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PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

CONDUCTED BY

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Errata in Dr Davy's Paper on the Combination of Carbonic Acid and Ammonia (Journal of April 1834.*)*

Page 5, Note, line 2, *for* fillet *read* pellet
... 10, line 1, *for* committed *read* connected
... 11, ... 18, ... or ... on
... 13, ... 5, ... maximum ... minimum
... 15, ... 20, ... *after* if *insert* the heat (Thus, which if the heat applied, &c.)

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On Terrestrial or Epigeic Deposits on the surface of the Morea.

By the term *Terrestrial* or *Epigeic deposits*, we mean all products formed on an emerged part of the surface of the earth. Though their loose texture exposes them to destruction during all great movements of the soil, there is no country where they ought not to be able to preserve themselves in some localities. In every region of the globe, a series of deposits of this nature should exist, more or less ancient, more or less continuous, parallel with that of marine deposits. Their age reaches back to the first emerging of solid rock, and their composition entirely depends on its nature.

The Morea had already partially emerged at the time of the deposit of the tertiary gompholites, which, in our opinion, resemble the nagelflue of Switzerland; great dislocations, upraisings from 1000 to 1200 metres, accompanied their appearance, entirely changed the form of the surface, and the anterior epigeic deposits must have almost entirely disappeared; but, in commencing at this epoch, the Morea having assumed, as we are going to show, the principal inequalities of its surface, we ought to find in it some epigeic deposits of the sub-appenine period, and all those of the succeeding period even to the present time.

The *period* which we embrace, accordingly, comprehends not only the sub-appenine epoch, but also that of the various upraisings which have given to Greece its present physiognomy, an effect produced not by a single movement, but by successive upraisings, and, in short, the present epoch.*

Before entering upon this new series of facts, we shall take a glance at the aspect presented by Greece at the moment when the deposition of our tertiary formations was suspended.

The Peloponnesus, then, formed an island not so elevated as at present, of which, a horizontal curve traced between 300 and 400 metres above the level of the sea, might almost represent an outline. Abrupt mountains descended every where into the sea, like the rocks on the eastern coasts of Laconia and a part of Argolis, without the existence of any intermediate plain or shore.

It varied only in a few localities of minor extent, such as the bottom of the gulf occupied at present by the Elis, where the ancient tertiary formation (the gompholites) already raised up, formed the high table-land of Mount Pholoë, and bordered the base of the mountains. Almost the whole of the Elis was under water. Messenia was in the same state, the gulf of which extended to the base of Mount Lycaeus, between the chain of the Taygètus and an archipelago, of which the mountains of Mali, between Arcadia and Messenia, those of Lycodimo or *Timathias*, and the summits of Cape Gallo, formed the three principal islands.

The Gulf of Laconia extended between two long narrow chains, as far as the sources of the Eurotas, and was united towards the north by a succession of lakes or depressions. In fact, those which we see at present (the basins of Tripolitzo, Orchomenus, and Phonia), chiefly formed by the crossing of the *Pindic* and Achaic, upraisings anterior to the sub-appenine deposit, ought to exist since that time in shapes but little altered.

The Gulf of Lepanto, bounded by two high chains flanked to the extent of 1800 metres by dislocated strata of gompholite, already separated Hellas from the Morea, and joined the Egean Sea by two outlets, north and south of the mountains of Megaris.

At that time the Archipelago was studded with almost all its islands; some of them, however, like the low isles adjoining the

* The present epoch is with us the *periode jovienne* of M. Brongniart, except that we do not assign fixed limits to it. It commences at the variable period, when the surface and lineaments of a country obtained the form and figure which we at present observe.

Continent, and wholly composed of tertiary deposits, were as yet only shallows. The massive trachytes of Egina, Mithana, Milo, and Santorin were above the water, though not so elevated as they are at present. Each of these islands remained a centre of volcanic operations, which afterwards elevated and disordered the newer tertiary deposits, and which have continued to manifest themselves more or less intensely to the present time.

On the other hand, a part of the present basin of the Mediterranean had become terrestrial or lacustrine; tertiary deposits and "atterrissemens" had united islands, inclosed gulfs, and produced lacustrine and fluviatile deposits, the *debris* of which we find on the summits of some islands, (as the Archipelago of Iliodroma, Rhodes, &c.)

In general, however, the narrow zone, having an almost constant level, which the tertiary sub-appenine deposit forms round the islands and continents, announces that even at that epoch all the great features of the surface of Greece had been delineated; and that a general rise, instead of dislocations, would suffice to give it the configuration which it has retained for upwards of four thousand years, without perceptible alteration.

In consequence of what we have said of the priority of depressions of basins closed or open in the interior of the Morea at the time of the deposition of the sub-appenine formation, it is evident that they may include the products of the same period, lacustrine, detritic, and alluvial, again covered by a succession of deposits of the same nature, formed during the whole period, even till the present time; but it would have been impossible for us to recognise and study the succession, if recent fractures of the soil had not formed openings, external or subterranean, for the waters of the closed basins, and had not in consequence caused their denudation. These different effects, the formation and destruction of terrestrial deposits, require, for that reason, a knowledge of the singular hydrogeic system of the Morea, or of the manner in which atmospheric water is collected on its surface, and reaches the sea by subterraneous passages.

This preliminary study will at the same time afford us a more general and natural explanation of the phenomena of continental caverns, and their deposits of osseous breccia; an explanation which does not require, like that of literal grottoes (see Memoir on the Action of the Sea, &c. *Journal de Geologie*, No. 10), any hypotheses at variance with the causes which are at present in action.

Hydraulic Laws of internal Waters.—The year is divided, in a great portion of the Mediterranean shores, as in the tropics, into two distinct seasons; the one rainy, which lasts from four to five months, and the other dry; an observation of great importance, when studying the whole of the recent deposits in the Morea. The actual quantity of rain which falls exceeds one metre, at least on the southern and western slopes. One part of this enormous mass of water is carried directly to the sea with great rapidity, owing to the inclination and denudation of the mountains. The surplus is collected in the high enclosed basins of the interior, or loses itself in the clefts, with which the formation compact chalk is traversed on all sides, and in both cases is the source of the real subterraneous rivers, which traverse the mountains, and are poured out on the shore, or below the level of the sea. The springs formed by such rivers are called by the Greeks *Kephalovrysi*, or heads of waters, and these are accurately distinguished by the inhabitants from springs of an ordinary nature.

The division of the surface into enclosed basins, the greater part being without permanent lakes, is not peculiar to the Morea, but is found throughout Greece, Italy, part of the Iberian peninsula, Asia Minor, Syria, in short, in all the zone where secondary formations of the meridional basin prevail.

In all other parts of Europe, the waters being directed in their course by a small number of large inclined planes, unite with each other regularly from the ridges of the continents to the sea, or branch out around some principal trunks. The consequence of this is, that the geographers of those countries, influenced by forms with which they were best acquainted, and by a systematic notion of the formation of depressions or valleys by water, considered the regular disposition as a general law, and the other as an exception or a mere accident.

If, however, the regularity extended over the great plains of the north of Europe, from the enclosing of the waters, to the shape and relations of the valleys, it would do so more completely in mountainous districts, where we ought to see basins which are divided into stages, again united by clefts, as in the whole of the southern zone. The pre-occupation of systematic ideas, however, was such, that these were not seen, and do not even appear, in the pretended topographical charts, which, we must say, pervert even at this day the external appearances of the earth, by a conventional method derived from these very hydrographical inductions.

It is for the geologist to correct such topographical errors. Familiarized with the effects of the dislocations which the crust of the earth has experienced in various directions, he should consider that the disposition in basins, either enclosed or communicating by mere gorges, ought to be nearly general, and that the regular establishment of the hydraulic laws of the waters, and of the connection of valleys, is only the result, in certain countries, of the absence of dislocations, and in others the effect of the slow modifications of original forms;—but he should ask how these modifications, which, in the upraised and fractured strata of France, England, Sweden, and Germany, have conducted all the water from valley to valley, from the summits of the continents to the sea, have not been productive of the same effect in the southern region, where the centre of the islands and continents remains formed of hydrographical basins, of all sizes, and independent of each other.

Two causes must aid in producing this phenomenon, the one meteoric, the other geognostic. We are of opinion that the second only is applicable to the enclosed basins in the mountainous regions of Greece and Italy.

For a basin without a subterranean outlet to exist isolated from the lower valleys, it is necessary that there be an equilibrium between the quantity of water which falls, and that which is evaporated throughout the basin; or, in other words, that the quantity of water evaporated at the surface of the receptacle, surpass or equal that which falls on this extent, together with that which flows into it; a state of things which cannot exist in the greater part of Europe, and which we shall prove is not applicable to Greece. It may thus be conceived how, independent of the continued transportation of the alluvion, the progressive rising of the waters produces a communication between the enclosed basins and the inferior valleys, as is seen throughout nearly the whole of Europe; whilst in the south and east the same meteoric influences maintain the equilibrium in the waters of the Caspian, and the other enclosed Asiatic lakes; and that, still farther south, numerous interior seas diminish progressively, o. have even already disappeared.

In the Morea, the lake Phonia, which did not exist in 1814, and has now required a depth of 40 metres, in spite of the small size of its orographical basin, shows how far the conditions of equilibrium of which we have spoken, are from existing, at least in a mountainous region.

