot to knot, or twelve inches in the square;" p. 70. It has, however, been supposed, that the meshes may be so closed up by floating weeds, as to enable them to interrupt the fry. But Mr Halliday and other witnesses declare, "If the sea-weed were to close the net, it would be broken down. I have had the stakes broken, and the nets thrown down by the sea-weed, when the meshes were not near fully closed by it."—" I have seen where there was sea-weed left upon the net, that the tide would have taken away the very clay from the foot of the stakes two or three feet deep, and the salmon have frequently gone through below the net, and been lost when this has happened."—" But we cleaned them every tide, or otherwise the sea would break them down; but it was very seldom they were closed; it was only at the bottom of the net, and at certain seasons of the year, when the summer's growth comes up out of the sea, about the month of July (not a smout month), for a short period;" p. 70. On the supposition that the fry did frequent the stations of the stake-nets, these explanations would have been satisfactory. But the fry do not frequent the places where stake-nets can be erected. In reference to the Tay, Mr Johnstone declares, that he " never" saw a smout in a stake-net; p. 43. Of the presence of such in stake-nets, Mr Halliday also says, " never; and they could not be there without being seen by me; it was impossible;" p. 70. Mr Little declares, " A stake-net neither injures the breeding fish, nor does it destroy the spawn of the salmon or the fry; I speak from having attended those nets, and never having seen any salmon-fry in them;" p. 122. Mr Sime, and Mr Shepherd, who surveyed the stake-nets, on purpose, during the " Tay case," never found in any of them any salmon-fry; p. 92–93. They are not even taken by the spirlin-nets, which have a small mesh. In fact, not only are the stake-nets innocent of the charge of catching the fry, but even the coble-net in the estuary can do them no harm, as they are beyond its reach in the deep water. Hence Mr Sime and Mr Shepherd, though fishing with a small meshed net *on purpose*, *both* in the eddy water and in the stream, found none after the fry had reached the tide, *ib.*

The period of the return of the fry from the sea, seems not well determined; and on this interesting subject the evidence is very imperfect. Mr Wilson seems to think that, as grilse, " they return again at the end of June and the commencement of July."—" Perhaps from the end of June they will average three pounds, and at the end of July about four or five pounds;" p. 10. Mr Halliday says, " I think we do not see them again from the time they leave the river as fry, until the next year, early in the spring, when they begin to return to the rivers young salmon;" p. 87. Mr Little says, " I consider that what we call the fry that go down in the early part of the season, if they are allowed to go down to the sea, they return the same year; and that we kill them from three to nine or ten pounds weight;" p. 111.

The witnesses seem generally to agree with the prevailing opinion, " *That the salmon fisheries in the kingdom are rapidly decreasing in value, owing to the increasing scarcity of fish.*" But the importance which should be attached to this evidence, will be estimated differently according to the judgment of the reader. Mr Wilson communicates a statement of the number of boxes of fish shipped from the Tweed, or rather for the first thirteen miles from its mouth, from the year 1796 to 1823. In this table we perceive the very great fluctuations of the fisheries, *depending on the seasons*; the years 1796 and 1815, were as 9.338 to 9.382 boxes; yet 1776 was to 1797 as 9.338 to 12.665 boxes; and 1815 was to 1816 as 9.382 to 11.471. The year 1803 is less than 1819, and 1809 than 1819 or 1821, and but little higher than 1822 or 1823. The box of salmon previous to 1816, contained 6½ stones of fish, since that period it contains 8 and 12 stones. In this table the consumpt of the neighbourhood, or what is sent to a distance by carriers and coaches, is not noticed. Hence the table is useless as an index of the actual productiveness of the Tweed, though it may serve to illustrate the character of the exports of Berwick. Mr Bell says, that in all parts of the Tay, the fisheries have decreased, but no statement is produced, p. 20. J. Proudfoot says, "In 1815, 1816, 1817, and 1818, it was a tolerable fishery, and the year 1819 was rather inferior with me; perhaps it might not be less with some; and since 1820, we have had regular bad years successively." But in reference to the influence of the seasons in producing these changes, he says, "for the last two years they have not been so good," p. 26. In reference to the fishery in 1824, of May, compared with the corresponding period in 1823, he says, "I believe that this season there is more fish caught in the Tay, as yet, than last season," p. 33. There is a statement given by Mr Little, of the relative produce of his Irish fisheries, from the year 1808 to 1823: we shall give a few examples of intervals of ten years. The produce in tons of fish was at the Bann in 1808 and 1818, as 76 to 70; in 1809 to 1819, as 80 to 82; in 1812 to 1822, as 65 to 31; in 1813 to 1823, as 47 to 52. In the Bush fishery, 1808 is to 1818, as 16 to 12; 1809 to 1819, as 9 to 12; in 1812 to 1822, as 8 to 8; and in 1813 to 1823, as 7 to 14; in the Foyle, 1808 is to 1818 as 37 to 44; 1809 to 1819 as 36 to 58; 1812 to 1822, as 48 to 57; 1813 to 1823, as 35 to 50.—*Evidence, p.* 106. The statements, then, which have been adduced, as exhibiting the increasing scarcity of salmon, may be regarded as entire failures, nor shall we find, that the *causes assigned* constitute any better proof. These may be reduced to the following.

1. *Poaching.*—The quantity of fish caught by poachers, cannot be ascertained in a satisfactory manner; but the following facts throw considerable light on the subject. Mr Wilson declares, that "the number of fish taken in close time is immense." "I suppose many thousands have been taken out of the Tweed this last winter.—" The last winter the bailiffs took upwards of eighty nets out of the river in close-time. It has increased very much within the last three years." "The winters have been very mild, and they can perform those operations much easier in mild weather than when there is frost and snow on the ground, and there are more men out of employment;" p. 11. James Gillies declares, "In the year 1820, I saw 250 salmon lying in one cellar in Perth, in the month of September;" p. 135. "I have seen upwards of a hundred killed in one night;" p. 136. In reference to the Tweed, he says, "My brother killed in one night 400 of salmon and grilses and upwards, at one hawling-place;" p. 139. And he adds in reference to the facility of sale, "I never found any difficulty for any that I got; I always found a very ready market for them;" p. 135. And as to the buyers he says, "They had generally people that took them and kippered them, using salt-petre to make them red, and sent them from Perth to Edinburgh and Glasgow;" p. 136. The evidence indeed in this Report, indicates these poaching operations to be carried on both night and day, occasionally under the very windows of the houses of our nobility, the Castles of Duplin and Kinfauns, and the Palace of Scoon. Whore this poaching has been prevented, as it seems to have been done in the Moy at Ballina, Mr Little declares, "I consider that they had no protection for some years previous to 1816; by that protection it has risen from six tons to an average of sixty tons in a season;" p. 106. The same witness adds, "The Dublin

market is just as regularly supplied with salmon during the close-season, as it is at any season of the year;" p. 116. How far these facts bear out Sir H. Davy in his assertion, that "the great northern fisheries, and the Irish fisheries, are much less productive than formerly, (p. 145.), the reader must determine. But if we believe the opinion of Mr Little, in reference to the Solway, to be true, and extend it, as supported by the preceding evidence, to all the other great fisheries, "I believe I can prove, from the dealers in salmon in the neighbourhood of the Solway Frith, that there were more killed in these nets by poachers, during the winter season of last year, than was killed during the proper season for killing salmon;" then must we conclude, that salmon are as abundant as ever, but poachers now enjoy a greater share than formerly, to the injury of the legal fisher.

2. *Stake-nets.*—This part of the evidence assumes three very different aspects. The river fisheries are said to have decreased, in consequence of the operation of the stake-nets in the estuaries and on the shore. The evidence on this subject exclusively refers to the Murray Frith, and the Frith of Tay. In reference to the Tweed, the decrease cannot be owing to stake-nets, for there they do not exist, (Mr Wilson says "Never; there is not a stake-net within fifty miles of the Tweed;" p. 12.); but the other supposed causes of decrease which exist there, likewise prevail elsewhere. In reference to the Beauly, Mr Wilson declares, that "it has decreased considerably," owing "to the stake-nets and yairs in the Murray Frith;" p. 16. With these stake-nets he acknowledges himself very little acquainted, and ignorant of the breadth of the frith where they are placed, or of the quantity of fish which are caught in them. The evidence of the *decrease* is of a very doubtful character. "I have seen in the books 7000 salmon taken in the Beauly, and I have seen only 1500 or 1600 in a year." But, in reference to the quantity taken last year, he says, "I think between 2000 and 3000 salmon, and about 6000 grilse." Even the rent in 1814 was increased to L. 50 a-year. His uncle, the lessee, in regard to the concern, has "not a very material interest, for Lovat would take the fishery of his hand when he pleases." Lovat, last year, gave an abatement of 20 per cent., and the lessee is to pay a share of the expence of a law-suit against the owners of the stake-nets." "Mr Berry is the only tenant of the river; he sends his own fishermen, that are employed in the summer, to protect the river in winter;" p. 16–18.

Not more satisfactory is the evidence to prove the destructive tendency of the stake-nets on the river-fishing in the Tay. The general decrease of the Tay is distinctly avowed by Mr Bell; and, while he admits the destruction occasioned by poaching, and killing fry, he seems inclined to refer the evil chiefly to *the erection of stake-nets*, formerly in the estuary, and now only on the sea-shore. When the stake-nets were erected in the frith, it is here asserted that the river fisheries fell off in quantity; that when these were removed, the river fisheries increased. No evidence, uufortunately, is produced to confirm this statement. And it may be mentioned, as a singular circumstance, that, in the process before the Court of Session, the proof of the decrease of the river fisheries was considered by several of the Judges as too imperfect to warrant such an inference, and by none as amounting to demonstration. The evidence for the injury sustained at present by the sea-shore stake-nets, amounts to nothing. Thomas Proudfoot considers the stake-nets set up at Montrose as the cause of the decrease in the river Tay; they "take a great many of the fish that would come into the Tay," p. 24.; but he is ignorant of the distance of these nets from the Tay; yet he believes they are destructive, because, in his opinion, the fish come from the north-east coast. Mr Bell considers that stake-nets on the shore of the Forth at Ely, would injure the Tay fishings; p. 52. In the absence of all proof, from the returns of river fisheries, we are here presented with some notices of the rents, as illustrating the injury occasioned by the stake-nets. But it appears that Lord Gray's fishing, before the erection of stake-nets, either in an estuary or upon the shore, was £3000, and that it is now between £3500 and £3700. In the interval, it has been as low as £1205; p. 26. Mr Halliday declares, "When I first came to the Tay, the rents of the upper fisheries were then about £4000 a-year for fifteen of the principal fisheries; and during the time of the stake-nets in the Tay, twelve of these fishings rented for above £6000 Sterling per annum." In reference to the cause of the reduction in Lord Gray's fishings, he states, "Because the upper fishers had joined together, and fished them jointly; before that, there was a separation of companies at Perth, but Mr Bell and Mr Richardson's people fished their fishings together as one company; after that, there was nobody there to oppose them; before that time Mr Bell and Mr Richardson were two opposite companies;" p. 71.

The evidence of a decrease in the Frith of Tay from the *abolition of stake-nets*, is of a more unequivocal kind. Mr Halliday states, that the total produce of the Tay when the stake-nets were in operation, amounted to between 50,000 and 60,000 salmon; and he says, "I do not believe the Tay has produced, since the discontinuance of the stake-nets, more than from 26,000 to 28,000 or 29,000;" p. 71. Mr Johnstone says, "Some of the properties that produced 2000 or 3000 salmon, and even 4000 a-year, are now not fished at all;" p. 42. Before the use of stake-nets, he says that the river fisheries produced annually about 30,000 salmon, and the frith fisheries about 4000; but that, by the use of stake-nets, the frith fishery rose to 30,000. It follows that, since 1812, 26,000 salmon, besides grilses, have annually been lost to the public.

The *increase* in the produce of the fisheries in those places where stake-nets have been erected, is equally manifest. Mr Johnstone says, "I have caught above 500 salmon and grilses in *one stake-net*, and at *one time*, far from any river;" p. 47. "We have caught thousands going away from the nearest river, the Findhorn;" p. 48. In the Esk at Musselburgh, Mr Halliday declares, that had he no stake-net, he would lose four or five hundred fish every year; p. 76. He says of one in the Forth, "I think the first tide after it was put up, we had about twenty-eight or twenty-nine salmon and grilses in it;" p. 77.

3. *Increase of natural foes.*—These are limited in the evidence to seals and grampuses. In regard to the *seals*, Mr Johnstone says, "I have often counted between fifty and sixty seals that lie a little from my house summer and winter. That they feed on the salmon is ascertained. "I have seen them chasing, catching, and eating them;" p. 47. Mr Halliday says, "I have observed from sixty to eighty seals in one flock, and I have seen three or four flocks

within my view at Balmerino;" p. 74. "I have known one seal take six or eight fish in the course of two hours and a half;" p. 75. The grampuses appear in April, and continue till October. They go up and down with the tide. "There are some hundreds," p. 47. Mr Halliday says, "I have seen as much salmon in the stomach of a porpoise (grampuses are so called in the Tay) as a man could lift;" p. 76. In reference to the quantity of salmon consumed by these mammalia, he says, "I have often thought that they destroyed four or five times more than all the fishermen of the Tay;" p. 75. Since the removal of the stake-nets, these depredators have increased; p. 47. 75. Mr Little states, that there are few seals in the Solway (where there are stake-nets), but that they are numerous in Ireland. The grampuses are in all the sea-coasts around Scotland and Ireland. It is indeed probable, that, in the United Kingdom Seas, grampuses devour many more salmon than the inhabitants.

4. *Cultivation of the Land.*—Mr Halliday says, "Since the lands have been so much drained, the rivers fall in so fast, that fish cannot get up to the *higher parts* of the river so freely as formerly," p. 82; and Mr Little says, "I consider that the draining of the land in Scotland has been as injurious to the fishings as the limeing of it. Formerly the small waters, in consequence of the rains remaining long in the land and in the marshes, were a length of time in rising and falling; now they get up very rapidly, and fall very rapidly. The salmon, when they go up those little rivers to breed, deposit the spawn; and, at a season of the year when the spawn ought to rise from the gravel, it is left dry;" p. 117. These remarks can only apply to the lower and smaller streams of our estuaries which flow through the cultivated districts, insignificant as salmon breeders, but are inapplicable to the higher branches of our principal rivers, which are fed by the mountains. What drainage has taken place in the Grampians, the Lammermuirs, or the Cheviots?

Having thus stated the facts in the natural history of the salmon detailed in this Report, and the evils prevailing in our fisheries, it is time to advert to the *changes* in our fishing system which seem to be requisite.

1. *Close time.*—The evidence contained in this Report demonstrates the inexpediency of permitting the fishing-season in *rivers* to commence before the 1st of May. In April, *the fry* are descending in "tens of thousands," and must be destroyed by the coble-net in great quantities, if used at all. The size of the mesh cannot prevent this destruction, since it becomes oblique while drawing on shore, and the net passes into folds. But the fry are not the only sufferers. The *kelts* are likewise captured; and as the *females* usually descend at this period, their death must be unavoidable. Even in May, both fry and kelts may be destroyed, but the quantity would bear but a small

proportion to those which had previously reached the sea. The fishing-season should terminate on the 1st of August. This is the month when the *red* fish, or those ready to spawn, begin to become numerous. The condition of the rivers, in reference to floods, varying in different seasons, the fishing-season should be rather *early* than late, to secure *always* an abundant supply of *breeding fish.* Were it not for the *habits* of the river proprietors, strengthened by their *vested rights,* the Legislature should *prevent all fishings in rivers,* as the breeding-ground of salmon, where the fish execute the duties of parturition, and where the young are hatched, but where at present the mother is surprised and taken in her weakness, and her progeny meet an untimely death.

In *estuaries,* and on the *sea-shore,* fishing may be practised at *all seasons,* as in such situations neither red fish, kelts, nor fry, are found. But there is one objection to this freedom, warranted by the habits of the fish.

The fishing-season should begin and end, in all parts of the kingdom, on *the same day.* It is true, that the condition of the fish varies with the seasons, in different rivers, and in different parts of the same river. But no law could accommodate itself to these variable circumstances. Experience here points out the remedy, having established the nature of the disease. Unless there be *one* time, poaching will prevail in the *close rivers,* and the produce will, in the market, compete with the fish from the open rivers. No statute could prevent this smuggling.

2. *Establishment of Stake-nets in Estuaries, and on the Sea-shore.*—It has been demonstrated in this Report, that stake-nets do not injure the *fry,* and do not capture *red* fish or kelts. They are the only efficient engine in estuaries and the sea-shore (but from their nature not more so than the coble-net in rivers), and greatly increase the value of the fisheries at those stations. They do not injure the river-fishings, because they catch fish not inclined to enter rivers, and at a season when the rivers are in an unfit state to receive them. They capture the fish which would otherwise fall a prey to seals and grampuses, and they serve to reduce the numbers of these depredators. They are useful in the estuaries, to the shipping as marks, (pp. 50. 79.

103. 126.); they employ many hands, (pp. 51. 80. 123.); they educate expert seamen, (pp. 51. 81. 104.)