The declivities of various enclosed basins are so steep and naked, that almost the whole mass of the rain-water runs into the receptacle; so that it would be necessary to preserve equilibrium, that the quantity of water evaporated at the surface should be nearly equal to as many times the quantity of water fallen, as the whole surface of the basin contains that of the receptacle, which is inadmissible.

For this reason we should conclude, that the existence of all these enclosed basins of Greece, without permanent water and external communication, depends on other causes than atmospheric influences, and that the nature of the rock alone may furnish us with an explanation of it.

We shall, in the first place, remark, that the compact limestone formation which forms the circumference of these enclosed basins, produces detritic or alluvial materials in a much smaller quantity than tertiary and secondary rocks, and even the schistose and other ancient rocks of northern Europe, and that these *debris* are also much more permeable than those of the formations more or less argillaceous, which have just been mentioned. Of course the filling up of the cavities should be less rapid, and the infiltrations should facilitate the action of the flowing of the subterranean water, which is the real cause of this phenomenon.

Of Gulfs or Chasms.—In every enclosed basin there is one or more gulfs, in which the waters of the torrents lose themselves; in Greece they are at present known by the term *katavothr;* the ancients called them *zerethra* and *chasma.** They are in general situated at the bottom of the mountains which form the circumference of the basin, and we always observe in the rocks which overhang them, open clefts, fractures, and frequently local changes in the stratification.

* We think that this latter word, which belongs to the English language, and has the same meaning, should be introduced into our nomenclature of physical geography.

When the opening is in the middle of the plain as at Kavaros (Pyrrichus), in the peninsula of Tenarus and at Tripolitza, its existence in summer is detected only by a deposit of reddish mud, split in all directions; but when situated in rocks at the bottom of mountains, it is often so spacious, that in summer one can penetrate into the interior. Examples of this kind are to be found in the gulfs of lakes Stymphalus, and Copais; and that of Tipiana near Mantinea, in the interior of which, a mill has been erected to take advantage of the fall of water. On entering it, we discover chambers with smooth walls, narrow passages and lakes, as in the caverns which have so frequently been described.

The existence of these clefts, which is the cause of the drying up of the enclosed basins, evidently arises from the hardness and extreme fragility of the compact limestone, which, at the time of the dislocation of the strata, has been broken to pieces, without either heaping up or sinking, and has left numerous chasms and loose debris.

A circumstance, however, which is favourable to the passage of water and the formation of caverns of "déblaiement," rather than of erosion, is the presence, below the calcareous matter, of a great arenaceous series (greensand) which the waters carry off with facility; consequently, cavities have increased, and have been also liable to be closed up on the instant, when the supports give way.

As the majority of these gulfs are unable to afford a passage for all the water during the rainy season, lakes are formed around their openings. The ground is raised up by deposits of alluvion, and the torrents are unable to carry along with them any thing else except sand, mud, and vegetable and animal debris, which are capable of floating. In short, the elevation of the alluvium becomes such, that the torrent throws itself out in another part of the plain, where it cannot fail to find new openings; and it is in this manner, that, flowing successively through its whole extent, it is maintained at a level which is nearly uniform; such at present is the nature of all the torrents in the plain of Tripolitza. Of course the deposits in the caverns and internal lakes must consist of *red* earth, sand, bones, and vegetables, like the greater number of the bone caverns.

In summer, the lakes become more or less completely dry, and their reddish soil enables us to detect the situation of the chasms. It is in these circumstances, that their entrance, almost always masked by the powerful vegetation produced by humidity, becomes for seven months the retreat of foxes and jackals, * who carry thither their prey. We saw, with Colonel Borry, the entire skeleton of a horse at the opening of one of these gulfs, which these carnivorous animals had partially stript, being unable to drag it in ; the bones, which bore the marks of their teeth, will, in a short time afterwards, occupy a place in the muddy deposits of the cavern, amongst rolled bones, and complete skeletons of animals, which must frequently be surprised in that place by storms of rain. We thus see, how, in all countries having seasons alternately wet and dry, caverns may be successively the abode of carnivorous animals, and a passage for subterraneous water ; and that the exclusive causes by which the presence of bones is wished to be explained, are also false in this case, as they are generally in all natural phenomena.

We have shewn, that the waters in the interior of the Morea are lost in genuine bone-caverns, and reach the level of the sea by subterranean outlets. What we are now to advance, will prove that their existence is entirely owing to causes at present in activity.

The obstruction of the internal drains is a phenomenon of frequent occurrence, which, noticed by the Greeks of ancient times as well as the present, enabled them to discover the outlet of subterraneous water from many enclosed basins. Thus they discovered, that the waters of Lake Stymphalus formed the *Erasinus ;* that those of the plain of Argos, near Mantinea, produced the submarine river Diné, which is known to modern Greeks by the name of *Anavolo:* that the waters of lake Phonia are the magnificent sources of the Ladon, below Lycouria, &c.

At this time, lake Phonia presents us with the phenomenon of the obstruction of the drains in a very remarkable manner. Drama Aly, the last Bey of Corinth, ordered gratings to be placed at the three openings; they were taken up at the commencement of the Greek revolution, and a fertile plain was soon converted into a lake, whose depth we previously mentioned, already reached, in some places, from 40 to 50 metres, and a diameter of 6000 to 8000.

* We have been told by the inhabitants, that wolves never retire thither.

More than a century ago, the waters had reached a much greater height. In the contour of the lake, within 100 metres of its actual height, traces are seen of red coloured mud, which it deposited on the surface of the ground and in all the fissures of the rocks, in the same manner as the identical cement of the osseous breccia traces a red coloured line along the boundaries of the ancient shores. The waters are rising at present, and may obtain a height of 400 metres before finding an outlet towards the plain of Orchomenes, unless the chasms be opened by earthquakes or pressure.

According to the ancients and moderns, it appears these frequent intermissions in the obstructions and the re-openings of the gulfs of Phonia were attributed to earthquakes. Thus, according to Eratosthenes, quoted by Strabo, "it sometimes happened, that, in consequence of the obstruction of the chasms, the water inundated the plain, and when they were again opened, it suddenly left it to swell the Ladon and the Alpheus; and thus the environs of the temple of Olympia were, on one occasion, inundated at a time when the marshes were dry." Strabo adds, that, at another epoch, some earthquakes having thrown down the walls of the chasms through which the waters flowed, the springs of the Ladon were completely intercepted.*

In this manner, the clearing-out of the subterraneous outlets, after their obstruction, in consequence of earthquakes or other causes, and the facility with which a torrent thrown off from one part of the plain by the increasing height of its bed, finds a new outlet elsewhere, shews, that the creation of drains, and consequently of lakes and caverns in the interior, is a phenomenon of the present time,—a phenomenon, besides, which must have been produced since the sub-apennine epoch, as the existence of enclosed basins is anterior to it. We should, therefore, find fossil bones of that epoch in the caverns of the Morea, if the

* The President, C. Capo d'Istria, intended to drain this place. At first sight it might be thought that such an undertaking would require Herculean labours; on the contrary, we believe that a geological engineer would easily bring it to a termination by searching in the direction of the galleries, and above the old pits, the parts of the soil which are most broken; by raising to the banks of the lake the red clay which obstructs the fissures, and by thus assisting to destroy the adherence, which could not be attempted by blasting: in our opinion it would be a labour of patience rather than toil.

soulèvement of the high Alps had dislocated the soil of the Morea, like that of southern France, and exposed the interior parts of the caverns.

Of the Mother-Springs, or *Kephalovrysi.*—Having considered the entrance of the courses of subterraneous waters in mountains, let us now examine their outlets.

The inferior outlets are called Kephalovrysi (head of the waters), not only on account of the volume of their waters but of its equality in all seasons, and irregular intermissions by which they are distinguished from other springs.

The position of the kephalovrysi seems, in our opinion, to be determined by geognostic circumstances; in the mountain, as at the springs of the Ladon, and those of the *Buphagus*,* near Carytène, and in many other places, they pierce above the beds of marl, situated at the inferior portion of the great formation of chalk and greensand, and in Laconia, at the junction of the marbles and the slaty rocks; but the most copious open towards the shore or in the plains, in the horizontal curve which the ancient banks mark out.

Such is the position of the springs of Lerna, Erasinus, Tyrinthus, Candia in Argolis, and the magnificent springs of Skala in Helos; in short, they often show themselves below the level of the sea, as at Anavolo near Astros, and at a great many points opposite the abrupt shores of Argolis, Laconia, and Achaia.

The submarine river Anavolo (now *Dinè*) †, presents the best instance of this phenomenon; at 300 or 400 metres from the shore, waves may be seen in calm weather, with large concentric circles, round a part very much swollen, and with the sand bubbling up over a considerable extent. The shore exhibits a concentric sinking at an elevation of 100 metres, hollowed out in the sides of Mount Zavitsa (see the new chart of the Morea, 3d sheet), a fact in which one cannot fail to observe the sinking of caverns produced by an action, not of erosion, but of clearing out.

It would have been so much the more important for our zoo-

* We are compelled to use the ancient names, as these rivers have no modern ones.

† Pausanias had noticed this phenomenon, but the text is so obssure, and the translations so faulty, that, had we not visited the places, we could not have divined what he was discussing.

logical researches, and for an explanation of the mixture of marine and fluviatile deposits in the same basin, to have been able to collect the species which lived at the bottom of the sea, as this outlet of fresh water rivers in the middle of gulfs is very common on all the coasts of Greece, especially in the Adriatic Gulf and that of Lepanto; and, according to M. Delcros, on the coasts of Calabria. The result of this should be conical masses of fluviatile deposits, in the midst of cotemporaneous marine deposits, as Montmartre with its gypsum and bones may be conceived to be in the middle of the calcaire grossier.

The plain of Argos is surrounded with these kephalovrysi, whose waters produce pestilential marshes, which fable has personified in the *Hydra of Lerna;* they are all at about the same level. The highest are not more than 20 metres above the level of the sea; all of them proceed from the middle of fractured beds of breccia and ferruginous conglomerate, which, in that country, formed a *talus* on the shore, after the deposition of the sub-appennine formation. It is a deposit cotemporaneous with the Mediterranean osseous breccia, and the ferruginous alluvions of the valleys of the Morea.

It is remarkable that these springs issue not opposite the opening of the valleys, but at the bottom of the buttresses which project into the plain, as if these waters had more easily opened a passage in the midst of the cracked beds of the compact limestone, than in the recent deposits of the valleys. Thus, the spring of Erasinus is situated at the extremity of a buttress, where there are large caverns *, the floor of which is not more than five metres above the actual opening of the spring. It may be seen in a manner which admits of no doubt, that the river flowed through these caverns, when the ferruginous alluvions were deposited at the bottom; and that it was not till after their rise, and their destruction by the action of the sea, that the waters abandoned the caverns to open a passage below the alluvium, or rather at the foot of the *falaise* which preceded that of the present epoch. The sources of Lerna, Candia, Piada, and the coast of Argolis, are in situations precisely similar. Seeing the greater part of the springs of Greece break out on banks, and

* We dug to the depth of a metre and a half, without finding any thing but the dung of bats.

at a small height above the level of the sea, we were of opinion that, in certain cases, this effect might have arisen from the repulsion produced by the superior density of the sea-water. Of this fact we have at least one proof, in lake Ino, near Epidaurus Limera (the coasts of the Monembasia), which, in consequence of this singularity, had acquired oracular honours. It is a circular cavity, from four to five metres in diameter, in the midst of compact limestones; its distance from the sea is not more than 100 to 150 metres, and it is not more than two metres above its level; though its depth be unknown (a plummet of thirty metres could not reach the bottom), it is in all seasons filled to the brim with water, slightly brackish. It appears to us that these various circumstances prevent us from considering the lake in any other light than as one of the branches of a syphon, of which the other would terminate below the level of the sea, at a depth which the difference in the density of the fresh and sea-water, and the elevation of two metres of the level of the lake, might fix at 77 metres.

Temperature and Nature of the Waters in the Kephalovrysi.—We have observed the *Kephalovrysi* of the rivers of Greece in various seasons of the year, and have seen with surprise that their waters retain the same purity, the same temperature, and nearly the same volume, after the melting of the snows, in the rainy season, and during the long drought of summer.

When the recesses of the interior basins receive an enormous mass of muddy water of a deep red, the springs of the banks of Argolis flow pure and limpid, and only carry along a little calcareous sand. In the extent of their subterraneous course, there must therefore be lakes in which deposits of sand and mud are found; and the waters have afterwards to pass through narrow conduits, which do not allow of an increase in the volume of the sources of the springs, but in the ratio of the increase of pressure.

The great quantity of bubbles, which, in spring, are disengaged from all these springs, especially from that of the Erasinus, marks distinctly the increase of pressure in the air of the internal caverns.

Our observations on the temperature of the *Kephalovrysi* lead to similar results. We have carefully ascertained, at different periods of the year, the temperature of the sources of

Velonidia near Cape Malea; of Skala, in Helos; of Mosuto, near Astros; of Lernia, and the Erasinus, all of which form rivers at their outlets from the rock, and situated a few meters only above the level of the sea, between latitudes 36° 30′, and 37° 4′; their temperature is the same in all seasons *, and decreases with the increase of latitude from 18° $\frac{5}{10}$ths to 17°; the average of these observations is 17°$\frac{6}{10}$ths; and it is to be observed, that not only is this average result in accordance with the formula of Meyer ($T = 27° 5', \cos^2 L$) for the average latitude 36° 57′, but it is also the case with each of the separate observations.

This constant elevation in the temperature of the Kephalovrysi, whilst that of the lakes of the interior, their principal feeders, is as frequently proved by the obstruction of the drains descended even to + 8°, and even + 5° at the time of the melting of the snow, also demonstrates the existence of vast lakes and long subterraneous canals, a result to which the ancients were also led by observation.

" In the Peloponnesus, there are great cavities in the bowels of the earth, where vast lakes are formed by the accumulation of water."—Diodorus Siculus, Liv. ii. chap. 41.

Lacos or small enclosed Basins.—Independent of the large basins without outlets, of irregular shapes, and the immediate result of the upraising of the mountains of the Morea, there are depressions of much smaller extent and of more regular form, on all the table-lands, mountains, and hills; but it is only in the district occupied by secondary limestones that the Greeks give them the name of Lacos (*λακκος*), although they never contain water, at least during summer.

Certain mountains with large summits are all in this manner cracked like volcanic domes, or like the surface of the moon. It rarely happens that we do not find one or more in these hills according to their extent. These *lacos* attracted my attention the more strongly, as they afforded me a certain shelter in pitching my tent, on the highest and most rocky mountains.

Of these cavities, some are the result of the dislocation of the

* As we were unable to return to these places, M. Virtet and Captain Peytier had the kindness to repeat these observations; we employed a centigrade thermometer, which gave $\frac{2}{10}$ths of 0°.

ground, and the indestructibility of the rock which forms their narrow circumference; but to us the greater number appeared to be the result of a sinking down of a more recent epoch. Among the latter, we shall cite those which we frequently meet with in the Peninsula of Hermionia from the massive trachytes of Poros to the island of Hydra and Cranidi. They are seen at the summit and the sides of the mountains, and, what in my opinion proves their recent origin, in the midst even of the alluvions of the enclosed basin of Didymus. We find, at a quarter of an hour's journey to the north-west of that village, situated at the deepest part of the basin, and near the opening of its gulf, a circular cavity with vertical walls, the depth of which is from 20 to 25 metres, and the diameter from 200 to 300. The walls merely present pebbly alluvium, in which it is impossible to detect any difference from the base to the summit, as that occurs in basins without outlets, which have not been exposed to denudations. We are of opinion, that the whole of the cavities of Herniconia may be the result of volcanic phenomena, of which this country has been the theatre since the appearance of the trachytes; and, that the more general causes of the phenomenon, are the action of subterraneous rivers and waters of infiltration, in the middle of broken up and moveable beds of the green-sand of the lower part, and the sinking of the vaults of the caverns, whose existence we have demonstrated.

Ochreous earth of limestone mountains.—After the melting of snow, there are formed in *lacos*, situated on the most elevated mountains, little lakes, which the heat and the fissures in the rocks soon drain; in that case, there is nothing but the ochreous earth, of which we have spoken without having as yet investigated its origin. On again finding this substance on the highest and most isolated peaks on the surface of the soil, and in the fissures of the rock, but only in limestone mountains, we have frequently asked what could be its origin. We believe we have discovered that this earth is identical with the cement of the osseous breccias, and with the matrix of the pisolitic iron of our Jura table-lands; but this comparison would require to be made with greater care. It dissolves with effervescence in acids, and leaves, besides the hydrate of iron, a residue of silica in small impalpable grains, with some little crystals of quartz, and iron in grains; a composition which seems to shew that it proceeds from the destruction of our secondary limestone formations, all of which are more or less siliceous and ferruginous. In some localities, kidney-shaped concretions slightly crystalline are also met with, which seem to me to be formed of a mixture of ferruginous calcareous spar, and the carbonate of the peroxide of iron, a substance which establishes that a chemical action has contributed to the production of the red earth. Mixed sometimes with calcareous gravel and with iron in grains, it is accumulated in the fissures on the summits of mountains, and one of these heaps was pointed out to me as a gold-mine, which had been abandoned (mountain of Tropezona, near Kelli, in Argolis); but I saw nothing to justify such an opinion. We have evidence of the ancient date of the formation of this earth on the continental surface of Greece, in its abundance in the midst of the ancient alluvium of the valleys, and even in certain detritic deposits of the sub-apennine tertiary formation, as the red conglomerates of Marathonisi, and the neighbourhood of Sparta, which represent the deposit of the sub-apennine marls at the bottom of the steep shores. One should suppose, from the composition of this earth, the presence of iron and silica, either disseminated or in grains, the constancy of its character at great distances, and especially its exclusive presence at the surface of secondary limestone, that it proceeds from their slow destruction. But if we examine the surface of rocks in the interior of the continent, we see it every where covered with green matter and lichens; so that if any destructive action was going on at this moment, it could only take place through the medium of the vegetation. We believe, in fact, that such action takes place: Colonel Borry has pointed out lichens to us almost entirely composed of the carbonate of lime, which have the property of assimilating this substance, as the molluscæ do in sea-water, and thence result small cavities; but it is not to this feeble action alone that we can have recourse to explain a production so abundant as the red earth.