Sir H. Davy assuming (though destroyed in the evidence) that salmon belong in fact to the river in which they were spawned, affect a particular river, and always return to it, declares, " As *the old law* of the country was framed upon this principle, salmon-fisheries never having been considered as belonging to *the coast*, all stake-nets should be abolished, as they enable persons having no interest in the river to cut off almost entirely the supply of fish;" p. 145. Without entering into the rather singular dispute in political economy,—whether British subjects should be fed with salmon, or the preference given to seals and grampuses,—we shall rather advert to the *law* and the *reason*, as laid down by the latter, in reference to stake-nets. Had Sir Humphry Davy ever *examined* the *old law* on the subject, he never could have risked such a groundless *assertion*. In *Magna Charta*, he will find these words: "Omnes *kidelli* (wears, or stake-nets, Coke and Court of Session) deponantur de cetero penitus per Thamesiam et Medweyam, et per totam Angliam, *nisi per costeram maris*." He will find in 9th Henry III. c. 23. " All wears from henceforth shall be utterly put down by Thames and Medway, and through all England, *but only by the sea-coasts*." And in 12th Edward IV. c. 7. " that all kidels by Thames and Medway, and throughout the realm of England, should be taken away (sinoun per les coaster del mear) *saving by the sea-banks*." In the statute of Robert I. of Scotland, 1318, c. 12. every thing in reference to wears or fixtures applies to these, " in *aquis* ubi mare fluit et refluit;" or, as it is expressed in the act 1424, c. 11. of King James I. " in *fresche watteris* quhar the sea fillis and ebbs." It hence appears, in opposition to Sir Humphry Davy's statement, that stake-nets, or engines similar to *stake-nets, were permitted on the sea-coast by the old law of the country*, though prohibited elsewhere. The *reason* given, that, by stake-nets, persons having no *interest* in the salmon, cut off the supply from the river heritors, to whom in fact they belong, will be found equally untenable. Let us see to what conclusion it would naturally lead us. If stake-net fishings, in estuaries and on the shore, should be abolished, because fish are taken in these which belong to the place " in which they were spawned," then no fishings should be allowed, *even in a river*, below the lowest *spawning-ford*, such as Lord Gray's, where there is no spawning-ground. Again, upon the same principle, no fishing should be allowed, even at the lowest spawning-ford, because the proprietor may capture fish there in which he has no interest, which were not spawned on his ground, but which in fact belong to a higher ford. Hence, the Town of Perth should not be permitted to fish their fords, least they catch (as they would do) salmon belonging to the spawning-fords of his Grace of Athole. The *proprietor of the uppermost spawning-ford* is alone safe from this objection (though a straggler from a lower ford would occasionally find its way into his net), and *should be the only fisher in the river*,—a conclusion which the deservedly celebrated individual did not probably anticipate. It seems necessary to speak freely, lest the influence of *name* should give currency to mistake.

The determination of the *stations* where stake-nets may with propriety be erected, near the mouths of rivers, seems not as yet to have occupied much of the attention of the Committee. Mr Little, indeed, is the only witness who delivers his opinion on the subject. He assumes, as had been proven in the Tay case by that acute engineer Mr Jardine, that the *river* ends at that *point* in the head of a frith where the sea is continually ebbing or flowing, or, to speak plainly, at *low-water mark;* and he says, " above that place, or within half a mile from it, down the estuary, or along the coast, no stake-nets should be allowed;" p. 123. This *point*, we may observe, must vary more or less in different rivers, from the mean level of the ocean, according to the size of the aperture or mouth of the estuary through which the tide enters and retires, and the quantity of water in the river opposed to it. A slight difference must likewise prevail between the low-water of spring-tides and of neap-tides, though Mr Jardine has proven, that the horizontal lines representing these gradually approximate in retiring from the mouth of an estuary to its head. But these differences do not perhaps deserve any very serious consideration. Indeed, we see no objection to the use of *stake-nets every where below this point.* The fry and the kelts would not be taken by them, and as the channel or stream would be clear, no fish intent on ascending would be prevented. But it does not appear upon what principle Mr Little wishes to have half a mile, any more than ten miles, kept clear of stake-nets. No two rivers are alike. The *half mile* would have very different *powers*, in those rivers which have intervening estuaries, and in such as enter the sea directly. The Spey and the Tweed would be placed in different circumstances from the Tay and the Forth. Besides, by such a rule, the proprietor of a small stream joining the sea directly, would have it in his power to injure the property of his neighbours, through an extent of a mile of coast, by preventing the erection of stake-nets, and probably in the only bay or spot for twenty miles where they could conveniently be placed. We again repeat, that stake-nets could do no injury to fry and foul fish, if not erected in rivers or friths higher than low-water mark. Above this point, the net and coble is an efficient engine; below this point it possesses but feeble powers. Above this point, the stake-net would interfere with the channel or stream; below this point, it could only capture fish floating with the tide. Proprietors would thus be able to avail themselves of the natural advantages of their respective estates, without injury to others.

3. *Removal of Obstructions.*—Under this head, the condition of dam-dikes deserves the consideration of the Legislature. Openings should be made, through which the water may flow at stated periods, so as to allow of the ascent of red fish, and the descent of kelts and fry to the sea; p. 119. In reference to the destruction of fry at mills, the following recommendation by Mr Halliday merits consideration: "Placing a heck across the narrow part of the dam, and making a sluice through the dam-dike, at the upper side of the heck, would allow the fry to pass down the sluice into the bed of the river, and the heck would prevent the fry going down the mill-dam."—"If the heck was properly constructed, by placing it slanting, the under part of it inclining up the water, and the upper part of it down, it would raise all the dirt to the surface of the water;" p. 67. No wicker-work, or any similar obstruction, should be allowed to remain on stake-nets or cruives during the close season. The river should be free.

4. *Punishment of Poachers.*—Many laws occur in the statute-book on this subject, but they seem to be inapplicable. Hence, even the appointment of water-bailiffs is not successful in pre-

serving the fisheries during the close season. Mr Wilson says, "at this very time we are expending about L. 600 a-year for the protection of the Tweed, and to very little purpose;" p. 11. Premiums should be offered to encourage fishers to destroy seals, grampuses, and even porpoises, as the latter probably devour the fry.

Judging from the evidence contained in this Report, we have no hesitation in asserting, that were *the limits of close time determined by the habits of the fish*, stake-nets erected in suitable stations, obstructions removed, and poaching checked, our rivers and shores may be made to yield four times more salmon than they do at present, and the increase of the breed be promoted. We trust the Committee will resume its labours this session of Parliament; and, should the results be as interesting as the present Report, we may feel disposed to lay a digest of the evidence again before our readers.

Feb. 17. 1825.

Art. XVIII.—*An Essay on the Composition of the Ancient Earthen Vases, commonly known by the name of Etruscan.* Read before the Royal Society of Göttingen. By Professor Hausmann.—(Translated from the Latin *).

The ancient painted vases, chiefly dug up in many districts of Lower Italy, have excited much interest among the learned and the admirers of ancient art. While the elegance and diversity of their forms, together with the singularity and boldness of their figures, delight the eye of the beholder, the variety of design and subject in the paintings with which they are decorated, equally conduce to the illustration of mythology, history and ancient art. The investigation of these paintings has already contributed in no small degree to improve our knowledge of antiquity; nor has the imitation of the forms of those vases been less a source of profit as applied to the art of pottery.

* A copy of this interesting memoir, published by the Royal Society of Göttingen, was sent by the Author for insertion in the Journal.

The famous Wedgwood-ware owes its celebrity as much to the successful imitation of the forms of those vases as to the excellence of its material. In like manner, the beautiful ornaments observed upon these vases, have, in our times, been transferred to the subjects of many other arts; and have been employed for the decoration of buildings, rooms, furniture, articles of dress, and other works of luxury; insomuch, that antique forms have become so common in modern art, that their origin has been nearly forgotten. Although ancient art has, in this manner, made its way into the shops of potters and other artificers, and even into our drawing-rooms, yet the scientific study of technology, and the history of the mechanical and chemical arts, have hitherto been little advanced by the investigation of those ancient vases. In the writings of the ancients we scarcely find any passages in which positive mention is made of them; and none, in so far as I know, where their composition is spoken of. This point, therefore, can only be ascertained by an accurate examination of the vases themselves. During a journey which I made last year through Italy, I had opportunities of examining the splendid collections of those vases which adorn the museums of Florence, Rome, and Naples. The pleasure derived from this investigation was much augmented by some observations which it suggested to me regarding their composition. The little that I have learned with regard to this subject, either during my journey or from subsequent observations and experiments, I shall endeavour to expose in the following essay.

Sect. I. *Of the Vases, commonly called Etruscan, in general.*—We shall confine ourselves to the vases commonly called *Etruscan*, although the greater part of them are not of *Etruscan* but of *Grecian* origin. The celebrated *Winkelmann* was the first who refuted the opinion chiefly supported by *Gorius* and *Buonarotti*, that these painted vases of pottery-ware had been manufactured in ancient Etruria *. But although it cannot be denied that the greatest quantity of vases has been dug up in those parts of Italy and Sicily which were formerly inha-

* Geschichte der Kunst, p. 193. et seq.

bited by the Greeks, nor that the style of their paintings and their inscriptions sufficiently demonstrate their Grecian origin; yet it is probable, that the art of fabricating painted vessels of earthen-ware was not confined to that portion of Italy, but also extended to other districts, since, in many places remote from it, vases of the same general description have been dug up, which, however, possess so much diversity of character, with regard to their forms and paintings, as to induce the inference, that they had not been transmitted to those parts by commerce. Nor was this art confined to ancient Italy alone, but was also practised in Greece *, and thence made its way into some of the neighbouring districts of Pontus †. The painted vases found in these countries are essentially the same as those discovered in Italy.

The vases found in different parts and situations of Italy differ more or less from each other, both with respect to the quality of their material, and to the workmanship and style of painting; the cause of which difference is to be sought for in the different natural qualities of the materials, or in a different degree of perfection in the art. For the art of forming vases of pottery-ware, and of ornamenting them with paintings, may not only have existed in various degrees of perfection in different places at the same time, but the state of this art had also, without doubt, been very different at different periods. And not only have earthen vases of very different degrees of fineness been manufactured at the same time and in the same places, but also plain vases, without any paintings, in all other essential respects agreeing with the painted ones, and destined for the same general purposes.

Of the painted earthen vases, dug up in different parts of Italy, those found in Lower Italy and Sicily are the finest. The best of all, however, are those found at *Nola*, both in respect to the excellence of their materials, and the elegance of their forms, together with the beauty of the paintings and the lustre of their varnish-like coating. Many of them are so perfectly preserved,

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* Clarke's Travels, vol. iv.—Walpole Memoirs. 2d Edit.—Antiq. of Athens, p. 322.—Ritter's Vorhalle Europäischer Völkergeschichten von Herodotus, p. 232.

† Ritter, as above, p. 231.

that you might imagine them newly made. Next to the Nola vases, are those of Locria and Agrigentum. Many vases have also been found near Pestum, the ancient Capua (now S. Maria di Capua), Sancta Agatha Sothorum, Trebbia, Aversa, Avella, Tarentum, and in some other places of *Apulia*, and of the Neapolitan province named *Abruzzo*, the greater number of which are remarkable for their beauty. Of late years, vases have also been dug up in the vicinity of the cities of *Angi* and *Pomarico* in *Calabria**. The largest and best collection of vases, found in these and other places of Lower Italy and Sicily, arranged most elegantly and in the best order, is preserved in the Royal Museum of Naples; this collection has, of late, been much enlarged by the purchase of the extensive one made at Nola, belonging to the family of *Vizenzio*. Of the private collections at Naples, the most remarkable is that of the Archbishop of Tarentum, which is preserved at his seat near Portici, elegantly adorned with the choicest works of ancient and modern art; and what renders this collection still more deserving of attention is, that it is illustrated by a learned description drawn up by its accomplished proprietor himself. A great number of vases, dug up in Lower Italy, have also been deposited in the Vatican Library at Rome, and the public Museum of Florence.

In the middle part of Italy painted vases have been found much more rarely. In some places of ancient Etruria, as for example, near *Voltena* and the cities of *Chiusi*, *Viterbo*, and *Corneto*, a few were formerly dug up, some of which are preserved in the Florentine Museum †. The true Etruscan vases may be distinguished from others by the inferior quality of their materials, by the dulness of their coating, but especially by the greater rudeness of their forms and painting, as well as by certain characters of the representations peculiar to the ancient Etruscan art ‡. These differences may be very clearly seen in

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* Millingen, Peintures ant. et inéd. de Vases Grecs, p. vii.

† *Fea* ad *Winkelmannum*, t. i. p. 215.—*Meyer* in *Boettiger's* work, entitled *Griechische Vasengemalge*, i. ii. p. 5. 20.—Peintures de vases antiques vulgairement appellés Etrusques, gravées par A. *Clener*; accomp. d'Explications par A. L. Millin. 1808. vol. i. p. 6. note 34.

‡ *Lanzi* de vasi antichi dipuiti, volgarmente chiamati Etruschi. Dissertazioni tre. p. 23.

the Florentine Collection, where authentic Etruscan vases are placed in the same apartment with others of Grecian origin. In the great collection at Naples, I was shown only a single mutilated true Etruscan vase.

No vestiges of ancient painted vases have, in so far as I know, been found in Italy to the north of the Appenines. Those which are preserved in the Museums of *Bononia*, *Turin*, and other cities of northern Italy, have migrated into those parts from southern Italy.

It is not my design, in this treatise, to institute any inquiry into the periods at which these vases were manufactured, not only because investigations have already been made with respect to this point by many authors of great learning, but especially also because the settlement of it would involve an examination, entirely foreign to my views, of the various inscriptions observed on those vases, as well as of the subjects and characters of the paintings. It is undoubtedly more easy to discover the period up to which these vases may have been fabricated, than the time at which the art, commonly considered as of Grecian invention, but assuredly possessed of claims to a much higher antiquity *, took its origin. It seems not improbable, that the latest period at which these vessels were manufactured in Italy, was the time of the civil wars †. The Roman vases, of later periods, dug up in many parts of Italy, as at *Nola*, *Pompeii* and *Rome*, have a very different character. They have no paintings, but are frequently ornamented with raised figures, and usually have a red coating; characters which are also observed in the Roman vases dug up in some parts of Germany and France.

To a later period also belong the vases dug up in great quantity near *Aretium*, so far down as the time of *Vasarius* ‡, many of which are preserved in the Florentine Museum. These vases have a red or blackish coating, and, in other respects, are of similar composition with the older Etruscan vases §, with which they are sometimes confounded. It seems not improbable, that they belong to the *Aretine* vases, so highly esteemed in ancient times,

* Ritter, l. cit. p. 230.

† Millingen, Peintures antiques, p. 8.

‡ Lanzi, l. c. p. 39.

§ Ibid. p. 37.

which have been praised by *Martial* *, and taken notice of by *Pliny* † and *Isidorus*, although it is difficult to arrive at any certainty with regard to this point ‡.

The painted earthen vessels of Grecian origin, which have been found in Lower Italy, seem to be of different ages. According to the opinion of the celebrated *Millingen* and some other antiquarians, an opinion which seems to be well grounded, the vases commonly, but incorrectly, called *Egyptian*, whose paintings are of a dusky red colour upon a yellow ground, in which condition some vases have also been dug up in Greece, are the most ancient. The vases, commonly called *Sicilian*, which have black paintings upon a reddish yellow ground, are, accord ing to the same opinion, less ancient, but more so than the vases with reddish-yellow figures and ornaments upon a black ground, which are the most common of all ||. This opinion has indeed been lately opposed by the celebrated *Rossi*, who has shown the vases with black figures to be of the same age with the rest ¶: his arguments, however, do not seem to invalidate the former opinion **.

Many vases, either having no paintings at all, or, instead of figures, having other singular ornaments, have been dug up, both along with painted vases and by themselves, not only in Lower Italy, but also in ancient Etruria, which have either the natural colour of burnt clay, or a black coating, or have been manufactured of clay evidently mixed with some black matter. The ornaments upon the black vases are very frequently of a white colour, sometimes yellow or red. Not only the forms, but also the colours, of the black coating and ornaments, as well as the other circumstances, correspond with those which are observed in vases adorned with more perfect and more complex paintings; from which it may be supposed that these ruder and less elegant vases are of the same age and manufacture with those more beautiful productions of art, which, without doubt,

* Lib. xiv. Ep. 98. † Hist. Nat. Lib. xxxv. cap. 12.
‡ Origin. 1. xx, cap. 4.
§ *Meyer* in *Boettinger's* work, Griechische Vasengemälde, 1. 2, p. 17.
|| *Millengen*, Peintures Antiques de Vases Grecs, p. iv. v.
¶ Ibid. Third letter addressed to M, Millingen by the Chev. *Rossi.*
** Gottingische gelehrte Anzeign, 1820, p. 739.

were more highly esteemed in ancient, as they are in modern times.

The vases dug up in Lower Italy are found in Grecian sepulchres more or less concealed beneath the surface of the ground, and constructed of stone in a rectangular form, placed near the remains of the dead body, and sometimes also suspended upon the walls; as is clearly shewn by the excellent representations delineated by Knipius, added to Teischbein's plates of vases, as well as by the accurately executed models exposed in the royal collection of vases at Naples. Many vases are often found in the same sepulchre, of various sizes and qualities. Some of these sepulchres, which are small, and constructed of rough stones, usually contain a smaller number of a coarser kind. In other sepulchres of larger size, constructed of hewn stones, and covered over with slabs like the roof of a house, some of which I have seen before the gates of the ancient Pæstum, vases of superior quality are found in greater number *. Sometimes they occur in their original position, and in a perfect state of preservation; at other times, however, they are crushed and destroyed. Some of them have retained in a surprising degree their polish and original colours; others, especially those dug up in moist places, are slightly incrusted with a white calcareous substance, easily soluble in acids, which has probably been precipitated upon them from the water that had penetrated through the walls of the sepulchre. This preservation of vases, constructed at so remote a period, of such frail materials, and with so thin a coating, is a subject of much interest, and not less than the perfection of the art as practised by the ancients, invites to the investigation of their mode of formation.

We shall endeavour to distribute the most ancient earthenware vases, whether Greek or Etruscan, according to their mode of composition, into classes, for the purpose of obtaining a more distinct perception of their varieties.

We shall place in the *first class* those vases in which the colour of the clay is natural, without glaze or other coating, or painting. Of this kind are some vases which were dug up at

* *Hamilton* in Boettiger's Work cited above, I. 1. p. 34.

Cumæ, as well as near *S. Agatha Sothorum*, along with others of a black colour *.

In the *second class*, we shall place those in which the natural colour of the clay is somewhat heightened by their having a very thin glaze or coating †.

To the *third class*, belong those vases which have been manufactured of clay intermixed with black matter. These vases are found, either simple, that is, without ornaments and paintings; or decorated with ornaments, either impressed or in relief; or they are painted with a white or yellowish colour. Of this description are many of the vases dug up, not only in Lower Italy, but also in the districts of ancient Etruria.

To the *fourth class* belong those vases whose clay is evidently covered over with a black glaze or coating. Like those of the third class, they are either simple, or with ornaments either impressed, or painted with a white, yellowish, or red covering.

The *fifth class* may contain those vases, in which, upon a basis of clay, either of the natural colour, or with a somewhat brighter glaze, there are ornaments or painted figures of a black colour, sometimes with impressed lines. These vases, which have been dug up in various places, although they commonly go by the name of *Sicilian*, are either simply painted with black, or ornamented with figures, in which the red and white colours are covered over with black; of which kind some exquisite vases have been found, as for example in the vicinity of Pæstum.

To the *sixth class* we shall refer those painted vases, the most common of all, which have figures and ornaments either of the natural colour of clay or somewhat heightened, the general ground, however, and some lines, being black: some of them are of more simple construction, others are ornamented with white, red, yellowish or dusky colours.

The *seventh class* includes those vases of rarer occurrence, in which the ground is black, and the figures which are red are laid

* Sul metodo degli Antichi nel dipingere i vasi. Due Lettere del Canonico *Andrea de Jorio* al Sig. Cav. M. Galdi, p. 4.

† *Jorio*, loc. cit. p. 8.

upon a white colour covering the black, the lines being impressed so as to penetrate to the black ground *.

The *eighth class* we shall appropriate to those very rare vases, commonly but falsely called *Egyptian*, in which the ground is yellowish, and the paintings of a coffee-colour, which, however, does not cover the ground perfectly, there being sometimes a covering of white and red colours. These vases, found in Lower Italy, correspond, in so far as regards the colour of the clay and paintings, with others discovered in Greece, one of which, that had been dug up at *Athens*, is preserved in the Museum of our University, having been presented to it by the celebrated English traveller *Hawkins*.

(*To be continued.*)

Art. XIX.—*On the Theoretical Principles and Power of Brown's Gas Machine.* By Thomas Tredgold, Civil Engineer, &c.

When a machine is proposed to the public as likely to rival the steam-engine in power and economy, it becomes necessary to investigate its principles, in order to be able to give an answer to the inquiries of one's employers; and as the subject is of public interest, perhaps a view of the method I followed in the investigation of the power and expence to produce a given effect with Mr Brown's gas machine, may not be wholly uninteresting to your readers.

The power of this machine is evidently owing to the air in the cylinder being rarified by the combustion of gas within it. A similar effect is produced by burning some very inflammable paper under an inverted bell glass, and letting it down, when full of flame, into a vessel of water; the water immediately rises within the glass, and condenses the rarified air it contained to about one-third of its volume.

Now, let us suppose the temperature of the water used for condensation to be 50 degrees, and let t be the temperature of the

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* *Jorio*, loc. cit. p. 5.

heated air and vapour in the cylinder, when the condensation takes place, then, $\frac{450+t}{500}$ = the volume of the air when heated, its volume at 50° being unity *; and the force of air being inversely as the space it occupies, taking the pressure of the atmosphere at 30 inches, we have,

$1 : \frac{500}{450+t} :: 30 : 30\left(\frac{500}{450+t}\right)$ = the resistance of the contents of the cylinder when cooled to 50°: consequently

$30\left(1-\frac{500}{450+t}\right)$ = the power in inches of mercury without reduction for friction.

Put g = the grains of combustible matter that will heat one cubic foot of water one degree; and as 0.00035 is the specific heat of air when that of an equal volume of water is unity †, $0.00035\, g\, t$ will heat one cubic foot of air t degrees; and if w be the weight of a cubic foot of the gas or combustible in grains, we have $\frac{0.00035\, g\, t}{w}$ = the volume of gas that will heat the air in the cylinder when its capacity is denoted by unity.

There will be a loss of heat in warming the cylinder, and the solid matter against which the flame and heated air must act at every stroke; these causes of loss I will not attempt to estimate, but proceed to compare the gas machine with the steam-engine.

The volume of steam produced by a bushel of coals (84 lb.) is 14,700 cubic feet, which, when condensed, gives a pressure equivalent to 26 inches of mercury on the piston. We have found the pressure on the piston in the gas cylinder to be $30\left(1-\frac{500}{450+t}\right)$ inches of mercury, under similar circumstances; therefore, that the powers may be equal, and x be the volume of air to be heated to produce the same effect, we must have $14700 \times 26 = 30\,x\left(1-\frac{500}{450+t}\right)$; or,

$$\frac{14700 \times 26}{30\left(1-\frac{500}{450+t}\right)} = x.$$

* *Principles of Warming and Ventilating*, 2d edit. p. 285.

† *Idem*, p. 281.

But, by our preceding calculation $\frac{0.00035\,g\,t\,x}{w}$ = the quantity of gas that will heat the volume x of air; whence, $\frac{14700 \times 26 \times 0.00035\,t\,g}{30\,w\left(1 - \frac{500}{450+t}\right)}$ = the cubic feet of gas that will produce the same power as a bushel of coals. This equation reduces to $\frac{4.459\,t\,g\,(450+t)}{w\,(t-50)}$.

But there is obviously a value of t which gives a maximum effect, or rather a minimum consumption of gas; therefore, considering t variable and making the fluxion of this expression equal to zero, we find $t = 208$ degrees. If this value of t be inserted, the expression becomes $\frac{3862 \times g}{w}$ = the cubic feet of gas that will produce the same effect as a bushel of coals.

If pure olefiant gas be used, we have, from Mr Dalton's experiments* $g = 35.7$ grains; and, according to Dr Thomson's table†, $w = 513.3$ grains; hence, $\frac{3862 \times g}{w} = 270$ cubic feet of gas; from whence we may conclude that 270 feet of the best oil-gas at the expence of somewhat more than 10s., at the Edinburgh price, will be required to do the same work as may be done by one bushel of Newcastle coals.

For carburetted hydrogen gas, $g = 36.75$ grains, and $w = 291.4$ grains from the same authorities; consequently, $\frac{3862 \times g}{w} = 482$ cubic feet; and, suppose coal-gas capable of producing the same effect, then at the Edinburgh price, 482 feet of coal-gas will cost 5s. 9d., and produce no more power than a bushel of Newcastle coals.

I have made the comparison with the effect produced by a bushel of coals, because that quantity is about equivalent to the day's work of a horse; that is, a bushel of Newcastle coals per day is a sufficient quantity for each horse-power of a steam-engine, and the engine day's work is ten hours, while a horse works only eight hours.

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* *Dr Thomson's System of Chemistry*, vol. i. p. 148. 5th edition.

† *Idem*, vol. iii. p. 25.

The calculations are made for the temperature which affords the greatest mechanical effect,—but a stranger to these matters would judge by the degree of vacuum that may be obtained in the cylinder. To show how far this may be done, we may consider the temperature of flame to be about 1050 degrees; and in a small cylinder and with oil-gas, I have little doubt but that it might be filled with a jet of flame of that tempetature, if not of a much greater one; but assuming $t = 1050°$, we have

$$30\left(1 - \frac{500}{450 + t}\right) = 20$$ inches of mercury. The advantage of this increase of moving force is, however, not so great as to repay the increased consumption of gas to produce it. The exchange of steam-boilers for the retorts and gasometers of a gas-work, will certainly not be esteemed an advantage; while, for a locomotive machine, the expence would be so great as to put it entirely out of question whether it would be better to carry oil-gas compressed into a 30th of its bulk, or to use a high-pressure engine.

Art. XX.—*On the Motions of the Eye.* By Charles Bell, Esq. F. R. S. &c. Read before the Royal Society of Edinburgh, March 21. 1825

In the march and progress of Science, as men choose to call that slow and painful advance which we make in knowledge, there seems to be a natural disposition to chide and hunt back whoever attempts to make a path for himself. While every one observes with complacency the improvement of the age, individual efforts meet with opposition almost amounting to enmity. To complain of this were about as wise as to lament any physical and unavoidable annoyance. But it is my apology for encroaching on the time of the Society. On any other account, I ought not to regret that I am brought back to the reconsideration of a subject which is full of interest.

Some papers of mine appeared in the *Philosophical Transactions of London,* on the Anatomy of the Nervous System; in which I found it necessary to make some observations on the motions of the eye. Principally from respect to that learned body, I did not enter into all the details necessary to complete the subject incidentally stated. Dr Brewster, in a paper read in the Royal Society of Edinburgh, has made his remarks on these papers very freely, and has persuaded himself, that, by rendering suspicious some of the illustrations of my system, he has undermined the whole. In proceeding to show how inapplicable his criticisms are, I shall, at the same time, expose the inaccuracy of his alleged "scientific facts."

I am not a little startled to find myself unexpectedly opposed to a man of Dr Brewster's philosophical habits, and I am very reluctant to go into an element where he is so familiar. But I have sometimes found very little meaning invested with scientific form, and I think I shall show, in the present instance, that the truth is more obscured than illustrated by phrases and diagrams, which deter the general reader from entering on the subject.

It will be necessary, in the *first* place, to assign due importance to the sense of *muscular exertion;* a subject which Dr Brewster treats, not only with inaccuracy, but with such chasms in the course of his argument, as to throw obscurity over the whole matter. I shall then examine the optical phenomena; where the inaccuracies are such, that were I interested in the discussions in which this gentleman is engaged, I should hold it to be a duty not to leave one of his positions, however wrapt up in the form of mathematical reasoning, without a thorough examination.

My original statement was to this effect: That not only are our ideas formed by a comparison of the different signs presented to us through the senses, but that there is a power in the body, which, though not called a sense, is superior to all the senses, in the precision which it gives to our perception: bestowing on us accurate ideas of distance, of space, of form, and substance: That the muscular frame, and that sense which we possess of the muscular frame in action, gives us this power: That the sense of vision in the eye is imperfect, until aided by muscular motion, as the sense of touch in the hand would inform us of nothing without the motions of the hand: That hardness, and softness, and smoothness, and angularity, are properties of matter not known to us merely by the sense of touch, but by *that* sense, aided by the motions of the hand, of which motions we are sensible; that the entire and complete exercise of the sense of touch comprehends a comparison of the exercise of the nerve of touch with the consciousness of, or the sensibility to, the muscular motion which accompanies it; and that, without this combination, the sense of touch would not be entitled to the name of the *geometrical sense.*

Following out this subject, I showed that it is possible to make the image of an object permanent on the retina, after the object itself is withdrawn from the eye; that the image or phantom in the eye is stationary, whilst the eye-ball is at rest; but that the slightest exertion of the voluntary muscles of the eye makes a change on the apparent position of that image, as it not only follows the motions of the body and the head, if we are conscious of these motions; but, even when the head is fixed, if the muscles of the eye are in action, the place of that image appears to be changed, whilst it is actually fixed on the same spot of the retina.

A man holds a ball in his hand; he does not see it, he only feels it. By what power is it, that he knows whether he holds that ball before him, or behind him? None of the five senses can aid him here: he knows it by means of his consciousness, first, of the exercise of the organ of touch,—secondly, through the sensibility to muscular action. The action of the muscles of the arm is combined with the sense of touch in the idea formed in the mind. So, when the image is fixed upon the expanded nerve of the eye, if the muscles strain to the right side or to the left, the position of the image appears to make a corresponding change,—because the mind is contemplating two operations; the impression on the nerve, and the action of the muscles.

In the course of this investigation, I had found a case in my hospital, where the eye had lost the power of the muscles, without losing the power of the optic nerve; and I had stated that the vision was entire, obviously meaning the possession of that sense which belongs to the optic nerve, in contradistinction to the other offices of the eye. Dr Brewster calls his reasoning on this passage the *reductio ad absurdum.*

That gentleman has failed to observe the difference between vision while yet unexercised and uneducated, if one may say so, and after the impressions upon the eye have become, by long experience, the signs of the qualities and positions of bodies, the knowledge of which is gained through the other senses and the operations of the muscular frame.

If I operate upon an infant, it may express pain, but it makes no effort to remove my hand. That motion which appears to us so natural, is the effect of education and experience. The candle before a child seems to enliven every faculty of its nature; but it cannot follow that candle with its eyes when it is moved, until repeated experience has taught it to combine the action of the muscles with the exercise of the sense.

If the eye of the patient, above alluded to, had been in its original and unexercised condition, the vision would have been imperfect in every respect, because the sign in the eye would have had no meaning; but as it was, it could not be called perfect, since it was incapable of ranging round the outline of an image, or of following and corresponding with the other eye.

We may pursue this subject a little further. When looking to an object in the country, we judge of its distance and place, by an operation as near to a trigonometrical survey as can be. The eye moves from hill to tree, from the steeple to the castle; and, by knowing their relative positions, we form an estimate of the situation and size of the object beyond them. How much we owe to the motions of the eye, we may know by cutting off the operation of the muscles, in looking through a tube. We then judge imperfectly of place and distance, and know nothing of them but by the degree of obscurity proceeding from the intervening atmosphere.

The same thing is illustrated, in looking on a panorama; for there we have before us the shades and colours of natural objects, which are their signs, but the means of comparison being carefully cut off, we suffer ourselves to be deluded.

In short, it is clear to demonstration, that the eye is in continual motion, making comparison of distances and angles, and thus informing us of that which we should never know, without the combination of the sense of vision with muscular activity. Even in the most minute object we examine, the eye travels over its outline; and, moving from point to point, the figure is ascertained by the same operation by which we have been informed of its distance from us, and its relation to other objects.

Our motions to and from an object, and the movements of the hand and the head, all aid in perfecting the vision. But, in the papers which Dr Brewster has criticised, I was treating of the nerves of the orbit, and I had occasion to speak only of the muscles of the eye.

But to return to the offices of the eye. This continual activity and searching motion of the eyeball, is owing to a well known property in the retina,—the more exquisite sensibility in that part of it which is directly in the axis of vision. When we look upon a scene or upon a wall, we see only a small part of it perfectly, whilst the objects around are presented to the eye in comparative obscurity. But, with a motion rapid as thought, the centre of the retina is opposed to all the objects in the field successively; and with a glance, of which, in one sense, we are scarcely conscious, the whole appears equally vivid.

If, however, by an effort, we try to fix the eye upon a spot, we shall be aware that the surrounding objects are imperfectly seen; and, at the same time, we shall be made sensible of the restlessness of the eye to search out whatever is obscure. It is this propensity to penetrate what is obscure, that makes the eye-ball roll continually, when, from a morbid state of the retina, objects in one part of the field of vision appear covered with a cloud. There is an uncontrollable effort of the eye to present its axis towards the objects thus obscured; and it is in this manner that we continually follow what appears a cloud, and which, by the motion of the eye, as necessarily flies from us.

To controvert my opinion, Dr Brewster has placed himself upon a stool which revolves; and is at the pains to have a leathern belt, and a friend to turn him round. I am truly at a loss to know whether the Doctor has placed himself here in perfect philosophical simplicity and singleness of heart. However that may be, thus he concludes: "That the notion of place or relation depends on the muscles of the assistant's arm, conveyed by some sympathetic action to the observer's eye, along the leathern belt,—a result so inadmissible," &c.

Is it possible that Dr Brewster, with the advantage of the society of Edinburgh around him, can be so totally ignorant of this subject? When a man stands or sits, he exercises the tension of the whole muscular frame, to the motions of which he is minutely sensible, and without which he would fall like one dead or drunk. He stands or walks by a fine adjustment of the muscles to the balancing of the body. It is quite obvious, that he cannot do this, without a consciousness or sense in the muscular frame. It is by the same power that he knows the position of his body, whether in motion or at rest. If he be twitched round, violence is done to these balancing powers, and a disturbance occasioned to the muscular system, which gives him as lively a conviction of the change, as if it came to him through all the five senses. And, if placed upon a stool, although the experimenter should be so careful as to apply a leathern belt, and an assistant to turn him round, he will be conscious of such vertical motion; and whether he closes his eyes the while, or not, he will be conscious that he is turning, by a succession of lesser motions, to the four sides of the room; and if there be an impression of an image on his eye, it will appear to be on that side of the wall to which he has turned.