In the memoir which we published in 1831, on the action of the sea, and of the aura-marina on calcareous rocks, we demonstrated that this latter action entirely corroded calcareous surfaces at a height of more than 50 metres, and at a great distance from the shores of the sea; and that beyond this zone, where the surface is quite naked, traces are also found of the same action at more than 1000 metres from the shore.*

We at first attributed this phenomenon of erosion to actions purely hygrometrical and mechanical; we have since discovered that it may be the result of the reaction of muriate of soda, on carbonate of lime.

Besides, whatever may be the cause of this phenomenon, if we observe, that there is hardly any mountain in the Morea on which we have not detected traces of ancient erosions perfectly similar to that of the actual sphere of the aura-marina, that the sea, at the sub-appenine epoch, cut the whole of the part emerging from the surface of the Peloponnesus by deep gulfs, so that it must have been universally subjected to the influence of the aura-marina; that, besides, this reaction of the muriate of soda on the carbonate of lime, produced soluble salts, which left iron and silica in excess in the midst of calcareous *debris*, it must be admitted that this red earth, for a long time observed on the surface of our limestone mountains, is the product of their slow destruction by atmospherical agents, aided by the aura-marina during the whole period of emersion.

Having now ascertained the principal agents of destruction and reproduction on the *emerged* surface of the Peloponnesus, we shall describe their products, first in the basins which have remained without any external outlet since the sub-apennine period, but whose deposits have been raised and excavated by the shutting and opening of the subterranean drains. We shall take the basin of Tripolitza as an instance, which presents hillocks of alluvion at two different levels, though it is entirely enclosed by high mountains.

The basin of Megalopolis, shut during the sub-apennine epoch and that of ferruginous alluvions, but opened afterwards by a large breach near Carytene, and excavated deeply by the flowing out of a lake and the increase of the fall in the torrent waters, presents us with some peculiar phenomena. Passing from

* Davy observed saline particles at a distance of more than 16 leagues from the sea. They have even been detected at a distance of 45 leagues, after a violent tempest. (See Memoirs of the Academy of Manchester, January 1832.)

thence to torrential valleys entirely open, we shall describe the ferruginous alluvium, in which the very beds of the torrents are hollowed out. We shall prove that they are the product of an action regular and prolonged, and not of a deluge; and that, since their deposit, the soil of the Peloponnesus has experienced a general rise of 20 or 30 metres. To this latter phenomenon is attached the existence of a violent and instantaneous (diluvial) deposit of transport, which covers some terraces slightly raised above the sea.

In short, the large open valleys, such as those of the Pamisus, the Alpheus, and the Eurotas, will, in their epigeic deposits, exhibit some of the characters of the fluviatile deposits. The limits of this article compel us to suppress these details, and confine us to the more remarkable phenomena presented by the valley of the Eurotas.

Recent Phenomena in the Valley of the Eurotas.

After the rise and denudation of the tertiary soil, the valley of the Eurotas presented four different terraced basins: the highest to the north of Mistra, communicated by passes with the principal basin, which at Sparta extended to the mountains of Lycovouno. A third basin comprehended the whole of the plain of Hieraki, and the marshes of Helos formed the fourth. The two highest basins were formed as soon as the first elevations of the subapennine formation took place; the third was still submarine, as we may judge from the disposition and nature of the alluvial matter; it was not entirely formed until the upraising of the ferruginous alluvium; and, lastly, the marshes of Helos are the product of the present period.

Such has been the destruction of the tertiary strata throughout this valley, that nothing remains except some shreds, forming eminences raised 200 metres above the level of the plain. Deposits of alluvion have replaced the subapennine formation, and we recognise several of very different epochs. The most ancient is the great alluvial and detritic mass, which flanks the whole base of the *dolomitic* wall at the bottom of Taygètus. It forms a red coloured talus at an inclination of 45°, and of a height of 50 or 60 metres from Mistra to the mountainous region of Lycovouna. This deposit is formed here, as at the bottom of all the ancient steep shores of Greece, by calcareous fragments of all sizes, united by the calcareous and ferruginous cement of which we have spoken. Its characters resemble the detritic more than the alluvial deposits ; it rests on the already denuded surface of the tertiary soil, and supports genuine alluvions of an age more recent, though anterior to the present period. Those much less ferruginous, form the regular and horizontal banks below which flow the beautiful springs of the Ayani and Slavo-Choico (Amyclée). On the surface of this last deposit, and especially in the excavations which furrow it, we find, at the opening of the gorges of Mistra and Paroria, a soil violently transported or washed away from its original place,—a real diluvium. It is composed of a loose mass of a greyish colour, formed of fragments of schistose rocks and quartzose sand, including rocks of anagenites, frequently many feet in diameter. This agglomerate is strikingly contrasted by its colour and nature (it is not effervescent) with the ancient alluvions formed of calcareous debris and ochreous earth, in the midst of which it rests in the bed of the Pontalimonia, and even in the town of Mistra. The boulders, scattered in great numbers on the surface of the soil, are distributed in rows, proceeding from the opening of the pass to a distance of 1500 or 2000 metres, and cannot fail to rivet the attention, as much by the beauty of the rock (green anagenite with rose-quartz) as well as by the foreign aspect they have in the midst of the alluvium of the valley. We mentioned, in the description of the ancient soils of the Morea, (chapter iii. p. 100.) that these boulders proceeded from the summits of the chain, where they form beds in the midst of a formation of talcose marbles, and that the ancients employed them in making millstones. Many of these ancient millstones, either broken or rough-hewn, has enabled us to discover, in the lower part of the gardens of Mistra, the position of the town of Aleisia, where, according to Pausanias, the millstone was invented.

This phenomenon of boulders does not appear to be limited to the pass of Mistra ; we have found some of them, composed, however, of limestone or quartz, even below Amyclæ. It is evident, beyond all doubt, that they have been thrown into the plain by narrow openings in the passes, at a time which cannot be carried farther back than the commencement of the present epoch.

The environs of Mistra exhibit the results of a catastrophe even more recent, and of which history has preserved the record. If we ascend the hills to the north of the town, in the direction of Tripi and the lovely cypress of Stavro, which every traveller admires, eminences are found on the surface of the soil, which, by their peculiar form and composition, cannot fail to attract attention.

The surface, formed of aluminous slates deeply ravined, is covered with eminences formed of great masses, and not of fragments, of siliceous limestones, quartzose rocks, and schists of different kinds, thrown together in confusion. The fractures are still fresh and the edges sharp, and when we leave the place where the principal masses are crowded together, small *debris* may be seen lying on the vegetable earth.

On looking at the shape of these hills, and judging from the nature and the disorder of the materials of which they are composed, we can have no doubt that they are the result of a tumbling down of the peak called Paximadi, which rises 1500 metres above these eminences, with one of the most rapid inclinations in the chain of the Taygetus.

If we compare these observations with the accounts of antiquity of the celebrated earthquake, which, 469 years before Christ, overthrew Sparta entirely, opened numerous gulfs in Laconia, and caused one of the summits of Taygetus to crumble down, facts established by Cicero, Plutarch, Strabo, and Pliny; and the first of whom describes the shape of the summit which was thrown down *, it cannot be doubted but we have discovered the remains of that great catastrophe, after a lapse of twenty-three centuries. *(Extract from the fifth chapter of the Description of the Morea:* RECENT PHENOMENA, by M. Boblaye, unpublished.)

* *Cum et urbs tota corruit et ex monte Taygeto extrema montis quasi puppis avulsa est.* (Cic. de Divin., lib. i.

OBSERVATIONS ON THE HURRICANES AND STORMS OF THE WEST INDIES AND THE COAST OF THE UNITED STATES. *By W. C. Redfield, of New York* *.

It has been found by a careful attention to the progress and phenomena of the more violent storms which have visited the Western Atlantic, that they exhibit certain characteristics of great uniformity. This appears, not only in the determinate course which these storms are found to pursue, but in the direction of wind, and succession of changes which they exhibit while they continue in action. The same general characteristics appear also to pertain, in some degree, to many of the more common variations and vicissitudes of winds and weather, at least in the temperate latitudes. The following points may be considered as established :—

1. The storms of greatest severity often originate in the tropical latitudes, and not unfrequently, to the northward or eastward of the West India Islands; in which region they are distinguished by the name of *hurricanes.*

2. These storms cover at the same moment of time, an extent of contiguous surface, the diameter of which may vary in different storms, from 100 to 500 miles, and in some cases they have been much more extensive. They act with diminished violence towards the exterior, and with increased energy towards the interior, of the space which they occupy.

3. While in the tropical latitudes, or south of the parallel of 30°, these storms pursue their course, or are *drifted* towards the west, on a track, which inclines generally to the northward, till it approaches the latitude of 30°. In the vicinity of this parallel, their course is changed somewhat abruptly to the northward and eastward, and the track continues to incline gradually to the east, towards which point, after leaving the lower latitudes, they are found to advance with an accelerated velocity.