It is in the course of the same singular mode of argument that Dr Brewster thus expresses himself. "Let the observer, with a spectral impression on his retina, close his eye, and turn round his head, either in a vertical or a horizontal plane, by *the muscles of his neck alone.* It will now be found, that the spectrum follows the motion of the head; and hence we must conclude, that the motion of place or relation depends on the exercise of the muscles of the neck, as those of the eyeball have been entirely at rest." If it were not addressed to this learned Society, I should imagine he was here trifling with us. If a spectrum upon the eye appears before us, it will continue before us in whatever way we turn; and, I have little doubt, I shall be excused for not having said so in my original paper.

I repeat, that, what I conceived it necessary to prove was, that the eye, with its apparatus of muscles, has the power of conveying the idea of the phantom in different positions, according to the operations of its muscles, and independent of the motions of the head or body.

By the extraordinary resistance of a man of Dr Brewster's general information, I begin to think there was more novelty in proving this fact than I at first conceived.

I shall, in the *second* place, examine the observations of Dr Brewster, which he introduces to the philosophical public as "*scientific facts.*"

In the papers referred to, I had shewn, that, if we look upon an illuminated object until its image is permanent in the bottom of the eye, the phantom moves with the motion of the eye, if that motion be performed by the voluntary muscles of the eye-ball. But if the eye-ball be moved by the finger, the phantom will remain stationary, while the ball itself is in passive motion.

Dr Brewster proposes to prove, that the spectrum or phantom is by no means immoveable, and that it moves the precise degree it ought to move. The diagram by which he would persuade us of this is given in Plate XI. Fig. 1. "Let A be the eye of the observer, and O an internal object, whose image at P is seen along the axis of vision POM. Let the eye be pushed upwards, suppose $\frac{1}{10}$th of an inch into the position B, the external object O remaining fixed. The image of O, upon the retina, will now be raised from P to Q, in the elevated eye at B. Hence the object will now be seen in the direction QON, having descended by the elevation of the eye from M to N.

"Let the eye be now brought back to its original position A, and let the object O be the lamp, with ground glass, used by Mr Bell. The spectral impression will therefore be made upon the retina at P, and will remain on that spot till it is effaced. If the eye A is now raised to B, the impression will still be at P in the elevated eye, having risen only $\frac{1}{10}$th of an inch, or the height through which the eye has been raised by pressure. This small space is not very visible to an ordinary observer," &c.

How could Dr Brewster conceive, that we could push the eye-ball aside, without its revolving on its centre? What we have above all to admire in the position of the eye-ball, is the manner in which it is poised, and prepared to revolve on the slightest action of its muscles, or lateral pressure. But we must prove that it actually does revolve in this very experiment.

It will be observed, that, in this diagram of Dr Brewster's, the line of the axis of the eye, when the organ is pushed aside, is parallel to the direction in which it was before it was displaced,—a thing impossible.

If you go to a distance from the candle and repeatedly press or strike the ball of the eye with the point of the finger, the light will seem to move and dance, through a considerable space, say a foot. Move close to the candle, and do the same, and the light will not seem to move half an inch. The reason is this. Let A (fig. 2.) be the centre, on which the eyeball revolves, its revolution will be attended with an appearance of motion in the body B, through a certain portion of the smaller sphere of vision C, D. But if the body be distant as E, it will appear to move, as the figure indicates, through a corresponding portion of a larger sphere of vision F G. Exactly the reverse would take place if the axis of the eye moved from one parallel to another: That is to say, the motion of the eyeball, which gives the apparent motion to the object, would be great, if the object were nearer the eye, and would be as nothing if removed to a distance. Thus we are informed, that when the eye-ball is moved whether covered by the eyelids or not, it revolves upon its centre; and, therefore, the diagram of Dr Brewster, however ingeniously reared, is founded on antecedent propositions which are false. Having cleared away this obstruction, I resume my original position.

If an impression is made upon the retina, and the eye be shut or in darkness, and a voluntary muscular effort be made with the eye, the image or phantom will seem to change its place in a direction corresponding with the effort. But if the eye-ball suffer any change of place or revolution from any other cause than voluntary effort, the image or phantom will retain its place, the mind taking no cognizance of that motion.

The next observation of mine, which Dr Brewster opposes, regards the motion of the eye-lids. When we wink or close the eye to lubricate the cornea, or render it fit for vision, I have asserted, that, at the same instant, the eye-ball is turned up, and that, without this, it would not be thoroughly lubricated and washed, and that the fluid would be left upon the cornea suffusing the vision.

Dr Brewster observes, " Unfortunately for these views, the clearing away of the lubricating fluid, which is left in the groove between the closed eye-lids, has not been accomplished by Almighty wisdom. Those who are familiar with this class of experiments, will have no difficulty in observing the ridge of accumulated fluid remaining after the eye is opened, and gradually falling to its level." Who would not believe, that Dr Brewster and his philosophical friends had actually seen the water running down the face of the cornea, and in their own eyes, too; thus stating an imperfection of the eye, at the very moment that they were using it with such perfection as to discover what we cannot see. This, in the proper sense of the word, is a complete hallucination. Physiologists did at one time conceive, that, when we see spots or lucid circles falling before the eye, it must be from the dropping of the water over the face of the cornea; whereas it has been proved by the most satisfactory suite of experiments, that these circles and spots proceed from an affection of the retina, and that their apparent motion is owing to the motion of the eye-ball.

Dr Brewster proceeds to illustrate the subject by one of those imposing figures, which the common reader takes as demonstration. "Let the eye be directed to a small point of light, such as the image of a candle diminished by reflection, from a convex surface, and let this image be brought near the eye, so that the pencils of rays, which diverge from it, may have their foci a great way behind the retina when the eye is open; the image of this luminous point will be a circular disc, or a section of the cone of rays formed by the refraction of the eye. If, when looking at this circular disc and power at A, (Pl. XI. Fig 2.,) we shut the eyelids, and then open them gradually, examining, at the same time, the appearance of the disc, we shall at first observe it to have the compressed form shown at B, occasioned by the ridge of fluid, and then gradually extending itself into its regular circular form."

The proposition affirmed is, that there is a ridge of fluid which gradually falls down upon the face of the cornea. It is not seen, but its presence is assumed from a certain change in the figure of an object. To have a definite idea of the point under consideration, let us suppose that there is such a ridge of fluid, let us give it a visible magnitude, and let us consider what would be its effects.

Let A B (fig. 4.) be the convexity of the cornea, and C the section of the ridge of fluid; it is obvious that, as a magnifying lens, it would elongate the object; as it is not a drop, but a *ridge*, it would elongate the object in the perpendicular, and not magnify it regularly. Dr Brewster's circular object would become changed in a direction opposite to what he has represented. Presuming that he has reasoned ill, and observed justly; something there must be acting like a concave glass instead of a convex lens. I should suppose that the fluid attracted by the margin of the eyelid had taken a concave form, so as to compress the circular figure as represented by Dr Brewster; but I believe the shape of the margin of the eyelid will prevent the ray of light from striking upon this fluid in the angle betwixt the cornea and the eyelid. I believe the effect contemplated, proceeds from another cause altogether. Something in this experiment disperses the rays, or, to speak more accurately, diminishes their convergence, and throws the image of the object, as it is the license of optical writers to express it, behind the retina. When the disc is extended in one diameter, the rays from it must have been refracted, so as to magnify the object. When the object is seen compressed, a contrary influence must be in operation; the rays must have been dispersed, and the object diminished in that diameter. We every day witness in those who are near-sighted the attempt to diminish the convergence of the rays by peering through the shut eyelids. The fact is, I must therefore presume, when Dr Brewster looked at this object with his eyelids nearly shut, the rays from the object were attracted by the eyelashes, and the image took that irregular figure which he has represented.

It will save Dr Brewster infinite trouble, if, when he sees what he supposes an attempt in the human structure, he will commence his speculations on the idea, that this intention is perfectly fulfilled. As to the present inquiry, he may rest satisfied, that when the eye was endowed with sensibility, that the eyelids might be regularly moved under that influence, the Power which bestowed sensibility, a property of life, did not leave the mechanism imperfect; and that there is no superfluous moisture left to fall down on the surface of the eye, unless when intended for other essential purposes than that of merely lubricating the cornea.

The last observation of mine which Dr Brewster contradicts, is, that the eyeball revolves a certain degree upwards when the eyelids are shut. Daily experience of things, which, in all probability, do not present themselves to that gentleman, authorise my conclusion. I am surprised that he did not sooner notice the fact, and that gentlemen do not understand the subject when it is put before them.

Experiments on this subject require very particular attention. If a person, with whom we are conversing, is asked to shut his eye, the axis of the eye-ball continues to be directed towards you as long as that person is conscious that you are looking at him, or is attentive to your discourse. Even when the eyes are shut, if the person has his mind awake, the eye-ball will continue in motion, and correspond with the ideas in the mind. This is the reason I apprehend that my friend Dr Knox has rather confirmed Dr Brewster in his misconception.

In the winking motions of the eye-lids, for the purpose of brushing the surface of the cornea, the motion of the eye-lid is more rapid than thought, and difficult to observe. But the gradual yielding up of the controul of the eye-ball, on the approach of sleep or insensibility, from whatever cause, is a thing so curious in itself, and so clear to demonstration, that I must express my surprise that ingenious men will rather deny the fact, than prosecute it in all its bearings.

But why should Dr Brewster take the facts of a case as stated by me, and which seem, to superficial observation, against my argument, and omit to notice that part of the statement which is in my favour. Is not this as if he preferred the pride of victory, and were more the advocate of his cause than of philosophy? In the case to which he has drawn the attention of the Society, the patient had lost the power of moving the eye-ball, and by far the most important circumstance of that case was, that when he shut his eyes the red light came through the eye-lid of the eye that was imperfect. How is this to be accounted for, unless we suppose that the cornea of the sound eye was turned up, whilst the other was in its fixed position?

Any one can confirm this fact by closing his eye-lids and looking through them; that is, making an effort of attention to the red light which comes through them. Let him then make an *effort* to close his eye-lids, and that red light will disappear. And this will be found to be the case, although the eye-lids be stretched with the finger so as to prevent all corrugation of the skin of the eye-lid. If this experiment be made on the eye of a friend, the cornea being visible through the stretched eye-lid, it will be seen to ascend upon every renewed effort to close the eye.

In my former paper I had stated, that, by an affection of the nerve of the face, the eye-lid remained open and fixed whilst the eye-ball retained its motion. Within these twenty-four hours I have had a case communicated to me of this kind. The physician at first conceived, that when his patient attempted to close his eyes the one eye went down and the other went up! But when he was requested to make more particular observation, he then found that when the eye-lids of the sound eye were closed, the cornea of the other eye was seen to turn up. Here the eye-ball performed its part of the office, but the eye-lids were immoveable.

Dr Brewster must now be satisfied that I have taken his advice, and that I have, with respectful diligence, examined his observations. As the utmost forbearance is required from all who carry side-arms among peaceable citizens, so ought a journalist, who has so great a power of annoyance in his hands, to be reserved and temperate above other philosophers; yet Dr Brewster has not only written in a temper ill calculated to conciliate, but he has hung up an announcement for nearly a year past, *of the refutation of certain supposed discoveries of mine*,—and although this title was of itself an attack and a condemnation, he delayed from week to week entering on the subject, and has finally failed to do what his advertisement announced.

Art. XXI.—*Remarks on the Illuminating Power of Coal-Gas.* By Adam Anderson, Esq. F. R. S. E., Rector of the Academy, Perth.

In the short memoir, which I submitted to public attention, in the last number of this Journal, with respect to the illuminating power of coal-gas, as it is manufactured at the Perth Gas-works, I stated that three retorts were found sufficient to produce an adequate supply of gas to about 600 lamps, lighted during the usual time of burning in large towns. As I understand this result has been ascribed to some peculiarity in the coal used for carbonization, I think it right, in order to remove all mistakes on the subject, to mention that the coal used at the Perth Gas-works, is of the kind termed Cannel Coal, and as I am informed, greatly inferior in quality to the coal of the same description, which is employed for the production of gas, both at Edinburgh and Glasgow. The retorts, which are set on separate furnaces, are charged every three hours, with about one hundred pounds of coal each; so that the whole daily consumpt of the three retorts is about 2500 lb., or nearly 23 cwt. From this small quantity of coal, which, inclusive of fuel, costs about 18s. a-day, abundance of gas is produced to supply, at present, no fewer than 891 lamps, of the following kinds:

Burners.		*Number.*	*No. of Jets.*
No. 1 Jets,		67	67
2 do.		134	268
3 do.		74	222
5 do.		2	10
7 do.		26	182
1 Argands	10 holes,	298	2980
2 do.	14 do.	136	1904
3 do.	18 do.	56	1008
4 do.	22 do.	37	814
Batwings,		61	732
	Total,	891	8187

Many of these lamps burn to a late hour, and some of them the whole night; but it is proper to add, that a few of them are lighted only on Sundays, and others now and then, in the course of the week. Still, however, if these occasional lights be reduced to equivalent ones, by making a suitable allowance for the time they are not used, it may be affirmed, that, *three retorts* at the Perth Gas-works furnish a sufficient supply of gas to about 800 lamps of the kind above mentioned, having 7334 jets, and giving a light equal to that of 8100 candles, for about five hours daily; and that, too, at a time, when a considerable portion of the gas is unavoidably wasted, by the daily opening of the main pipes, for the purpose of extending them to streets where they are not yet laid.

This result, which greatly exceeds what has been obtained by means of an equal number of retorts * at any coal-gas work in the kingdom, I ascribe much less to the quantity of gas which is decomposed from a given weight of coal, than to the processes of purification by which the gas is prepared for consumption, in consequence of which, it retains nearly the same proportion of super-carburetted hydrogen, as the best oil-gas. In fact, the quantity of gas procured at the Perth Gas-work, from a certain weight of coal, differs little from that which is usually stated to be obtained at other coal-gas establishments, from the same species of coal; being, when the coal is carbonized for three hours, about four cubic feet from the pound, and, consequently, about 9600 cubic feet from the quantity of coal daily subjected to distillation.

This quantity of coal-gas, according to the report submitted by Taylor and Martineau to the Dundee Gas Company, would not give a light equal to that which is in reality afforded by the burners used in Perth above two hours daily, which is only about a third part, at an average, of the time they actually burn. We are thus compelled to admit, either that these individuals have grossly underrated the illuminating powers of coal-gas in general, or that the gas manufactured in Perth, possesses nearly three times the illuminating quality of the coal-gas to which they refer. The former of these conclusions, notwithstanding the obvious interest which Taylor and Martineau have to undervalue the properties of coal-gas, cannot, in justice to their characters, be admitted; and, on the other hand, the alternative would imply, that the Perth coal-gas is of a quality so superior to the ordinary kind

* In the report furnished by Mr Tait to the Dundee Gas Company, the quantity of gas requisite to maintain 700 burners is estimated at 6,336,250 cubic feet annually; and the quantity of coal necessary for its production, at 528 chaldrons, or 712$\frac{4}{5}$ tons. By the mode of decomposition and purification practised at Perth, the same extent of illumination will be procured from 180 tons of coal. Mr Neilson of Glasgow, in his report to the same company, estimates, that a gas establishment, supplying 5000 jets, would require 3$\frac{1}{2}$ tons of coal daily. The Perth gas-work now supplies about 8000 jets, by means of less than a third-part of that quantity of coal.

from coal, that nothing but the most unquestionable facts can be expected to satisfy the public mind with regard to its truth. These facts have already been stated. They do not consist of a few insulated and doubtful trials, made with a particular kind of coal-gas carefully prepared on the small scale, from selected materials for a special purpose: but they may be said to be the average result of a numerous and extensive series of experiments, conducted for months together, under every variety of circumstance by which that result could be affected in the largest establishment. They furnish, therefore, data for a legitimate extension of all the consequences which they involve, in their application to the economy of coal-gas, as contrasted with that of oil-gas. Of these consequences, it is not the least important, that 9600 cubic feet of coal-gas, when duly prepared, are capable of emitting a light equal to that of 8100 candles, for at least five hours, or of 40,500 candles for one hour.

If this result be compared with the light afforded by oil-gas, of which $1\frac{1}{2}$ cubic feet, (as stated by Taylor and Martineau), yield a light equal to that of ten candles for an hour, it would appear, that one cubic foot of oil-gas affords a light equal to $6\frac{2}{3}$ candles for an hour; while an equal volume of coal-gas gives a light equal to $4\frac{7}{32}$ candles, during the same length of time. The illuminating power of the two gases, bulk for bulk, is thus as $6\frac{2}{3}$ to $4\frac{7}{32}$, or as 8 to 5 nearly. This result coincides almost exactly with the conclusions to which I was led by the experiments recorded in the last number of this Journal; and ought to be the more satisfactory, as it has been deduced by a mode of investigation totally different.

With regard to the probability of extracting from coal a species of carburetted-hydrogen, which shall contain a larger proportion of olefiant gas than has hitherto been obtained, I am disposed to indulge the most sanguine hopes. I conceive myself justified in cherishing this expectation, from observing the vast quantity of carbonaceous matter which escapes during the decomposition of the coal; and from considering the evident possibility of causing it, in a state of nascent volatilization, to unite in larger proportion, with the hydrogenous element, with which, even by the most approved methods of carbonization, it still combines only in a partial manner. One mode of effecting this union has already occurred to me, which promises to lead to the most favourable results; but, at present, it would be premature to do more than simply advert to the fact.

I shall conclude these general observations with a few cursory remarks on the comparative cost of oil and coal gas; taking, as a standard for the former, the gas produced under the patent of Taylor and Martineau; and for the latter, the gas of the Perth Gas-work. From the statements which have already been given, it appears, that the illuminating quality of oil-gas, is to that of the coal-gas in question, as 8 to 5. Now, if it be admitted, that, with due management, a gallon of oil will yield 100 cubic feet of gas *, (and this is certainly rather above than below the truth), and that 40 lb. of coal are capable of yielding 160 cubic feet of gas (which is rather below than above the truth), we should have from a gallon of oil and 40 lb. of coal, the equivalent quantities of oil and coal gas, or the quantities of the two gases that afford equal degrees of light. But reckoning the oil at L. 20 *per* ton, and the coal at 15s., the cost of the oil-gas would be 1s. 7d., and that of the coal gas something less than $3\frac{1}{4}$d.

It is no doubt true, that, for the due preparation of coal-gas, certain substances are requisite, which are unnecessary in the case of oil-gas; but the expence of these is very trifling, and, at any rate, the value of the coke, tar, and other products arising from the coal, more than meets the extra outlay which they occasion.

To counterbalance these advantages, however, in favour of coal-gas, it is admitted, that the gas-holders, conducting pipes, &c. do not, in the case of oil-gas, require to be quite so large, for an equal extent of illumination, as in the case of coal-gas. But the difference, though it has often been pressed upon the public attention by the advocates for oil-gas, is much less than it might, at first sight, appear; for, admitting that even two measures of coal-gas were requisite to yield the same degree of

* At Lord Gray's oil-gas establishment, erected by Mr Milne of Edinburgh, under the patent of Taylor and Martineau, a gallon of oil yields at an average only 80 cubic feet of gas. On the other hand, some kinds of cannel coal have been found, at the Perth Gas-work, to yield upwards of 5 cubic feet per lb.; and that, too, when the distillation was carried on only for three hours.

light as one measure of oil-gas, the conducting pipes of the former would need to be enlarged, on that account, only in the subduplicate ratio of 1 to 2, or as 5 to 7; while the gas-holders would require to be increased in the subtriplicate ratio of 1 to 2; that is, as 4 to 5 nearly. It thus becomes evident, that the relative expence of the pipes and gas-holders for oil and coal gas, is but little affected by the difference between the illuminating powers of the gases; and that, in point of economy, so far at least as regards the prime cost of the materials from which the gases are produced, oil and coal gas do not admit of comparison.

But, in forming a correct and impartial estimate of the respective merits of the two gases, it is obvious that various circumstances may require to be brought under consideration, besides the prime cost of the materials from which the gases are procured. A proper view of these can only be exhibited, by a faithful statement of the actual expence incurred by an oil and a coal establishment, producing an equal degree and extent of illumination. Of the former, I can only speak from the reports of others; but, of the latter, I can give a distinct account, from what has fallen within the range of my own experience. Leaving, therefore, to persons who are more conversant with the economy of an oil-gas work, the task of laying before the public a correct statement of the expenditure and *capability* of that description of a gas manufactory, I shall proceed to give a brief account of the original cost, as well as of the annual outlay and income of a coal-gas work, such as I have lately planned, for a town containing about 12,000 inhabitants.

MASONRY, &c.

	L.	s.	D.
Masonry, including a substantial gasometer-house, retort-house, purifying-house, lime-sheds, boundary-wall, pavement, brick-work, &c. - - - - - - -	613	10	0
Two stone-tanks for gasometers, double-walled, and clayed between, with hewn faces, - - - -	343	0	0
Carpentry and slater-work, doors, &c. - - -	323	10	0
	L. 1280	0	0

IRON-WORK, &c.	L.	S.	D.
8 Retorts, with condensing main, &c. - - -	186	16	0
Tar condenser, &c. - - - - -	81	16	0
Purifying apparatus, &c. - - - -	86	1	0
2 Gasometers, with chains, pulleys, and counterpoise, -	397	7	0
3978 yards of main-pipes, from 4½ in. to 1½ in. diameter, -	955	14	0
Jointing and laying pipes, &c. - - - -	397	16	0
Bend-pipes, traps, &c. - - - -	50	0	0
4000 yards of service-pipes, - - - -	200	0	0
Iron-pillars for street-lights, - - - -	64	0	0
2 Workmen for 8 months at 21s. per week, - -	64	0	0
Contingencies, including salary of engineer, &c. - -	300	0	0
	L. 2783	10	0

From this statement, it appears that the total outlay upon the coal-gas manufactory referred to, would amount to L. 4063, 10s. Supposing only half the number of retorts belonging to the establishment to be in actual use at a time, the whole weight of coal they would decompose, in 24 hours, would be 1⅗ tons, and the quantity of gas they would produce 14,400 cubic feet. This volume of gas would, in the depth of winter, (when the lights were used, at an average, six hours daily), afford a sufficient supply to the following burners:

	Hourly consumpt of gas, in cubic feet.	Equal light with candles.
300 No. 1. Argands, 10 holes,	650	3000
100 No. 2. do. 14 ——	280	1200
50 No. 3. do. 18 ——	150	750
180 Batwings,	400	2160
150 Jets, with 3 holes,	280	900
200 do. 2	300	800
400 do. 1	300	900
1380	2360	9710
	6	
Daily consumpt,	14160 cubic feet.	

The quantity of coal carbonised daily to supply gas to burners of the above description, in the depth of winter, being only 1⅗ ton, the whole quantity of coal used in the course of a year would not exceed 250 tons; and as the coke from the retorts would do more than supply fuel, it is unnecessary to make any allowance for it.

It now remains to give a view of the probable return that may be expected to be derived from the establishment. In doing this, I shall suppress no outlay connected either with the cost of the materials, or the expence of the manipulations, and the general management of the business; while, on the other hand, I shall charge the different burners at a lower rate than has yet been done by any coal-gas company with which I am acquainted, supposing they are to be allowed to burn from dusk till nine o'clock.

DEBIT-SIDE.

				L.	S.	D.
250 Tons cannel-coal, at 15s.				187	10	0
125 Bolls lime, at 3s. 9d.				23	8	9
Other purifying materials,				10	0	0
Manager,	L. 60	0	0			
Clerk,	40	0	0			
2 labourers, at 15s. per week,	78	0	0			
				178	0	0
Contingencies,				120	0	0
4 per cent. on outlay,				162	10	10
				L. 681	9	7

CREDIT-SIDE.

	L.	S.	D.
300 No. 1. Argands, 10 holes, at 30s.	450	0	0
100 No. 2. do. 14 do. at 35s.	175	0	0
50 No. 3. do. 18 do. at 42s.	105	0	0
180 Batwings, at 31s. 6d.	283	10	0
150 Jets, 3 holes, at 20s.	150	0	0
200 do. 2 do. at 15s.	150	0	0
400 do. 1 do. at 10s.	200	0	0
Surplus coke, lime, tar, &c.	60	0	0
Credit-side,	L. 1573	10	0
Debit-side,	681	9	7
	L. 892	0	5

This would afford a clear profit of 20 per cent. on the original outlay, after laying aside the interest of the capital, and reserving L. 199 : 6 : 5 annually for repairs and contingencies.

By an examination of the debit-side of the account, it may be inferred, that, since 250 tons of coal yield 2,240,000 cubic feet of gas, the total expence of which is L. 681 : 9 : 7, the cost of manufacturing 1000 cubic feet is 6s. 1d., including every item of outlay, as well as the interest of capital.

By examining the credit-side of the account, it may be inferred that the same extent and degree of illumination, which, in the case of coal-gas, costs the consumer L. 1513, 10s., could not be procured by means of tallow-candles for less than L. 10,114, 12s., supposing a candle (four in the pound) to burn 12 hours, and the price to be 10d. per lb.; being a saving of nearly 7 to 1 in favour of coal-gas. The *prime cost* of the oil alone, to afford the same extent and degree of illumination, would be L. 1456, 10s.; admitting, on the statement of Taylor and Martineau, that $1\frac{1}{2}$ cubic feet of oil-gas yield a light, for an hour, equal to 10 candles, and that a gallon of oil at 2s. gives by decomposition 100 cubic feet of gas.

On the other hand, if 1000 cubic feet of oil-gas be supposed to cost 26s., the price at which it is stated to be obtained in oil-gas manufactories, the expence of a quantity of oil-gas, equal in illuminating power to the quantity of coal-gas above mentioned, would be L. 1820. Hence the *prime cost* of the oil-gas would exceed the *selling price* of an equivalent quantity of coal-gas, produced at an establishment such as I have sketched, by more than the interest of the capital vested in the manufactory.

If from these pecuniary views, which have a reference, in some measure, to the private interest of gas companies, we pass to considerations of a public and more comprehensive nature, and inquire which of the two rival gas manufactories ought to be encouraged on the ground of national policy, an enlightened Legislature, it may be presumed, could have no hesitation about giving the preference to coal-gas. It appears, indeed, that, so far as economy is concerned, the prices at which the two gases can be procured scarcely admit of comparison. Coal, the substance from which one of them is evolved, is an article so very abundant in this country, that any increase in the demand for it, so far from raising its price, would probably render it cheaper, in consequence of the improvements that might be expected to result from more extended *workings;* whereas oil, the substance from which the other is obtained, must always be limited in quantity, as well as precarious in supply. The very extension of oil-gas establishments would enhance its price, and set bounds to its use. Moreover, in the case of coal-gas, we obtain a product which is vastly more valuable than the raw material from which it is procured by decomposition; whereas, in the case of oil-gas, it is well known that its illuminating power is rather diminished, than augmented, by its change of condition; the light which it emits, in the gaseous state, being somewhat less than that of the oil itself, when it is consumed in an Argand lamp, according to the ordinary mode. Lastly, the residue of the coal, after the latter has been used for the purpose of producing gas, is still valuable as an article of fuel; while that of the oil is good for nothing, but to clog with an useless product the vessels in which the decomposition is effected.

Art. XXII.—*Notice regarding Malleable Iron Railways.*

No subject, in Mechanical Philosophy, is at present more interesting than that of Railways, and we had expected to have been able, in the present Number, to lay before our readers a short view of their construction and operation, and of the general principles and comparative advantages of this mode of conveyance over that of Canal Navigation, so far as they can be deduced from the facts and observations already known, as well as to point out where additional information and experiment is yet wanting, to complete the theory of this important branch of mechanics. We must now, however, defer this to another opportunity. Meantime, we recommend to the attention of our readers the perusal of the printed correspondence, on the merits of malleable iron and cast-iron rails, published by Mr Birkinshaw, at Newcastle. The patent malleable iron-rails are thus described in the article Railways, in the Supplement to the Encyclopædia Britannica.

" An improvement has lately been made in the construction of the malleable iron-rails, which promises to be of essential utility. It consists in the use of bars, not rectangular, but of a wedge form, or swelled out on the upper-edge. In the rectangular bar, there is evidently a waste of metal on the under surface, which, not requiring to be of the same thickness as where the waggon-wheel is to roll, may be evidently reduced with advantage, if it can be done easily. The bar may then be made deeper and broader at the top than before, so as with the same quantity of metal to be equally strong, and present a much broader bearing surface for the wheel. This has been accomplished by Mr Birkinshaw, of the Bedlington Iron-works, who has obtained a patent for those broad topped rails. The peculiar shape is given them in the rolling of the metal, by means of grooves cut in the rollers, corresponding with the requisite breadth, and depth, and curvature of the proposed rail. Mr Birkinshaw recommends his rails to be eighteen feet in length. We have seen one of these patent rails at Sir John Hope's colliery; and it certainly forms the most perfect iron-rail which has hitherto been contrived; combining very simply and ingeniously in its form, qualities of lightness, strength, and durability.

"It is twelve feet long, two inches broad along the top, and about half an inch along the bottom, and still thinner between. It rests on sleepers at every three feet, and at those places the rail is two inches deep; while, in the middle point, between the sleepers, it is three inches deep. All these inequalities, we believe, are performed on the metal, by means of the rollers; and this circumstance is well deserving of attention, as it may obviously be applied not only to the formation of railways, but to a variety of other arts. The moulding and shaping of metal in this way is quite a new attempt in the iron-manufacture, and it is not easy to say how far such an invention may yet be carried by the skill of British artists."

We have frequently had an opportunity of observing these rails, and agree entirely in the above description and opinion of their utility, and should regret to think, that the oxydation of malleable iron should prevent this improvement from being of that utility it otherwise would. On this subject we may also, in the mean time, recommend to the attention of our readers a very ingenious letter written on the subject of Railways, lately published in this city, being a series of papers of great merit, which originally appeared in the Scotsman newspaper. The author's views on the subject of friction are in general sound, but they only apply to the friction of the axles of the carriages. The rolling of the wheels along the way is quite a different sort of action, and may possibly modify considerably the results. But, on this subject, we can state from authority, that some experiments are now in progress by the Glasgow and Edinburgh Railway Company, which, we have no doubt, will set this matter completely at rest.

ART. XXIII.—*List of Rare Plants which have Flowered in the Royal Botanic Garden, Edinburgh, during the last three months.* Communicated by Professor GRAHAM.

Mar. 15. 1825.

Amaryllis Johnsoni.

Ardisia paniculata.

Bauera humilis.

Bletia hyacinthina.

Canna gigantea.

——— iridiflora.

The principal flower-stem of this splendid plant is above ten feet high. If placed in rich light loam, with plenty of pot-room, the plant would get much larger. It has never before flowered in this country; and a beautiful drawing has therefore been made of it by Dr Greville for Mr Roscoe's work on the Scitamineæ.

Canna pedunculata.

——— speciosa.

Columnea hirsuta.

Chamærops humilis, mas.

Epacris attenuata.

Gnidia sericea.

Goodyera discolor.

Hippeastrum splendens.

Jacksonia spinosa.

Laurus Camphora.

The specimen which has produced flowers, is a small plant, struck from a cutting two years ago, and kept in stove heat, which is probably the cause of bringing it into flower. The large specimen of the camphor tree in this garden, has always been kept in a cool situation, and has never been observed in flower, although more than half a century old, with a trunk nearly 2 feet in circumference; but the whole height of the tree does not exceed 15 feet, having been very frequently pollarded, to confine it under the glass.

Laurus glauca.

Lobelia surinamensis.

The rich vermilion blossoms of this plant are badly described and figured as "pale red," in Bot. Mag. t. 225.

Lysinema pungens.

Mirbelia reticulata.

Passiflora Herbertiana.

Pothos fœtida.

This singular plant has been in full flower in the open border for three weeks. It stands in a very dry situation, and is quite as strong as it usually is in this country when cultivated in damp situations, which, in its native country, it always inhabits.

Rhododendron dauricum.

——————— ——— β sempervirens.

These two beautiful plants were covered with flowers in the open border in January; but a sharp frost coming on at the time, completely killed the flowers on the first. The plant, however, has not suffered, and has shewn many flowers since, as fine as those which appeared before. The var. β sempervirens has been in no way injured by the frost, being much hardier, and much more deserving of cultivation in this climate.

Art. XXIV.—*Meteorological Observations made at Leith.* By Mr John Coldstream.

The Journal from which the following Monthly Results are extracted, is kept about 20 feet above the level of the sea, and a few hundred yards distant from it. The Thermometer is registered at 9 A. M. and 9 P. M.; the Barometer at 9 A. M. Noon, 4 P. M. and 9 P. M.; the Pluviometer and Wind-vane at Noon. The Hygrometrical observations are made by means of two Thermometers, one of which has its bulb covered with silk, and moistened with water; their indications are registered at Noon.

January 1825.

Results.

1. Temperature.	Fahr. Ther.
Mean of the Month,	40°.975
Maximum observed,	60.500
Minimum observed,	25.000
Range,	35.500
Mean of the extremes,	42.750
2. Pressure.	Inches.
Mean of the Month,	29.995
Maximum observed,	30.900
Minimum observed,	28.800
Range,	2.100
2. Humidity.	Fahr. Ther.
Mean difference during the month between the two Thermometers,	3°.84
Maximum ditto,	6.50
Minimum ditto,	0.25
4. Rain,	4.070 Inches.
5. Winds,	NE. 2, SW. 25, W. 2, NW. 2...days.

Remarks.

January 2.—At 3 A. M. there were several loud thunder-peals, and very vivid lightning. Upwards of an inch of rain fell in the course of the 24 hours. Wind moderate. Mean temperature 40°. Mean pressure 29.58, increasing.

5th.—Greatest dryness observed. Wind NE. by N. Mean temp. 30°.25.

9th.—Barometer at 6 P. M. 30.90 inches. The pressure had been variable for some days previous, with NE. and SW. winds; and the weather very agreeable. Temperature moderate. The barometric column has not been observed so high here for many years past as on this day. An equally great pressure seems to have occurred at the same time over the whole island, and the western shores of the Continent.