The rate at which these storms are found thus to advance in their course, varies much in different cases, but may be estimated at from twelve to thirty miles an hour. The extent to which their course is finally pursued, remains unknown; but it is

* In vol. xx. of Dr Silliman's Journal, there is a full view of Mr Redfield's opinion in regard to the prevailing storms of the Atlantic Ocean.

probable, that as they proceed, they become gradually extended in their dimensions, and weakened in their action, till they cease to command any peculiar notice. One of the hurricanes of August 1830, has been traced in its daily progress, from near the Caribbee Islands to the coast of Florida, and the Carolinas, and from thence to the banks of Newfoundland, a *distance of more than 3000 miles*, which was passed over by the storm in about six days. The duration of the most violent portion of this gale, at the different points over which it passed, was about twelve hours; but its entire duration was in many places more than twice that period. Another hurricane, which occurred in the same month, passed from near the Windward Islands, on a more eastern but similar route, and has also been traced in its daily stages by means of the journals and reports of voyagers, *near 2500 miles*. It was in this storm, that the Russian corvette Kensington, Captain Ramsay, suffered so severely. The hurricane of August 1831, which desolated the Island of Barbadoes on the 10th of that month, the daily progress of which has also been ascertained, passed in nearly a direct course to the northern shores of the Gulf of Mexico and New Orleans, where it arrived on the 16th of the same month, having passed over a distance of 2300 *statute miles* in six days after leaving Barbadoes. Many cases of like character might be adduced.

4. The *duration* of the storm, at any place within its track, depends upon its extent, and the rate of velocity at which it moves, as these circumstances are found to determine the time which is required for the storm to pass over any given locality falling within its route. Storms of smaller extent or dimensions are usually found to move from one place to another with greater rapidity than larger storms.

5. The direction and strength of wind exhibited by a storm, over the greater portion of its track, are found *not to be in the direction of its progress*. The rate or velocity of this progress would indeed be insufficient to produce any violent effect.

6. In the lower latitudes, while drifting to the westward, the direction of the wind at the commencement, or under the most advanced portion of these storms, is from a *northern* quarter, usually from northeast to northwest; and during the latter part of the gale, it blows from a *southern* quarter of the horizon, at all places where the whole gale is experienced.

7. After reaching the more northern latitudes, and while pursuing their course to the northward and eastward, these storms commence with the wind from an eastern or southern quarter, and terminate with the wind from a western quarter, as will appear more distinctly under the three following heads; —the latter portion of the storm being usually attended with broken or clear weather.

8. On the outer portion of the track, north of the parallel of 30°, or within that portion of it which lies farthest from the American coast; these storms exhibit at their commencement, a *southerly* wind, which, as the storm comes over, *veers gradually to the westward*, in which quarter it is found to terminate.

9. In the same latitudes, but along the *central portions of the track*, the first force of the wind is from a point near to *south-east*; but after blowing for a certain period, it *changes suddenly*, and usually after a short intermission, to a point nearly or directly opposite to that from which it has previously been blowing, from which opposite quarter it blows with equal violence till the storm has passed over or has abated. This sudden change of a south easterly wind to an opposite direction, *does not occur towards either margin of the storm's track*, but only on its more central portion, and takes effect in regular progression along this central part of the route, from the *south-west* towards the *north-east*, in an order of time, which is exactly coincident with the progress of the storm in the same direction. It is under this portion of the storm, that we notice the greatest fall of the barometer, and the mercury usually begins to rise a short time previous to the change of wind. In this part of the track the storm is known as a *south-easter*, and is usually attended with rain previous to the change of wind, and perhaps for a short time after.

10. On that portion of the track which is *nearest* the American coast, or which is farthest inland, if the storm reaches the Continent, the wind commences from a more eastern or north-eastern point of the horizon, and afterwards veers more or less gradually, by north, to a north-eastern or westerly quarter, where it finally terminates. Here also the first part of the storm is usually, but not always attended with rain, and its latter or western portion with fair weather. The first or foul weather

portion of the storm, is on this part of its track recognised as a *north-easter.*

It should be noticed, however, that near the latitude of 30°, and on the shores of Carolina, where the storm enters obliquely upon the coast, while its track is rapidly changing from a northwardly to an eastwardly direction, the wind on the central track of the storm will commence from an eastern or north-eastern point of the compass, and will gradually become south-easterly as the storm approaches its height.

11. A full and just consideration of the facts which have been stated, will show conclusively that the portion of the atmosphere which composes for the time being the great body of the storm, whirls or blows in a horizontal circuit, around a vertical or somewhat inclined axis of rotation which is carried onward with the storm ; that the course or direction of this circuit of rotation is from *right* to *left* ; and that the storm operates in the same manner, and exhibits the same general characteristics, as a tornado or whirlwind of smaller dimensions ; the chief difference being in the magnitude of the scale of operation *. This view of the subject, when fully comprehended, affords a satisfactory solution of the otherwise inexplicable phenomena of storms, and will also be found to accord entirely with the fact, which has been previously stated, that in the phases or changes which pertain to a storm, the wind, on one margin of its track, veers, in seaman's phrase, *with the sun*, or from *left to right*, while under the opposite margin of the same storm, it veers *against the sun*, or from *right to left*, for this peculiarity necessarily attends the progress of any whirlwind which operates horizontally.

12. The barometer, whether in the higher or lower latitudes, always sinks while under the first portion or moiety of the storm on every part of its track, excepting, perhaps, its extreme northern margin, and thus often affords us the earliest and surest indication of the approaching tempest. The mercury in the barometer always rises again during the passage of the last portion of the gale, and commonly attains the maximum of its elevation on the entire departure of the storm.

* It is to be understood that the diameter of the whirlwind which constitutes the storm, is commensurate with the width of the track over which the storm passes.

The great value of the barometer to navigators is becoming well understood, and its practical utility might be greatly increased by hourly entries of the precise height of the mercurial column, in a table prepared for the purpose. Its movements, unless carefully recorded, often escape notice or recollection, which may easily happen at those times when a distinct knowledge of its latest variations might prove to be of the greatest importance.

In the foregoing statements, our design has been to designate, in a summary manner, the principal movements which, in these regions at least, constitute a storm; and we do not attempt to notice the various irregularities and subordinate or incidental movements and phenomena of the atmosphere, with which a storm may chance to be connected, or which may necessarily result from such violent movements in a fluid which is so tenuous and elastic in its character. It may be remarked, in general, that the most active or violent storms are usually the most regular and uniform in the development of those characteristic movements which we have already described. It is also probable, that the vortex or rotative axis of a violent gale or hurricane, oscillates in its course with considerable rapidity, in a moving circuit of moderate extent, near the centre of the hurricane; and, such an eccentric movement of the vortex may, for aught we know, be essential to the continued activity or force of the hurricane. Such a movement will fully account for the violent *flows* or *gusts* of wind, and the intervening *lulls* or remissions which are so often experienced towards the heart of a storm or hurricane, when in open sea; but of its existence we have no positive evidence.

It frequently happens that a storm, during the first part of its progress over a given point, fails to take effect upon the surface, while it exhibits its full activity at a greater altitude. This commonly happens, when this portion of the storm arrives from, or has recently blown over, a more elevated country, or is passing or blowing from the land to the sea. On land, the most violent effects are usually felt from those storms which enter and blow directly from the open ocean upon the shores of an island or continent. Upon the latter, under such circumstances, the *first* part of the gale is usually the most severe, and that coast of an island upon which a storm first enters or blows, also suffers most from the early part of the gale; but its latter or receding part often acts with the greatest fury upon the opposite side of the island, which had previously derived some degree of shelter from the intermediate elevations, and other obstacles, opposed to the force of the wind, the benefit of which is now lost by its counter direction from the open ocean. Owing to similar causes, the force of the storm is sometimes very unequal at different places situated in nearly the same part of its track, and such inequality, as we have before intimated, necessarily pertains to two places, one of which is near the centre, the other towards the margin of the route.

Of the multitude of facts by which this part of the subject might be illustrated, we shall only state, that, in the late hurricane at Barbadoes (that of August 1831), the trees near the northern coast of that island, lying from N. NW. to S. SE., had been prostrated by a northerly wind in the earlier part of the storm, while in the interior, and some other parts of the island, they were found to lie from south to north, having fallen in the later period of the gale: That after the same hurricane, advices which were received from the islands of St Croix and Porto Rico (which lay near the northern margin of its track), stated that no hurricane had been experienced at these islands; but it afterwards appeared that some portions of these islands had suffered damage from this hurricane in the night of the 12th to 13th of August, two days after it passed over the Island of Barbadoes: That the sea islands which border the coast of Georgia and the Carolinas, are known to suffer greatly from these tempests, while little or no injury is sustained in the interior, at a distance of a few miles from the coast. One of the most striking characteristics of these storms is the *heavy swell* which in open sea is often known to extend itself on both sides of the track, entirely beyond the range of the gale by which it was produced. The last hurricane to which we have alluded, threw its swell with tremendous force upon the northern shores of Jamaica, having passed to the northward of that island.

A variety of deductions may be drawn from the general facts which we have stated, some of which are deeply interesting to the philosopher and votary of science. For ourselves, we disclaim any bondage to existing theories in meteorology; and shall, on the present occasion, only proceed to notice a few of the more practical inferences which, to navigators and others, may perhaps be of no doubtful utility.

1. A vessel bound to the eastward, between the latitudes of 32° and 45° in the western part of the Atlantic, on being overtaken by a gale, which commences blowing from any point to the eastward of S. E. or E. SE. may avoid some portion of its violence, by putting her head to the northward, and, when the gale has veered sufficiently in the same direction, may safely resume her course. But, by standing to the southward, under like circumstances, she will probably fall into the heart of the storm.

2. In the same region, vessels, on taking a gale from S. E., or points near thereto, will probably soon find themselves in the heart of the storm; and, after its first fury is spent, may expect its recurrence from the opposite quarter. The most promising mode of mitigating its violence, and at the same time shortening its duration, is to stand to the southward upon the wind as long as may be necessary or possible; and, if the movement succeeds, the wind will gradually head you off in the same direction. If it become necessary to heave to, put your head to the southward; and, if the wind does not veer, be prepared for a blast from the north-west.

3. In the same latitudes, a vessel scudding in a gale, with the wind at east or north-east, shortens its duration. On the contrary, a vessel scudding before a south-westerly or westerly gale, will thereby increase its duration.

4. A vessel which is pursuing her course to the westward, or south-westward, in this part of the Atlantic, meets the storms in their course, and thereby shortens the period of their recurrence, and will encounter more gales, in an equal number of days, than if stationary, or sailing in a different direction.

5. On the other hand, vessels, while sailing to the eastward, or north-eastward, or in the course of the storms, will lengthen the periods between their occurrence, and consequently experience them less frequently than vessels sailing on a different course. The difference of exposure which results from these

opposite courses, on the American coast, may, in most cases, be estimated as nearly two to one.

6. The hazard, from casualties, and of consequence the value of insurance, is enhanced or diminished by the direction of the passage, as shown under the last two heads.

7. As the ordinary routine of the winds and weather, in these latitudes, often corresponds to the phases which are exhibited by the storms, as before described, a correct opinion, founded upon this resemblance, can often be formed of the approaching changes of wind and weather, which may be highly useful to the observing navigator.

8. A due consideration of the facts which have been stated, particularly those under our twelfth head, will inspire additional confidence in the indications of the *barometer*, and these ought not to be neglected, even should the fall of the mercury be unattended by any appearance of violence in the weather, as the other side of the gale will be pretty sure to take effect, and often in a manner so sudden and violent as to more than compensate for its previous forbearance. Not the least reliance, however, should be placed upon the prognostics which are usually attached to the scale of the barometer, such as *set-fair*, *fair*, *change*, *rain*, &c. as, in this region at least, they serve no other purpose than to bring this valuable instrument into discredit. It is the mere rising and falling of the mercury which chiefly deserves attention, and not its conformity to a particular point in the scale of elevation.

9. These practical inferences apply in terms chiefly to storms which have passed to the northward of the thirtieth degree of latitude on the American coast, but, with the necessary modification as to the point of the compass, which results from the westerly course pursued by the storm while in the lower latitudes, are, for the most part, equally applicable to the storms and hurricanes which occur in the West Indies, and south of the parallel of 30°. As the marked occurrence of tempestuous weather is here less frequent, it may be sufficient to notice, that the point of direction, in cases which are otherwise analogous, is, in the West Indian Seas, about ten or twelve points of the compass *more to the left* than on the coast of the United States, in the latitude of New York.

Vicissitudes of winds and weather on this coast, which do not conform to the foregoing specifications, are more frequent in April, May, and June, than in other months. Easterly or southerly winds, under which the barometer rises or maintains its elevation, are not of a gyratory or stormy character; but such winds frequently terminate in the falling of the barometer, and the usual phenomena of an eastern storm.

The typhons and storms of the China Sea and eastern coast of Asia, appear to be similar in character to the hurricanes of the West Indies, and the storms of this coast, when prevailing in the same latitudes. There is reason to believe, that the great circuits of wind, of which the trade winds form an integral part, are nearly uniform in all the great oceanic basins, and that the *course* of these circuits, and of the stormy gyrations which they may contain, is, in the southern hemisphere, in a *counter direction* to those north of the equator, producing a corresponding difference in the general phases of storms and winds in the two hemispheres.—*Amer. Journ. of Science and Arts*, vol. xxv. No. I. p. 114.

Critical Notices of various Organic Remains hitherto discovered in North America. By Richard Harlan, M. D.

(Concluded from last Number.)

ORDER SAURIA.

Genus Crocodilus, Cuv.

C. *macrorhyncus*, Harlan.

Journ. of the Acad. of Nat. Sciences, Philada. vol. iv. p. 15, pl. 1.

Several fine specimens of the jaw, teeth, vertebræ, &c. of an extinct fossil species of crocodile from the New Jersey marl-pits,* are contained in the Cab. of Ac. Nat. Sciences; the most perfect of these is described and figured as above referred to. It consists of the dental bone of the right side, in a good state of preservation, perfectly fossilized, or impregnated with iron, so abundant in the marl-pits of New Jersey; it contains the sockets of eleven teeth in a space of twelve inches.

The most striking peculiarity of this remnant is its great

* Marl-pits occur both in the secondary and tertiary of the Atlantic coast.

thickness in proportion to its length, compared with the same part in recent crocodiles, with which circumstance the structure and appearance of the teeth perfectly correspond, being exceedingly thick, short, and blunt. Length of one of these teeth, two inches, diameter at base, one inch; only one-half an inch projecting beyond the alveole.

We have seen a portion of the jaw of a very distinct species of fossil crocodile, in possession of Dr J. E. Dekay, who is about to describe it in the Annals of the Lyceum of Natural History. This fossil is also from the Atlantic secondary in New Jersey; it displays considerable analogy with the *Crocodilus gangeticus* of Cuvier.

Genus Plesiosaurus, of Conybeare.

The fossil vertebræ of a Plesiosaurian reptile, from the New Jersey "marl," is contained in the Cab. of Ac. Nat. Sciences, which we have described in the Journal of the Academy, vol. iv. p. 232, pl. xiv. Although the general character of this vertebra associates it with the plesiosaurus, yet the comparative great length of the axis of the bone will distinguish it from any species of that genus hitherto noticed.

Genus Basilosaurus, Harlan.

A name we have used to distinguish the remains of an immense fossil saurian lately discovered on the banks of the Washita, or "Ouachita," river, state of Louisiana, and described in the Trans. Am. Philos. Soc. vol. iv. new series, p. 297, pl. xx. 1834.

The principal fossil, which forms the subject of this paper, consists of a vertebra of enormous dimensions, possessing characters which enable us to refer it to an extinct genus of the order "Enalio Sauri" of Conybeare. The animal of which the present remnant constituted a portion existed in a period more recent than that of any of its congeners hitherto discovered.

On comparison of this vertebra with those of its congeners, it appears to be generically distinct from them all, but bears a closer approximation to the Plesiosaurian vertebræ than to any other. The length of the axis of the bone is twice its diameter, being fourteen inches long, and seven inches broad. Its sides are slightly concave in the middle, and the weight of the vertebra is forty-four pounds. Allowing the individual to possess as many vertebræ as the Plesiosaurus, that is to say, sixty-six, independent of those of the tail, the weight of the whole fossil skeleton may be fairly estimated as exceeding two tons, even supposing each vertebra to weigh only thirty pounds instead of forty-four, and calculating the weight of the extremities, pelvis, and tail, to be collectively but a little heavier than the spine alone.

Judging from the position and descending obliquity of the transverse apophyses, and the small size of the canal for the spinal marrow, this vertebra must be referred to the posterior part of the column, and most probably to the lumbar region. This opinion is strengthened by the coalition of the two foramina or fossæ, which characterize the *inferior* aspect of the vertebræ of the *posterior* part of the column in the spiral bones of the *Plesiosaurus*, in which respect these portions of the two fossils closely resemble each other; they are also similar in the form of the *planes* of the articulating surfaces of the bodies of the vertebræ. But our fossil differs totally from the same portion of the Plesiosaurus in its *proportions*, the vertebræ of the latter being broader than long. All the superior apophyses of the Plesiosaurus are attached by suture to their bodies, but there are no marks of such a structure in our fossil.

Judging from relative proportions, the Megalosaurus did not attain to more than thirty or forty feet in length. The Iguanodon of Mr Mantel did not exceed sixty feet, but the individual now indicated could not have been less than from eighty to a hundred feet. According to the statement of Judge Bry, to whom the society is indebted for the specimens, they were four hundred feet in extent, nearly in a curvilinear direction marked by these fossils in the soil, which we must presume included the remains of several individuals. If future discoveries of remaining portions of this skeleton should confirm the indications above pointed out, we may suppose the genus to which it belonged will take the name, not inappropriately, of *Basilosaurus*.

Locality.—Banks of the Washita, Louisiana.

Place in the Geological Series.—Atlantic tertiary. The piece of "sea-marl" which accompanied the specimen is a conglomerate mass of small marine shells, principally of an extinct species of *Corbula*, similar to those observed in the same formation in Alabama. Most of these shells are comminuted; a few, however, remain perfect. On the upper surface of the mass, there remains a stratum of clay half an inch in thickness, inclosing pieces of crystallized carbonate of lime.

Genus Ichthyosaurus, Conybeare.