16th.—The pressure gradually and regularly diminished till this day, when it began again to increase. The weather during the whole week was very fine. Temp. 36°–56°.

18th.—The pressure diminished again on the 17th, and this morning the minimum for the month occurred, 28.80. Wind W. brisk. Heavy rain fell during the day. At 10 A. M. a remarkably distinct convergence of the solar beams was seen, under the usual circumstances.

27th.—For several days about this period, the temperature was very variable. Excepting on the three first days, no storms of wind occurred during the whole month.

FEBRUARY.

Results.

1.	Fahr. Ther.
Mean of the month,	39°.625
Maximum observed,	57.000
Minimum observed,	21.500
Range,	35.500
Mean of extremes,	39.250
2. Pressure.	Inches.
Mean of the Month,	29.956
Maximum observed,	30.410
Minimum observed,	29.140
Range,	1.270
3. Humidity.	Fahr. Ther.
Mean difference during the month between the two Thermometers,	2°.99
Maximum ditto,	5.75
Minimum ditto,	0.75
4. Rain,	2.89 inches.
5. Winds,	NE. 1 SE. 6 SW. 13 W. 5 NW. 3 ... days.

Remarks.

This month has been a very pleasant one, mild and dry. Pressure remarkably steady for the season, and gradual in its variations. No storms of wind occurred.

3d.—A light shower of snow fell, which soon dissolved; cirri very prevalent.

7th.—Two colourless rainbows were observed to-day, one at 9 A. M. and the other about noon: the primaries only were seen.

17th.—The sky at sunrise this morning presented an uncommonly splendid appearance, being covered with long cumuli and cirro-strati, decked in the richest tints of the spectrum, the *green* not excepted: heavy nimbi passed in rapid succession, discharging a few showers of rain till about 3 P. M. About 4 P. M. when the sky was covered by a thin sheet of *cirro-stratus* and floating *scud-clouds*, and when a large nimbus, advancing from the west, was obscuring the sun, then, near the horizon, a *halo* of very interesting appearance was seen. It consisted of two faintly-coloured arcs, one of which had a diameter of about 45°, and the sun for its centre; the other had a diameter somewhat less, and a point some degrees above the sun for its centre. The upper arc therefore cut the lower in two points, but was not visible within its circumference. It continued visible for a few minutes only. The colours of the exterior arc were much fainter than those of the interior. Is it possible that the exterior one could have been formed by reflection of the sun's rays from the surface of the nimbus? Similar phenomena have been seen accompanying the solar rainbow, which could be distinctly traced to like causes.—Phil. Trans. Abridg. vol. ii.—Ac. Paris, 1743, p. 54. &c.

18*th*.—Force of Solar Radiation to-day at noon 17°. Therm. in shade 50°.

28*th*.—SE. winds have prevailed for several days. This morning there was a sharp frost; in the afternoon heavy showers of snow.

Art. XXV.—*Celestial Phenomena from April* 1. *to July* 1. 1825, *calculated for the Meridian of Edinburgh, Mean Time.* By Mr. George Innes, Aberdeen.

The times are inserted according to the Civil reckoning, the day beginning at midnight.—The Conjunction of the Moon with the Stars are given in *Right Ascension.*

APRIL.

D.	H. ′ ″		D.	H. ′ ″	
1.	0 9 22	Im. II. sat. ♃	20.	1 47 37	☌ ☽ δ ♈
1.	19 22 0	☌ ☿ ζ ♓	20.	3 37 32	☌ ☽ ♉
2.	6 27 20	☌ ♂ ο ♓	20.	9 35 47	☉ enters ♉
3.	6 13 39	○ Full Moon.	21.	1 54 27	☌ ☽ A ♉
3.	21 18 49	☌ ☽ ι ♍	21.	3 36 28	☌ ☽ ε ♉
3.	23 4 18	Em. I. sat. ♃	21.	10 27 12	☌ ☽ ♀
5.	6 17 0	☌ ♀ η ♉	21.	11 6 38	☌ ☽ 2 *k* ♉
6.	0 11 54	Em. II. sat. ♃	21.	11 26 34	☌ ☽ ♄
6.	10 26 25	☌ ☽ δ ♏	22.		☿ greatest elong.
7.	20 51 0	☌ ☽ B. Oph.	23.	10 21 7	☌ ☽ 132 ♉
7.	22 10 0	☌ ☿ ♂	23.	10 23 30	☌ ☽ η ♊
9.	14 51 31	☌ ☽ ο ♐	23.	13 50 50	☌ ☽ μ ♊
9.	17 10 40	☌ ☽ π ♐	24.	7 42 5	☌ ☽ ζ ♊
10.	4 17 28	☌ ☽ ♅	25.	22 55 5	☌ ☽ ♃
10.	4 57 15	☾ Last Quarter.	26.	0 13 10	☽ First Quarter.
11.	0 59 11	Em. 1. sat. ♃	26.	23 17 54	Em. I. sat. ♃
12.	19 27 56	Em. I. sat. ♃	27.	0 45 28	☌ ☽ ξ ♌
18.	9 7 24	● New Moon.	27.	4 53 26	☌ ☽ ο ♌
19.	5 1 30	☌ ☽ ♂	27.	13 26 55	☌ ☽ π ♌
19.	5 55 0	☌ ☿ δ ♈	30.	21 20 34	Em. II. sat. ♃
19.	21 22 54	Em. I. sat. ♃			

MAY.

D.	H.	′	″	
1.	7	51	27	☌ ☽ ι ♍
2.	9	1	14	☌ ♄ α ♉
2.	14	43	35	○ Full Moon.
3.	20	52	19	☌ ☽ δ ♏
5.	6	35	0	☌ ☽ B Oph.
6.	23	38	10	☌ ☽ ο ♐
6.	23	40	28	Em. III. sat. ♃
7.	1	49	46	☌ ☽ π ♐
7.	5	21	11	☌ ☽ d ♐
7.	12	57	55	☌ ☽ ♅
7.	23	57	32	Em. II. sat. ♃
9.	21	4	27	☾ Last Quarter.
11.	16	45	0	☌ ☿ ♂, near con-
12.	18	45	0	☌ ♃ δ ♋ [tact.
12.	21	36	41	Em. I. sat. ♃
14.	5	45	0	Inf. ☌ ☉ ☿
15.	7	55	52	☌ ☽ η ♓
17.	8	24	40	☌ ☽ δ ♈
17.	12	56	38	☌ ☽ ☿
17.	23	49	27	○ New Moon.
18.	4	36	0	☌ ☽ ♀
18.	4	55	20	☌ ☽ ♉
18.	6	25	16	☌ ☽ A ♉
18.	17	20	0	☌ ☽ 2 k ♉
19.	0	3	9	☌ ☽ ♄
19.	16	4	54	Inf. ☌ ☉ ♀
20.	16	2	55	☌ ☽ η ♊
20.	19	27	16	☌ ☽ μ ♊
21.	9	56	30	☉ enters ♊
21.	13	2	13	☌ ☽ ζ ♊
23.	10	4	5	☌ ☽ ♃
23.	15	21	15	☌ ☽ 2 α ♋
24.	19	29	50	☌ ☽ π ♌
25.	6	35	5	☾ First Quarter.
26.	22	5	12	☌ ☉ ♂
28.	16	29	13	☌ ☽ ι ♍
29.	21	44	50	☌ ♂ α ♉
31.	6	39	53	☌ ☽ δ ♏
31.	23	42	34	○ Full Moon.

JUNE.

D.	H.	′	″	
1.	16	28	0	☌ ☽ B Oph.
2.	5	12	7	☌ ☉ ♄
3.	9	3	12	☌ ☽ ο ♐
3.	11	16	50	☌ ☽ π ♐
3.	14	45	24	☌ ☽ d ♐
3.	20	56	52	☌ ☽ ♅
4.	19	41	12	☌ ☽ β ♑
4.	21	50	33	Em. I. sat. ♃
8.	14	3	1	☾ Last Quarter.
10.				☿ greatest elong.
11.	15	44	45	☌ ☽ η ♓
13.	19	21	24	☌ ☽ ♀
14.	15	2	0	☌ ☽ ☿
14.	15	58	43	☌ ☽ A ♉
15.	0	58	23	♂ ☽ 2 k ♉
15.	14	14	15	☌ ☽ ♄
16.	1	37	14	☌ ☽ ♂
16.	12	9	58	● New Moon.
17.	2	25	13	☌ ☽ μ ♊
17.	19	41	5	☌ ☽ ζ ♊
18.	12	35	40	☌ ☿ ε ♉
19.	13	19	53	☌ ☿ α ♉
19.	21	7	30	☌ ☽ 2 α ♋
19.	23	30	53	☌ ☽ ♃
20.	16	15	36	☌ ☽ ο ♌
21.	0	56	53	☌ ☽ π ♌
21.	18	36	58	☉ enters ♋
23.	11	3	35	☾ First Quarter.
23.	17	26	18	☌ ♀ ♄
24.	17	7	30	☌ ♂ 132 ♉
24.	22	49	22	☌ ☽ ι ♍
27.	14	33	50	☌ ☽ δ ♏
29.	1	0	0	☌ ☽ B Oph.
30.	9	55	9	○ Full Moon.
30.	17	57	11	☌ ☽ ο ♐
30.	20	11	23	☌ ☽ π ♐
30.	13	43	56	☌ ☽ d ♐

On the 31st of May and 1st of June there will be a very small Eclipse of the Moon, which will be visible.

	D.	H. ′ ″
The Eclipse begins,	May 31	23 38 22
Ecliptic opposition,		23 42 35
Middle,		23 53 7
End of Eclipse,	June 1	0 7 51

Digits eclipsed, 0° 12′ 25″, by the south side of the Earth's shadow, or on the north part of the Moon's disc.

Times of the Planets passing the Meridian.

April.						
	Mercury.	Venus.	Mars.	Jupiter.	Saturn.	Georgian.
D.	H. ′	H. ′	H. ′	H. ′	H. ′	H. ′
1	12 25	14 49	12 57	19 45	15 21	6 45
5	12 39	14 44	12 52	19 30	15 17	6 33
10	12 55	14 29	12 45	19 10	14 59	6 11
15	13 8	14 28	12 40	18 52	14 41	5 54
20	13 14	14 16	12 34	18 34	14 24	5 34
25	13 13	14 1	12 29	18 15	14 7	5 15

May.						
	Mercury.	Venus.	Mars.	Jupiter.	Saturn.	Georgian.
D.	H. ′	H. ′	H. ′	H. ′	H. ′	H. ′
1	13 1	13 37	12 23	17 53	13 40	4 51
5	12 45	13 17	12 19	17 40	13 33	4 34
10	12 19	12 50	12 13	17 21	13 15	4 15
15	11 53	12 18	12 8	17 4	12 59	3 55
20	11 21	11 48	12 3	16 48	12 42	3 35
25	10 57	11 19	11 58	16 31	12 25	3 16

June.						
	Mercury.	Venus.	Mars.	Jupiter.	Saturn.	Georgian.
D.	H. ′	H. ′	H. ′	H. ′	H. ′	H. ′
1	10 33	10 39	11 50	16 7	12 0	2 46
5	10 27	10 20	11 47	15 57	11 49	2 30
10	10 24	10 0	11 43	15 38	11 36	2 10
15	10 28	9 45	11 38	15 22	11 15	1 50
20	10 36	9 29	11 32	15 7	10 55	1 30
25	10 52	9 18	11 27	14 50	10 39	1 9

Art. XXVI.—*Proceedings of the Royal Society of Edinburgh.* (Continued from last Number, p. 175.)

Jan. 3. 1825.—The following paper was read: *On the Dispersion of Stony fragments remote from their native beds*, as displayed in a statum of Loam near Manchester, by Dr Hibbert.

Jan. 17. There were read, 1. *Description of Fergusonite*, a new Mineral Species, by Mr Haidinger. 2. *Extracts from a Journal of Travels through part of Persia*, by James Baillie Fraser, Esq.

Feb. 7.—There were read, 1. *A Memoir on a singular Block of Stone*, occupying the Summit of a Hill at Dunkeld, by Dr MacCulloch. 2. *Description of Withamite*, a new Mineral Species found in Glenco, by Dr Brewster.

Feb. 21. There were read, 1. *Account of a Sepulchral Urn*, containing fragments of Bones, and a Boar's Tusk, found near the village of Rathen, in Aberdeenshire, by John Gordon, Esq. of Cairnbulgh. 2. *Description of a New Photometer*, with its application, by Mr William Ritchie, A. M. Rector of the Academy of Tain. 3. *On the first introduction of Greek Literature into England after the Dark Ages*, by Patrick Fraser Tytler, Esq.

Art. XXVII.—*Proceedings of the Wernerian Natural History Society.* (Continued from p. 176.)

1824, *Dec.* 18.—At this meeting were read, 1. A communication from Dr Treviranus of Bremen, *On the Cochlea of the Internal Ear of Birds;* 2. Notice by Mr J. W. Reddoch of Falkirk, regarding the bones of a quadruped found in a bed of clay, and of razor-shells found in a bed of sand under the clay, near Camelon, 90 feet above the present level of the Forth; 3. Description, by Dr Traill of Liverpool, of a new species of Silurus, *S. Parkeri*, found in the river at Demerara in 1821.

At this meeting the following gentlemen were admitted members:

NON-RESIDENT:

Sir David Moncreiffe, Bart.
Jacob Verzfeld, Esq.

FOREIGN:

Dr Keyser, Professor of Chemistry and Natural Philosophy at Christiania.

1825, *Jan.* 8.—Dr Knox read a short communication, shewing, that the bones found in the bed of clay near Camelon, (noticed above), were those of a seal, of the species still inhabiting the Frith of Forth, *(Phoca vitulina).*—The first part of Dr Richardson's *Remarks on the Climate and Vegetable Productions of the Hudson's Bay Countries* was then read.

Jan. 22.—The Secretary read the second part of Dr Richardson's Remarks, containing *Observations on the Climate at Fort Enterprize, Lat.* 64° 28′ *N.; Long.* 116° 6′ *W.; with an account of the progress of Spring and Summer, at that station, in the year* 1821.—Dr Greville read extracts from, and gave a general account of, the third memoir, by himself and Mr Arnott, on a *New arrangement of the Musci.*—There was also read an account of a *New species of Ornithorynchus* (O. crispus), drawn up by Mr William Macgillivray; specimens of the new species, and of the one formerly described, being at the same time placed on the table.—Professor Jameson gave an account of the *Sea Leopard* from New South Orkney, a large animal, of the genus Phoca, and of the *Eared Seal* from New South Shetland. Specimens of both, brought home by Captain Weddel, were exhibited to the meeting.

Feb. 5.—The concluding part of Dr Richardson's *Observations on the Botany of the Hudson's Bay Countries*, was read. The Secretary was directed to communicate to Dr Richardson the thanks of the Society for his valuable paper (read at this and two preceding meetings): And, on the motion of Professor Jameson, received with acclamation, he was directed at the same time to convey to the Doctor and to Captain Franklin the cordial good wishes of the Society, for the successful issue of the enterprizing and perilous journeys which they are about to undertake, for the second time, in the service of their country, and for the furtherance of science. [Dr Richardson's paper is printed in the present Number of this Journal, p. 197. *et seq.*]

At this meeting the following communications were also read. 1. Notice of the occurrence of Mineral Pitch in *Primitive* rocks in Ross-shire; by Mr Witham of Lartington. 2. Account of fossil-trees found in secondary trap-rocks at Cleghorn in Lanarkshire, illustrated by specimens; by Mr John Baird. 3. Notices regarding the Rhinoceros' horns of Blair-Drummond, tending to shew that they may probably be regarded as having occurred in the blue clay of that district; by Mr A. B. Blackadder, Allan Park. 4. Account of some remarkable fossilized trunks and branches of trees found in a quarry near Coldstream; fine specimens of which were exhibited.

At this meeting, the following gentlemen were admitted members:

RESIDENT:

Henry Englefield, Esq.
William Gibson Thomson, Esq.

NON-RESIDENT:

Dr Colin Rogers.
Richard Davie, Esq.
Joseph Mitchell, Esq.

FOREIGN:

Professor Hansteen of Christiania.
Professor Rathke of Christiania.

Feb. 19.—The Secretary gave a general account of two communications received from Captain Franklin, viz. 1. *Tables of Summer Temperature observed in Spitzbergen*; and, 2. *Table of the Temperature of the Sea at various depths, made during the voyage to Spitzbergen.* [Both these interesting tables are given in the present Number of this Journal, pp. 232, 234.]

There were then read, 1. Account of fossil-trees, &c. found imbedded in the clay strata near Harwich, by Mr William Knott, Landguard Fort; 2. Notice in regard to a collection of buried trees, apparently native species, lately discovered in the course of draining a peat-moss in West Lothian, in a letter from Mr Logan of Clarkstone, to Mr A. Blackadder.—Professor Jameson gave an account of a sandstone cast of a large fossil tree or arboreous stemmed plant, lately found in the quarry at Cullalo in Fife; the specimen being at the same time exhibited.