I. *Missouriensis*, Harlan, ut supra, p. 405.

The fossil fragments which indicate the existence of the above named species, consist of the anterior portions of the upper and lower jaws. The form and structure of these fragments, as well as of the portions of teeth remaining in the sockets, bear a close analogy to those of the Ichthyosaurus, but the extreme length and breadth of the intermaxillary bone, which projects beyond the extremities of the superior maxillaries, will distinguish it from all other species of this genus hitherto described.

The portions of maxillary bones attached contain three teeth on each side, all equally broken off at the sockets. The intermaxillary bone contains four teeth, two on each side, also broken, thus displaying in all ten teeth, in a space of alveolar processes, four inches long, the length of the fragment. The mode of growth and reproduction of the teeth is well displayed in the fractured portions which remain: the animal is allied to the Ichthyosaurus in these particulars. For further minutiæ we must refer to the volume above quoted.

Locality.—In the vicinity of the Yellow-stone and Missouri rivers. Missouri territory.

Place in the Geological series.—Secondary limestone of the sub-cretaceous group.

We are indebted to Major N. A. Ware for the specimens, who obtained them at St Louis, from a fur-trader or trapper, who, "on his return home from the Rocky Mountains, observed in a rock the skeleton of an alligator animal, about seventy feet in length; he broke off the point of the jaw as it projected. He said that the head part appeared about three or four feet long."*

GENUS MOSASAURUS, Conybeare.

MAESTRICHT *monitor,* Cuv.

Ossemens Fossiles, vol. v. part 2, ed. 3d, p. 310; Harlan, Journ. Acad. Nat Sciences of Philad. vol. iv. pl. xiv.; Silliman's Journal, vol. xvii.; Dekay, Ann. of the Lyc. of New York, vol. iii. pl. xiii. p. 134.

Locality.—From a "marl pit" near Woodbury, Monmouth county, New Jersey.

Specimens of the teeth, and probably of the femur, in the cabinet of the Academy of Natural Sciences, and the jaw teeth in the cabinet of the Lyc. Nat. Hist. N. York.

These remains are completely fossilized and impregnated with iron, dense and heavy, and of a deep dark colour. The teeth of the second series, whilst they yet remain in the sockets, are serrated on the edges.

Place in the Geological series.—Atlantic secondary, of New Jersey.

GENUS GEOSAURUS. Cuv.

LACERTA *gigantea.* Soemmering.

G. *Mitchelli.* Dekay.

Ann. of the Lyc. Nat. Hist. of New York, vol. iii. p. 138, pl. iii. fig. 3, 4.

Dr Dekay has established the existence of this genus in the United States, upon a fossil tooth, with a small portion of jaw attached.

"From various considerations we should be disposed to place this tooth among the most anterior of the lower jaw. Its elevated position on its osseous support, places it in the group of Mosasaurus and Geosaurus, while its compressed shape removes it from the former. The tooth now described agrees with those of the Geosaurus in shape, attachment and mode of dentition."

Judging from the size of the tooth, the American species

* Baron Braunsberg Maximillian Prince de Weid, during his recent visit to Philadelphia, on his return from the Rocky Mountains, informed me that he had obtained the fossil skeleton of a saurian animal, fifteen feet in length from the "great bend" of the Missouri river, which, on comparison of its characters with those of the animal above noticed, he thinks belongs to the same species.

must have been of much larger dimensions than the European, or Manheim species. (G. *Soemerringi*, Dekay.)

Locality. Monmouth, New Jersey.

Place in the Geological series. New Jersey secondary.

GENUS SAUROCEPHALUS, Harlan.

S. *lanciformis*, Harlan.

Journ. Acad. Nat. of Philad. vol. iii. p. 331, pl. xii. 1824.

This new fossil genus was originally established on the dental bone and teeth, discovered in 1804, by Lewis and Clark, in their "Expedition to Colombia River," by whom it was presented, on their return, to the American Philosophical Society, in whose cabinet it remained unknown and neglected, until about ten years since we published our description and figure in the work as above referred to.

Place in the Geological series. Secondary limestone? Missouri, (subcretaceous group.)

This fossil genus has been further confirmed by the subsequent discovery by Mr Lea of a distinct species of the same genus, in a "marl pit" of New Jersey, which was imperfectly described by Dr Hays, as the

SAUROCEPHALUS *Leanus*.

Trans. of the Am. Philos. Soc. new series, vol. iii. p. 471, pl. 19, 1830.

Locality. In a "marl pit" near Moorestown, New Jersey.

Place in the Geological series. Atlantic secondary, New Jersey.

Very soon after the memoir on the last named species was presented to the American Philosophical Society, we took occasion to read the following observations before that learned body, which are now offered for the first time for publication.

Note on a paper entitled "Description of a fragment of a head of a new fossil animal, discovered in a marl-pit, near Mooreston, New Jersey."

This fossil relic, in the possession of Mr Lea, is interesting, not only on account of its geological locality, but also as it serves further to establish a new fossil genus, the *Saurocephalus*, described by the author of these remarks, in the Journal of the Academy of Natural Sciences, Philad. vol. iii part 2d,

p. 331, 1824. Both these relics evidently belonged to animals allied to the genus *Ichthyosaurus*, of Conybeare; but which approach, in their organization, more nearly to the fish than to the lizard. The specimen described by Dr Hays, in the Transactions of the American Philosophical Society, possesses the following characters in common with the Saurocephalus *lanciformis:* the bodies of the teeth are in close contact throughout, the nerves and vessels of the teeth passing on the inner side of the alveolar processes. The inferior series of teeth entering the cavities of the superior directly in the centre, in the process of shedding; the inferior series are completed before they enter the superior, the dental serrature of the superior and inferior jaws closing like incisors. In both also, there exists a longitudinal groove along the mesial aspect of the jaw-bone, directly below the alveolar margins, though this groove is not so evident in the S. *Leanus;* but it must be remarked that this species was not more than one-half the size of the S. *lanciformis.*

In all these particulars of organization, both species differ from the Ichthyosaurus and Plesiosaurus, and from the Saurian order in general.

The S. *Leanus*, we find, on comparison, to be characterized as a distinct species from the S. *lanciformis*, by the greater acuteness of the teeth, by their greater *comparative* length, but particularly by their curvature; they are also slightly compressed at their inner face.

In both descriptions of these different specimens, it is stated that "the bodies of the teeth are placed close together;" which would seem to imply that their exists no "separate and distinct aveoli." But as the author of the paper on the S. *lanciformis* was not privileged to dissect the relic, he may have been mistaken in this point, a question which he is willing to cede as one of little importance in the present instance, as the statement was only made to convey an idea of the close approximation of the bodies of the teeth.

Dr Hays would appear to entertain different opinions on this point, and although he states that distinct alveoli do exist in both specimens, yet has made a new genus for his animal under the name "Saurodon," which he subsequently altered to

" SAUROCEPHALUS," and thus appropriated to himself the labours of another without acknowledgment, and dedicates the species to his friend Mr Lea, in the first place in the feminine gender at page 476, " S. *Leaæ* ;" but is notified of this amphibious compliment, whilst the paper is still in press, in time to re-christen the bantling, which finally, at page 477, figures as the S. *Leanus !* On the most critical examination, the animals will be found to agree *generically* in every point of the least importance. The *reasoning* in the following paragraph of Dr Hays' description, we are unable to comprehend. The *most important generic character* which was supposed to distinguish this animal from the one we describe, [viz. the absence of distinct and *separate* alveoli,] having no existence, it appears proper, in the present state of our knowledge, to place the two species in the same genus ; and as the *genus Saurocephalus is founded on erroneous characters*, and will not admit our species, it becomes necessary to construct a new genus, which we shall accordingly do, and shall retain for it the name " *Saurodon* !"

Nothing can be more incorrect than the statements here made, or more preposterous than the deductions drawn from them. In the account of the SAUROCEPHALUS *lanciformis*, in the Journ. of Acad. of Nat. Sciences p. 336, vol. iii., are the following paragraphs in direct opposition to the above gratuitous assertions :

" The row of teeth on the inferior, appear to have passed within those of the superior jaw ; this supposition is farther strengthened by the worn appearance of the sides of the teeth. This arrangement of teeth, which would require a peculiar configuration of the jaw, together with the peculiar distribution of the maxillary nerve, appear to entitle this animal to rank as a new genus."

The distinct and separate alveoli are not even alluded to in the characters of the genus *Saurocephalus*, which are thus designated in the account published several years ago,

SAUROCEPHALUS *lanciformis.*

" *Generic characters.*—Bodies of the teeth approximated ; those of the inferior and superior jaws closing like incisors. Inferior maxillary nerve passing along a groove on the mesial aspect of the dental bone." If it should be hereafter ascertained that the groove for the nerve does not exist in all the species which may be discovered, it will only be requisite to strike out the words "*a groove on*," to make the generic characters as originally established on a single fragment of jaw, apply correctly to all.

In the present state of our investigations the following are the *specific* characters which distinguish the *species* already ascertained:

S. *lanciformis*. Projecting portions of the teeth smooth and obtusely lanciform.

S. *Leanus*. Teeth rather acute, slender, slightly compressed and aduncate.

Coprolites.

These curious organic fossils, so classically described by Dr Buckland, and which occurred so plentifully in the *Lias* of England, are occasionally met with in the New Jersey secondary.