A series of observations made at Guayaquil, by Mr William Jameson, surgeon, contained in a letter to Professor Jameson; also, observations made during a voyage to the East Indies and China, in 1817 and 1818, by Captain Charles Stewart of the Honourable East India Company's ship General Harris; were laid on the table.

Dr R. E. Grant then read the first part of a memoir, containing a *Series of observations and experiments on the natural history of Sponges*, which he illustrated by means both of living and of dried specimens.

Art. XXVIII.—SCIENTIFIC INTELLIGENCE.

GEOGRAPHY.

1. *Scylla.*—As the breadth across this celebrated strait has been so often disputed, I particularly state, that the Faro Tower is exactly 6047 English yards from that classical bug-bear the Rock of Scylla, which, by poetical fiction, has been depicted in such terrific colours; and to describe the horrors of which, Phalerion, a painter, celebrated for his nervous representation of the awful and the tremendous, exerted his whole talent. But the flights of poetry can seldom bear to be shackled by homely truth; and if we are to receive the fine imagery, that places the summit of this rock in clouds, brooding eternal mists and tempests; that represents it as inaccessible, even to a man provided with twenty hands and twenty feet, and immerses its base among ravenous sea-dogs; why not also receive the whole circle of mythological dogmas of Homer, who, though so frequently dragged forth as an authority in history, theology, surgery, and geography, ought, in justice, to be read only as a poet. In the writings of so exquisite a bard, we must not expect to find all his representations strictly confined to a mere accurate narration of facts. Moderns of intelligence, in visiting this spot, have gratified their imaginations, already heated by such descriptions as the escape of the Argonauts, and the disasters of Ulysses, with fancying it the scourge of seamen, and that, in a gale, its caverns " roar like

dogs;" but I, as a sailor, never perceived any difference between the effect of the surges here, and on any other coast; yet I have frequently watched it closely in bad weather. It is now, as I presume it ever was, a common rock, of bold approach, a little worn at its base, and surmounted by a castle, with a sandy bay on each side. The one on the south side is memorable for the disaster that happened there, during the dreadful earthquake of 1783, when an overwhelming wave (supposed to have been occasioned by the fall of part of a promontory into the sea) rushed up the beach, and, in its retreat, bore away with it upwards of 2000 people, whose cries, if they uttered any, in the suddenness of their awful fate, were not heard by the agonized spectators around.—*Smyth's Memoir.*

2. *Charybdis.*—Outside the tongue of land, or Braccio di St Rainierè, that forms the harbour of Messina, lies the Salofaro, or celebrated vortex of Charybdis, which has, with more reason than Scylla, been clothed with terrors by the writers of antiquity. To the undecked boats of the Rhegians, Locrians, Zancleans, and Greeks, it must have been formidable; for, even in the present day, small craft are sometimes endangered by it; and I have seen several men-of-war, and even a seventy-four-gun ship, whirled round on its surface; but, by using due caution, there is generally very little danger or inconvenience to be apprehended. It appears to be an agitated water, of from seventy to ninety fathoms in depth, circling in quick eddies. It is owing, probably, to the meeting of the harbour, and lateral currents, with the main one, the latter being forced over, in this direction, by the opposite point of Pezzo. This agrees, in some measure, with the relation of Thucydides, who calls it a violent reciprocation of the Tyrrhene, and Sicilian Seas; and he is the only writer of remote antiquity I remember to have read, who has assigned this danger its true situation, and not exaggerated its effect. Many wonderful stories are told respecting this vortex, particularly some, said to have been related by the celebrated diver Colas, who lost his life here. I have never found reason, however, during my examination of this spot, to believe one of them.—*Smyth's Memoir.*

3. *Hansteen's projected Journey to Siberia.*—" I have endeavoured to shew (in the Christiania Journal), that the situa-

tion of the magnetic poles of the earth may be determined from observations with regard to the variation of the compass in their neighbourhood. The observations of the English navigators in the north-west polar seas, have proved, in the most satisfactory manner, the situation of the North American magnetic pole. In Siberia, where the other north magnetic pole lies, we have no determinations of that sort, except those founded on Stadtsraad Schubert's observations of the variation of the compass, which I have employed in that paper. In a particular manner, we want altogether the observations both with regard to the dip of the needle, and the magnetic intensity which are so necessary to determine the longitude of the magnetic axis, and its comparative internal force. To supply this want, and to promote the investigation of a theory so important both to navigation and to our physical knowledge of the earth, his Majesty our gracious King has given permission to the undersigned to undertake a journey of from two to three years through Siberia to Kamtchatka. Besides the magnetic observations, which are the chief purpose of this journey, experiments will be made with the pendulum, to assist in obtaining a more accurate determination of the figure of the globe, together with such observations as may tend to ascertain geographical, hypsometrical, and meteorological points; and, in short, every thing contributing to physical science, which ability, time and circumstances enable him to accomplish. He trusts, too, that steps will be taken to prevent so fine an opportunity of enriching natural history from passing without advantage *."—*Hansteen.*

HISTORY.

4. *Notice regarding Copernicus.*—The name of this celebrated

* It must be a matter of hopeful expectation to men of science to look forward to the accomplishment of the expedition which Professor Hansteen has here announced. Particular circumstances, we understand, have as yet prevented its commencement. We trust, however, that an undertaking so worthy of the patronage of the King, and of a country in which science is taking fast and deep root, will not be long delayed. In the mean time, the public will not fail to give the credit so amply due to the Professor, whose zeal for science, which he is so well qualified to promote, makes him desirous, leaving for so long a time his interesting family, to expose himself to the hardships and dangers of every kind attending such a journey, of which it is scarcely possible for us to have any conception.

astronomer was written Koppernick; he was a canon and physician, and occupied himself in directing buildings. The aqueducts which he constructed at Graudenz, Thorn, and Dantzig, still exist. He took 24 years to produce his famous astronomical system, against which the thunders of the Vatican were hurled when the author was dead. The sentence of condemnation was only repealed at Rome in 1821; Copernicus died in 1543. The monument which Bishop Kromer erected to him in the Cathedral of Frauenbourg, no longer exists. Prussia claims Copernicus as one of her sons, although, at this period, Thorn did not belong to the Prussians.

METEOROLOGY.

5. *Temperature of the Sun.*—M. Dulong communicated to the Institute a letter from M. Pouillet, in which that philosopher announced, that he was occupied with experiments relative to the measure of very elevated temperatures, such as those on the surface of incandescent bodies, or bodies in ignition, of flames, and particularly of the sun. The instrument used by M. Pouillet to obtain these results, is founded on the properties of radiant heat, and principally on this datum, that a body, the bulb of a thermometer for instance, perfectly insulated in the midst of a sphere of ice, but so placed as to receive the rays of the sun through a circular aperture of such a form and position, that all the lines, forming tangents to the sun and the ball, may pass through it, will be heated precisely in the same manner as if it were supposed that a portion of the surface of the sun, or of a body heated to the same temperature, exactly filled the aperture in the ice. M. Pouillet, among other results, states, that the temperature of the sun, thus determined, is 1400° (2552° F.).

6. *Luminous Snow Storm on Lochawe.*—Towards the latter end of March, in the year 1813, a shower of snow fell on Lochawe in Argyleshire, which alarmed or astonished those by whom it was witnessed, according as they were influenced by curiosity or superstition.—Some gentlemen, who had crossed the lake in the morning, had a good opportunity of marking the phenomenon. All had been calmly beautiful during the day, and they were returning homewards from

Ben Cruachan, when, the sky becoming suddenly gloomy they rowed more smartly towards the shore in order to avoid the threatened storm. In a few minutes, however, they were overtaken by a shower of snow; and immediately after, the lake, which was of glassy smoothness, with their boat, clothes, and all around, presented a luminous surface, forming one huge sheet of fire. Nor were the exposed parts of their bodies singular in this respect, for to the eye they all seemed to burn, although without any feeling even of warmth. When they applied their hands to any of the melting snow, the luminous substance adhered to them as well as the moisture, and this property was not lost by the snow for twelve or fifteen minutes. The evening became again mild and calm, but lowering and very dark. The natives had not witnessed any similar appearance before; and many of them believed it the forerunner of some dire calamity that was to befal their mountain land. — *Rev. Colin Smith.*

7. *Form of Hailstones.*—Whilst ascending the volcano of Poracé, in the Andes, M. Humboldt had occasion to observe, that, during a hail-storm, the hailstones, which were white, from five to seven lines in diameter, and formed of layers of different translucency, were not merely very much flattened at the poles, but were so much swelled in their equatorial dimensions, as to have rings of ice separate from them on the slightest blow. M. Humboldt had twice previously observed this phenomenon in the mountains of Bareuth, and near Cracow, during a journey in Poland. "May it be admitted, that the successive layers, which are added to the central nucleus, are, in a state of fluidity, sufficient to allow of the flattening of the spheroids being caused by a rotatory movement?"—*Ann. de Chim.* xxvii. 120.

8. *Falling Star seen at Mid-day.*—"On the 13th August 1823, at a quarter past eleven in the forenoon, as I was employed in measuring the zenith distances of the pole-star to determine the latitude, a luminous body passed over the field of the universal instrument telescope, the light of which was somewhat greater than that of the pole-star. Its apparent motion was from below upwards; but as the telescope shows images in an inverted position, its real motion, like that of every falling,

body, was from above downwards. It passed over the telescope in the space of a second or a second and a half, and its motion was neither perfectly equal nor rectilinear, but resembled very much the unequal and somewhat serpentine motion of an ascending rocket, from the unequal burning of the charge, and the irregular reaction of the stream of air issuing from it on the atmospheric air. It was thus evident, that this meteor moved in our atmosphere; but it must have been at a considerable height, since its angular motion was so slow. This is perhaps the only instance in which a shooting-star has been seen at mid-day in clear sun-shine."—*Hansteen.*

9. *Quantity of Rain near Hexham.*— The Reverend Mr Wastell of Newbrough, near Hexham, Northumberland, has for several years past kept a very accurate register of the quantity of rain which has fallen there, as indicated by one of Mr Adie's best gauges. The following is the monthly report for 1824.

	Inches.		Inches.
January	0.96	July	1.31
February	0.98	August	1.72
March	1.69	September	2.61
April	0.84	October	2.43
May	1.19	November	4.11
June	1.35	December	4.78
			23.97

The total depth of rain in 1824 has not been quite an average. The following were the annual quantities ascertained at Newbrough for the three preceding years.

In 1821,	-	27.41
1822,	-	26.98
1823,	-	23.54

It may be noticed, that the quantity of rain which fell near Wakefield in Yorkshire, in September and October last, was much greater than at Hexham.

10. *Meteorological Table, extracted from the Register kept by Lord Gray, at Kinfauns Castle, North Britain. Lat.* 56° 23′ 30″.—*Above the level of the Sea* 129 *feet.*

1824.	Morn. 10 o'clock. *Mean height of* Barom.	Morn. 10 o'clock. *Mean height of* Ther.	Even. 10 o'clock. *Mean height of* Barom.	Even. 10 o'clock. *Mean height of* Ther.	Mean Tempr. by Six's Ther.	Depth of Rain. Inches.	N° of days. Rain or Snow.	N° of days. Fair.
January.	29.799	41.193	29.829	41.322	41.933	1.35	8	23
February.	29.710	40.193	29.700	39.517	40 862	1.45	11	18
March.	29.660	39.774	29.670	37.548	39.451	1.05	11	20
April.	29.779	46.980	29.728	43.366	45.370	1.00	9	21
May.	29.915	52.677	29.901	47.258	50.710	.40	6	25
June.	29.858	58.533	29.833	52.700	56.400	1.95	9	21
July.	29.802	60.387	29.800	56.419	59.420	1.80	9	22
August.	29.798	58.710	29.787	54.258	57.450	1.70	16	15
September.	29.743	54.800	29.714	52.066	53.960	2.20	13	17
October.	29.517	47.451	29.502	45.322	47.255	4.00	22	9
November.	29.317	40.966	29.320	40.200	41.433	4.40	13	12
December.	29 440	38.677	29.434	38.061	39.451	2.90	16	15
Average of the Year.	29.695	48.386	29.685	45.670	47.808	24.00	148	218

Annual Results.

MORNING.

Barometer.				*Thermometer.*		
Highest, 16th Jan.	30.54	Wind SW.		Highest, 14th July,	68°	Wind SW.
Lowest, 8th March,	28.41	E.		Lowest, 4th December,	25	W.

EVENING.

Highest, 15th Jan.	30.55	W.		Highest, 2d September,	65	SE.
Lowest, 23d Nov.	28.40	E.		Lowest, 4th December,	22	W.

Weather.	*Days.*	*Wind.*	*Times.*
Fair, - -	218	N. & NE. -	15
Rain or Snow, -	148	E. & SE. -	110
	366	S. & SW. -	55
		W. & NW. -	186
			366

Extreme Cold and Heat, by Six's Thermometer.

Coldest, 5th December, Wind W. 21°
Hottest, 14th July SW. 75
Mean Temperature for 1824. 47 808′

Result of Two Rain Gauges.

	Inches.
1. Centre of the Kinfauns Garden, about 20 feet above the level of the Sea, - - - -	24.00
2. Kinfauns New Castle, Round Tower, about 150 feet, -	20.18

GEOGNOSY.

11. *Human Skeletons found inclosed in Calcareous Tufa in India.*—To get at an aqueduct, which was to be repaired at Ahmedmygur in 1821, it was necessary to cut to the depth of fifteen or twenty feet, through a sort of sandstone which covered it. The stone, which is a calcareous tufa, is called by the natives Morrum, and the name is adopted by Europeans. It is found near the surface; of great thickness, in most parts of the Deccan; and in many places presents itself naked and barren. On digging for the aqueduct above mentioned, at the depth of eight or ten feet, there were found lying across its course several human skeletons completely imbedded in the morrum, or rather surrounded by it; for there remained the hollow space that had been occupied by the corpse, and above, below, and round it, the morrum appeared as solid as if it had never before been cut into. Now, as we know that the aqueduct, over which the skeletons were found, was only built about 300 years ago; that the ground over it had subsequently been a cemetry, that morrum, though ever so much broken, will, by the influence of water, unite again, and become compact; and that it is necessary, when the earth on the surface is thin, as at Poonah, to dig the grave into the morrum, we can account for those skeletons being so imbedded; but had we found them without a knowledge of such circumstances, we might have been led to consider them as remains of an earlier period, and to have been deposited there by other means.—*Captain Stirling.*

12. *Hyæna Caves in Devonshire.*—Professor Buckland has lately examined two caves in Devonshire, in both of which he found, in a bed of mud beneath a crust of calc-sinter, gnawed fragments and splinters of bones, with teeth of hyænas and bears. There were no entire bones except the solid ones of the toes, heels, &c., as at Kirkdale, which were too hard for the teeth of the hyæna. They appear simply to have been dens, but less abundantly inhabited than that at Kirkdale. In the same cave, Professor Buckland found one tooth of the rhinoceros, and two or three only of the horse.

13. *Remains of the Fossil Elephant found in Ayrshire.*—Tusks of the fossil Elephant were last month found in old al-

luvial strata, at the water of Carmel. The details of this interesting discovery will be inserted in next number of Journal.

ANTHROPOLOGY.

14. *Frequency of Goitres, especially in Women, in the river district of the Paraiba.*—Among the inhabitants of this place, in the river district of the Paraiba, we observed an endemic swelling of the glands of the neck, in such a high degree as is perhaps nowhere to be found in Europe. Frequently the whole neck is covered with the great swelling, which gives a horrid appearance to these people, who are for the most part mulattoes, and have, independent of this, no very agreeable features. But, in this country, they seem to regard this swelling rather as a particular beauty than as a deformity; for we often saw the women adorn this enormous goitre with gold or silver ornaments, and, as it were, displaying it, while they sat before their house-doors with a tobacco-pipe in their hand, or a reel to wind cotton. We have annexed a drawing of one of these women in her national costume. Negroes, mulattoes, descendents of whites and Indians (*Mamelucos*), which form the greater part of its population, are peculiarly subject to this disorder; among the whites the women have it more commonly than the men. The causes of this deformity seem to be quite the same here as in other countries. For it does not occur in the high, colder, and airy mountainous districts, but in the low valley of the Paraiba, which is often covered with thick fogs. The reason of this is, that the direction of the two chains of mountains from south to north, does not allow a free issue to the exhalations and vapours: the same mists which, during the day, rise from the river and the neighbouring marshes, which are partly covered with thick woods, fall again into the valleys at night; the warmth is at the same time considerable, and the water of the river, which is often very muddy, impure, and lukewarm, must supply the place of spring-water. Their habitations, too, are uncleanly, damp, and windy. The raw flour of maize, which is here more frequently used than that of mandiocca, and is, though more nourishing, more difficult of digestion, and eating much pork, may likewise contribute to the development of this disease. Perhaps excess in sexual enjoyments may be considered as one cause of the goitre,

as it is at Rio of the sarcocele and hydrocele. It is true, we do not here see the melancholy appearances of idiocy which are so frequently combined in Europe endemically with the goitre; yet the look of the persons who have the disorder in a high degree, is not merely drowsiness and want of energy, but even stupidity, in the strict sense of the expression. It is customary to apply, at the commencement of the disease, poultices of warm gourds, the patient at the same time drinking water, which has stood for several days upon the pounded mass of large ant-hills. The component parts of the ant-hills, which are from five to six feet high, in the construction of which the insect makes use of a peculiar animal slime as a cement, certainly seem capable of counteracting the causes which produce the goitre. Perhaps, too, the acid of ants may have a beneficial influence on the relaxed nerves of the patient, as well as on the debility of the lymphatic system. The negroes here, as in Africa, make much use of mucilaginous substances: they use, for instance, gum arabic against the goitre with good success; a mode of treatment which seems to point at the origin of this disease as proceeding from diet.—*Spix and Martius' Travels.*

ZOOLOGY.

15. *Acute Rheumatism observed in the Horse.*—Rheumatic affections are very frequent in domestic animals, and yet the works on veterinary medicine contain few examples of them. It is therefore useful to collect with care all the facts of this nature, in order to fix the attention upon a disease which is the cause of the greater number of those incurable claudications, which baffle the skill of the physician. Towards the end of August 1818, a sound horse, which had till then been in good health, appeared less free than usual in the motions of his fore legs. This constraint increased progressively, and especially in the left fore leg, so that on the 27th, the animal could with difficulty support himself. The appetite was good, the pulse regular, the diseased part was not sensible to the touch. On the following day the animal did not limp on the left leg, while he could with difficulty draw the right one along. The claudication increased or diminished, and even disappeared, several times during a month, sometimes attacking one limb, sometimes the other, ac-

cording to the alternation of good and bad weather. At length a month of dry weather produced so sensible an effect, that six months after the animal had not experienced any new accession.

16. *Salmon of different rivers can be distinguished from each other.*—With respect to the opinion entertained by many, that the salmon of one river can be distinguished from those of another, a strong analogical evidence is derived from the common trout, the Salmo Fario, which every body knows exhibits the greatest differences from one river to another. Even in the same lake, this species will exhibit, at different places, characters so marked and so very different, that a person ignorant of the great variation produced by circumstances, might fancy a multitude of distinct species. In Loch Langavad, for example, in Harris, at the western extremity, among the rushes and scirpi, with a muddy bottom, the trouts are moderately large, and darkish coloured beneath, with white flesh in general. Farther on towards the east, among the small islands, where the bottom is rocky and pebbly, the trouts are smaller, more lively, brighter beneath, and with the spots more vivid, and the flesh, at least in May, June and July, is red. On the south side, about the middle, in deep water, the trouts are large, strong, with few spots, and with a tint of yellow upon the belly, mixed with dark grey. On the same side, near the east end of the loch, the trouts have more yellow beneath. On the north side, in a bay nearly land-locked with shallow water, they are very small, with white flesh. In many of the small lakes in the neighbourhood, and in the rivulets, they are of this last kind; but in one small and deepish lake, filled with Nymphæa alba and carices, near the western extremity of this lake, the trouts are very strong, thick at the tail, with the belly deep yellow, and the flesh red.—*Mr Macgillivray.*

PHYSIOLOGY.

17. *Case of sleep continuing for 451 days.*—A sanitary report of a Prussian physician, addressed during the month of August, to the authorities, contains what follows. At Medebach in Westphalia, a young woman of twenty years has slept 451 days. She was wakened only with difficulty, in order to

make her take food, and immediately after slept again. From the commencement of her sleep, she only wakened once of her own accord. All the functions, even the periodical evacuation, are regularly performed; the heat and pulse presented nothing particular. No cause could be discovered for this extraordinary sleep, unless it might be a hurt which she had previously received on the head. Two physicians are observing the case attentively.

18. *Quantity of Blood in Animals.*—Those who have not considered the subject, must be surprised at the quantity of blood which passes through the heart of any moderately sized animal, in the course of twenty-four hours. In man the quantity of blood existing in the body at any given moment is probably from 30 to 40 pints. Of this, an ounce and a half, or about three table spoonfuls are sent out at every stroke; which multiplied into 75, (the average rate of the pulse) give, 112.5 ounces, or seven pints in a minute; *i. e.* 420 pints, or 52.5 gallons, in an hour; and 1260 gallons, *i. e.* nearly 24 hogsheads in a day. Now, if we recollect that the whale is said to send out from its heart at each stroke 15 gallons, the imagination is overwhelmed with the aggregate of the quantity that must pass through the heart of that animal in twenty-four hours. It is a general law, that the pulse of the larger animals is slower than that of the smaller: but even if we put the pulse of the whale so low as 20 in the minute, the quantity circulated through the heart, calculated at 15 gallons for each pulsation, will be 432,000 gallons, equal to 8000 hogsheads in twenty-four hours. The consideration of this amazing quantity is however a subject of mere empty wonder, if not accompanied with the reflection, that, in order to produce the aggregate amount, the heart is kept in constant motion; and that, in fact, it is incessantly beating, as it is termed, or throwing out the blood into the arteries, from the first period of our existence to the moment of our death, without any sensation of fatigue, or even without our consciousness, excepting under occasional corporeal or mental agitation.—*Dr Kidd.*

19. *On the Causes of Animal Heat.*—The following are some of the conclusions obtained by M. Despretz, during the course of his experimental investigations of the causes of animal heat; 1. Respiration is the principal cause of the development

of animal heat; assimilation, the motion of the blood, the friction of various parts, may produce the small remaining portion. 2. Besides the oxygen employed in the production of carbonic acid, another portion of this gas, which is sometimes very considerable in proportion to the first, disappears; it is supposed generally, that it is employed in the combustion of the hydrogen of the blood. In general more oxygen disappears in the respiration of young animals than in that of adults. 3. Exhalation of nitrogen takes place in the respiration of those mammiferous animals, which are carnivorous or frugivorous, and in the respiration of birds; the quantity of nitrogen exhaled being greater in frugivorous than in carnivorous animals.—*Ann. de Chim.*, xxvi. 360.

20. *Lizars on the Ovaria.*—Mr Lizars, Lecturer on Anatomy and Surgery, is about to publish an account of his operations in extracting morbid ovaria, which have been eminently successful. We have seen the beautiful drawings intended for Mr Lizars's work. They represent the colours, surface, and form of the ovaria; but representations of internal structure ought also to be given.

21. *Seeing in Water.*—In experiments made with the view of determining whether or not we can see under water, some individuals maintained that they could see, while others, with equal confidence, asserted, that all around them was dark. In explanation of this seeming contradiction, it may be remarked, that in some individuals, owing to the delicacy of the conjunctiva and lachrymal gland, the eye remains shut when immersed in cold water; others, whose eyes remain open, and who maintain that they see under water, actually do not see the *forms of objects*, only the light reflected from bodies having a bright surface, as silver. The pearl fishers of antiquity are said to have used glasses of a particular kind, to enable them to see the pearl mussels. Instruments for seeing under water have been proposed by modern artists.

CHEMISTRY.

22. *Presence of Mercury in Common Salt.*—Boyle, Stahl, Senac (Athanasius), Kircher, Glauber, and many other chemists, have presumed the existence of mercury in common salt. Hil

Rouelle, in 1777, published the fact, that sea-water formed spots of amalgam upon the walls of a silver vessel in which it had been distilled, and that the salt, which was produced, treated with sulphuric acid, gave rise to a mercurial deposit in the neck of the retort. Fifteen years after, Westrumb, making concentrated sulphuric acid act upon salt of the Pyrmont salt-works, in presence of the author, equally obtained a product of sublimation, in which the presence of mercury as well as that of iron were determined. Results of experiment, from which the same consequences as the preceding may be deduced, have been since announced by Proust and Scherer. The author, lastly, having prepared muriatic acid with a mixture of salts obtained from various salt-works in Germany, has equally collected a volatile matter containing mercury and iron. He calls the attention of chemists to these phenomena, and, in accordance with M. Proust, recommends that a small plate of gold be fixed to the keel of a vessel, and it be examined, at the end of a long voyage, if it be not covered with mercury.—*Professor Wurzer.*

23. *Reid's Academical Examinations.*—The first volume of this work has just been published, the second and concluding one will appear soon. Mr Reid's arrangement is good,—the chemical details correct,—the exposition of general principles and views luminous; and the language suited to the subject. We have therefore no hesitation in recommending this interesting little work to chemical and medical students.

ARTS.

24. *Composition of an Ink similar to China Ink.*—Take six parts of isinglass, which are to be dissolved in double their weight of boiling water; in like manner, dissolve in two parts of water one part of Spanish liquorice; mix the two liquors warm, and gradually incorporate with them, by means of a wooden spatula, one part of the best ivory-black. When this mixture is properly made, it is heated in a water-bath, that the whole of the water may be evaporated. The requisite form is then given to the paste which remains. The colour and goodness of this ink are equal to those of the true China ink.

25. *Engraving on Zinc.*—There has lately been published by Leske, the bookseller, at Darmstadt, the first large work of

which the plates are executed in zinc. It is a collection of monuments of architecture, which will consist of twenty numbers. The work is done on zinc in the same manner as on stone, and the expence of engraving is thus avoided; hence the publisher has been enabled to sell the number, consisting of twelve folio plates, at five francs upon common paper. In an economical point of view, this method, therefore, deserves to be recommended. We see by the German journals, that M. Eberhard, author of the collection in question, has recently published a pamphlet upon the use of zinc, with the view of replacing copperplates and lithographic stones, for engraving and designing; 8vo. with 10 plates, Darmstadt 1824.

26. *Observation regarding the Alcanna of the Orientals, or Egyptian Henné.*—M. Virey having received some of the powder of henné, sent to him from Egypt, is induced to publish some remarks upon the employment of this cosmetic and tinctorial vegetable, the use of which is extremely ancient in all the countries of the east, for dyeing the fingers and nails, and sometimes the feet, of women. This practice has been so extended over the globe, with the conquests and religion of the Arabians, that it is found to exist at the present day from Damietta to Macao. It is used for dyeing skins and maroquins of a reddish-yellow. Messrs Berthollet and Descotils have not found any tannin in it, although it precipitates sulphate of iron black, which indicates the presence of gallic acid. The acids diminish its reddish-yellow colour, the alkalies deepen it. According to the above-mentioned chemists, wool may be died with the henné of a good yellowish red or brown colour. An orange-red colour is also extracted by alcohol. According to Russel and Forskal, it is sufficient to apply to the skin the leaves of the henné, beaten to a paste, and rub it with the hands when it is wished to colour it. Old women tinge their hair brown in the same manner, and some old men of the lower sort the beard also, when it has grown white. When it is wished to render this colour more brown, the juice of green nuts is added.

27. *Native Oil of Laurel used in Spanish Guyana.*—The inhabitants of Spanish Guyana extract, under the name of *Azeyte de Sassafras*, an oil from a species of tree of the natural family of Laurels. This tree abounds in the forests of Parimia, and on

the banks of the Orinoko. The natural oil obtained from it is similar to other volatile oils obtained by chemical processes, and although rectified it is heavier than alcohol. It remains transparent, its taste is warm and pungent, its smell aromatic. It is very inflammable, and burns entirely. Acids and alkalies have little action upon it. It is soluble in alcohol and ether, and dissolves camphor, caoutchouc, wax, resin, &c. It is employed externally as a discutient, and internally as a diaphoretic, diuretic, and resolvent. The Indians regard it as an infallible remedy against rheumatisms and pains of the kidneys. The decoction of the root of the tree is also employed for the same purpose.—*Journ. de Pharm.* No. xi. p. 547.

28. *Chica, a Pigment used by the Indians of the Orinoko to stain the Skin red.*—The native Americans on the banks of the Orinoko, use two species of dye for the purpose of staining the skin red. One of these is the product of the *Bixa Orellana*; the other is the extract of the leaves of *Bignonia Chica*, which is cut into round cakes five or six inches in diameter, and two or three in thickness, and dried. Experiments have been made upon this substance, from which it appears, that the *chica* has some peculiar properties, by which it is distinguished from other vegetable principles; and though it approaches in nature to the resins, it differs from them in being infusible by heat, without decomposition; it not being separable by water from its solution in alcohol and sulphuric acid, and in being readily soluble in ammonia, which does not touch the true resins. The *chica* is begun to be used for dyeing cotton, to which it gives an orange-red.—*J. B. Boussingault.*

29. *Brown's Pneumatic Engine.*—The principle of this engine appears to be nothing more nor less than a very sudden expansion and condensation, not of the gases used in the operation, but of the small quantity of water formed from the combustion of the hydrogen with the oxygen of the atmospheric air, admitted into the cylinder at every stroke of the engine. When the union of these two gases takes place at a very high temperature, as is the case in Mr Brown's model, exhibited in Printing-house Square, London, the water generated is instantly converted into steam of a high degree of elasticity, filling the capacity of the cylinder with an elastic fluid capable of instantaneous

condensation by cold. This sudden expansion of the steam produced from the union of the two gases, expels from the cylinder a great proportion of the gaseous fluids, incapable of condensation; and, in fact, operates so much like the steam in a common engine, that Brown's discovery may still with propriety be called a steam-engine,—with this difference, that the elastic and condensible fluid is generated at a high temperature, from materials admitted into the cylinder itself. The extent of power, or the vacuum produced, must depend upon the temperature at which the combustion takes place; a slow combustion producing steam of a low degree of elasticity, while a rapid union of the gases will highly expand the steam, and effect an extent of vacuum when condensed, corresponding to the degree of its previous expansion.—*Edinburgh Times.*

30. *Loco-motion steam-carriage.*—We understand, that two engineers of this neighbourhood, (Messrs Buntals and Wilt,) have recently taken out a patent for a loco-motive or steam-carriage, considered by the patentees to be adapted as well to common roads as railways. The whole weight of a coach, with machinery, water and coal, will not be above a ton heavier than the present stage-coaches, while the power may be readily varied from two to ten horses, according to the inequality of the road. The speed at present contemplated, is twelve miles per hour; and if the inventors, (who are represented to us as ingenious and experienced practical engineers), have not, like many other projectors of the present day, deceived themselves, our next number may have to record an important application of steam power.

ART. XXIX.—*List of Patents granted in Scotland from 2d December* 1824 *to 7th March* 1825.

70. TO ROBERT BOWMAN of Aberdeen, Scotland, chain-cable-maker, for "an improved apparatus for stopping, releasing, and regulating chain and other cables of vessels, which he denominates Elastic Stoppers." Sealed at Edinburgh 16th December 1824.

71. To Pierre Jean Baptiste Victor Gosset of Clerkenwell Green, county of Middlesex, merchant, for "certain improvements in the construction of looms or machinery for weaving various sorts of cloths or fabrics." Sealed at Edinburgh 30th December 1824.

72. To John Potter of Smidley, near Manchester, County Palatine of Lancaster, spinner and manufacturer, for "certain improvements in looms, to be impelled by mechanical power, for weaving various kinds of figured fabrics, whether of silk, cotton, flax, wool, or other materials or mixtures of the same, part of which improvements are applicable to hand-looms." Sealed at Edinburgh 30th December 1824.

1. To David Gordon of Basinghall Street, London, Esq., for "certain improvements in the construction of portable gas-lamps, and which improvements are applicable to other apparatus for facilitating the use of compressed gas." Sealed at Edinburgh 1st January 1825.

2. To Walter Forman, Esq. of Bath, county of Somerset, Commander in the Royal Navy, for "certain improvements in the construction of steam-engines." Sealed at Edinburgh 17th January 1825.

3. To Thomas Wolrich Stansfeld of Leeds, county of York, merchant, for "improvements in looms, and in the preparation of warps for the same." Sealed at Edinburgh 17th January 1825.

4. To William Shelton Burnett of New London Street, in the city of London, merchant, for "certain improvements in ships' tackle." Sealed at Edinburgh 1st February 1825.

5. To David Gordon of Basinghall Street, London, Esq., for "certain improvements in the construction of carriages or other machines, to be moved by mechanical powers." Sealed at Edinburgh 9th February 1825.

6. To Lieutenant William Hopkins Hill, Royal Artillery, of Woolwich, county of Kent, for "certain improvements in the machinery of propelling vessels." Sealed at Edinburgh 10th February 1825.

7. To John Phipps of Upper Thames Street, London, paper-

maker, and Christopher Phipps of the parish of River, county of Kent, paper-maker, for "an improvement or improvements in machinery for making paper." Sealed at Edinburgh 14th February 1825.

8. To Stephen Wilson of Streatham, in the county of Surrey, Esq., who, in consequence of communications made to him by a foreigner residing abroad, is in possession of "a new manufacture of stuffs with transparent and coloured figures, which he calls Diaphane Stuffs." Sealed at Edinburgh 21st February 1825.

9. To James Surrey of Battersea, county of Surry, miller, for "a new method of applying heat for the production of steam, and for various other purposes, whereby the expence of fuel will be lessened." Sealed at Edinburgh 22d February 1825.

10. To Richard Badnall, the younger, of Leck, county of Stafford, silk-manufacturer, for "certain improvements in the winding, doubling, spinning, throwing or twisting of silk, wool, cotton, or any other fibrous substances." Sealed at Edinburgh 5th March 1825.

11. To Thomas Masterman of the Dolphin Brewery, 38. Broad Street, Ratcliffe, county of Middlesex, common brewer, for "an apparatus for bottling wine, beer, or other liquids, with increased economy and dispatch." Sealed at Edinburgh 7th March 1825.

12. To John Masterman of 68. Old Broad Street, London, gentleman, for "an improved method of corking bottles." Sealed at Edinburgh 7th March 1825.

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