A specimen of the *Saurocopros* genus is described and figured by Dr Dekay, Ann. of the Lyc. Nat. Hist. N. York, vol. iii. p. 140, pl. iii. fig. 6.

We have only further to observe concerning the fossil Sauria of the United States, that we possess a curious fossil tooth from South Carolina, presented by Dr S. Blanding, whose root displays a mode of articulation peculiarly its own, and which may be hereafter found to indicate the type of a new fossil genus of animals; the same may be inferred from numerous fossil vertebræ from the New Jersey secondary formations in my possession, which differ in their structure from any others hitherto described. We have seen in possession of Mr Dekay, the inferior jaw-bone of a nondescript fossil animal found in New Jersey, which bears some analogy with a jaw-bone figured in Mr Mantell's "Geology of the South East of England," p. 153, under the name of "Jaw of a Reptile." My friend Dr Pickering refers this fossil to the jaw of a fish of the genus Sphyræna, Bl. *

CLASS PISCES.

Ichthyolites.

The fossil remains of fish are by no means of rare occurrence

* Dr Agassiz has referred the specimen of "Jaw of a Reptile" in Mr Mantell's collection, to the class Pisces.—*Ed.*

in many parts of the United States, but the observations of our men of science on this subject are not yet sufficiently numerous or so completely digested, as to enable us to give a scientific classification of them. The largest and most noted of the fossil fish of this country belong to the division

CHONDROPTERYGIA.

Or Cartilaginous Fishes.

The bones of one species of shark, upwards of forty feet in length, allied to the Carcharias, have occasionally been found in several localities. In Cuvier's " Theory of the Earth, by S. L. Mitchell," p. 400, it is stated :—" The skeleton of a huge animal was found on the Bank of the Meherrin river, near Murfreesborough, N. C. It was dug out of a hill, distant sixty miles, from the ocean. Capt. Neville and Dr Fowler, who visited the spot, gathered the scattered vertebræ which the Negroes had thrown out, and laid them in a row thirty-six feet in length. If to this the head and tail be added, the animal must have been fifty feet or more in length. The former of these gentlemen enriched my collection with two of the teeth and a joint of the neck-bone : the teeth weigh sixteen ounces each ; they are covered with an ash-coloured enamel, except at the roots where they were fastened to the jaws ; the sides of the triangles are six inches long, and the base is four inches and a half across. The single vertebra weighed twelve pounds and a half." These fossils are at present in the cabinet of the Lyceum of Nat. Hist. in New York. We have recognised them as the remains of a gigantic species of shark. The proteiform varieties presented by the teeth of the individual sharks, render it almost impossible to classify the species from these organs, viewed separately, those of the upper and lower jaw being in most instances entirely different in form. The Cabinet of the Academy of Natural Sciences, however, contains specimens of sharks' teeth from New Jersey " marl pits," which resemble closely those of the Squalus *zygena*, S. *mustelus*, S. *squatina* and S. *carcharias*, two specimens of the last measuring five inches in length and four broad at base. Provided the same proportion exists between the fossil and recent *Carcharias*, the former must have been more than forty feet in length. Parkinson's Organic remains, vol. iii., contains good figures of the teeth of most of the above named species; also Mantell's Geology of the South East of England, p. 132. For further observations on the fossil remains of sharks, *vid.* "Journ. Acad. Nat. Science of Philad." vol. iv. p. 232. pl. xiv., in an essay published by the author, entitled "Notice of the Plesiosaurus, and *other fossil reliquiæ*, from the state of New Jersey, 1824."

Professor Hitchcock, in his "report of the geology, &c. of Massachusetts," p. 193, pl. xi., and xii. has given figures of fossil teeth and vertebræ, found in what he terms the plastic clay formation at Gay-head, Martha's Vineyard; the former are evidently the remains of sharks, similar to those found in the green-sand of New Jersey, the latter are either not well figured, or resemble but indifferently the vertebræ of sharks; but possibly the statement of the author, that "in general they (the bones) are much broken and often rolled," will explain their anomalous forms.

In addition to the genus Squalus, the insolated fragments of other cartilaginous fishes, as the Raia and Acipenser, are occasionally found in similar localities as the former.

Fishes *proper*.

The fossil bones of fishes hitherto discovered in the United States, belong principally to Cuvier's second division, or

Malacopterygia.

Including among others the carp and the gar. On the 24th of January 1825, the author of these remarks had the pleasure to be present at the reading of an essay by Dr Dekay, before the New York Lyceum of Nat. History, on the "Fossil fish of the U. States." This essay we believe has never yet been published, but we were impressed at the time by the following statement of Dr Decay : "All the fossil fish which I have examined in the United States, are modelled after the *Esox osseus*, or bony-scaled pike of the Mississippi," which last species then, he thinks, may stand, "as the representative of a former creation,— the Logans of their race." This curious fact was subsequently confirmed by the observations of Baron Cuvier—vid. " Ossemens Fossiles."

ORDER ACANTHOPTERYGIA.

Genus Sphyræna, Bl.

The fossil jaw from N. Jersey secondary referred to above, is in possession of Dr Dekay, who has not yet published a description of it.

Many years ago we received from Mr A. Jessup, a fine collection of fossil fishes in the slate from Westfield, Connecticut.

Connected with the fossil fish of this locality, Prof. Hitchcock in his recent work, " Report on the Geology, &c. of Massachusetts," has given a very interesting chapter—we quote his observations for the benefit of our foreign readers, who may not conveniently refer to the original. " The remains of fish have been found on bituminous shale, and on bituminous marlite, in Middleton, Con., at Sunderland, Mass., and also in West Springfield and Deerfield. Sunderland, however, is the only spot where they can now be procured. The shale there forms the bank of the river several feet high: but the Ichthyolites are most abundant in the lower part of the bed, which corresponds nearly with low-water mark. I have dug out hundreds of specimens at this spot, though perfect ones are very rarely to be obtained.

" On one layer of the rock, fifteen inches by three feet, seven distinct impressions are visible. Indeed I have not unfrequently met with one fish lying across another, without the intervention of a layer of shale, and from these specimens, I can easily conceive how the mistake should have been made, that among the Monte Bolca ichthyolites, one fish was found in the act of swallowing the other.

" A thin layer of carbonaceous matter usually marks out the spot where the fish lay, except the head, whose outlines are rendered visible only by irregular ridges and furrows. In some cases, however, satin-spar forms a thin layer over the carbonaceous matter, and being of a bright gray colour, it gives to the specimens an aspect extremely like that of a fish just taken out of the water.

"We sometimes find the specimens a good deal mutilated; so much so indeed, that the form of the fish is entirely lost, and the tail and fins are scattered about promiscuously; and this too in the vicinity of other specimens that are entire. Hence we cannot impute this mutilation, as is usually done, to a disturbing force acting on the rock at the time in which the fish was enveloped, or afterwards. But if we suppose that the fish, as they died, were gradually enveloped by mud, it is easy to conceive how some of them might have putrified and fallen to pieces, before they were buried deep enough to be preserved; or it might be, that most of the fish was devoured by some other animal: and in either of these ways we might expect to find only scattered relics enveloped in the rock. The great resemblance of these ichthyolites to those found on the bituminous slate of Mansfield, in Germany, has been already noticed. Probably all of them belong to the genus *Palæothrissum*, (Blainsville). I am inclined to believe that I have found four species." *Vid.* p. 236, pl. xiv., fig. 44, 45, 46, 48.

As is generally the case, the fish appear to have lain on their sides when enveloped in the rock.

There are doubtless numerous localities of fossil fish in our widely extended country, which have not yet met the eye of a scientific naturalist. An intelligent friend has recently furnished us with a notice of a very interesting locality of this nature; he is the proprietor of a marble quarry situate in "Oval Limestone Valley," or "Nipnose Valley," on the west branch of the Susquehanna river, Pennsylvania. The marble is a greenish coloured conglomerate, somewhat resembling verd antique, and admits of a high polish, being fine grained and hard, interspersed with softer spots of an argillaceous nature. Some parts of this marble are represented as being replete with the remains of fossil fish, about the size of a herring or carp; some specimens retaining the impressions of the scales; others only of the bones. The stone was too brittle to permit the obtaining of any of the specimens whole.

On the Chemical Composition of the Crystallized Oxychloride of Antimony. By James F. W. Johnston, A.M., F.R.S.E., F.G.S., Reader in Chemistry and Mineralogy in the University of Durham. Communicated by the Author.

It has been very long known, that when a solution of oxide of antimony in muriatic acid is diluted with water, a white powder is precipitated, which, after prolonged washing, still obstinately retains a portion of the acid. This substance was formerly described under the name of the powder of algaroth.

The difficulty of separating the whole of the acid from this powder naturally leads to the opinion, that, when first precipitated, it is itself a definite compound less easily decomposed than the neutral chloride of antimony, or that it contains a quantity of some such compound. In either case, as water continues to separate acid from it at each effusion, it is obvious that washing must decompose this compound. The newly precipitated unwashed powder, therefore, must be, or must contain, the compound in its normal state.

We have many analyses of this substance, no two of which agree, obviously because having washed it more or less, each chemist operated upon a mixture in which the relative quantities of oxide and chloride of antimony actually differed. According to Bucholz, it contains $4\frac{2}{3}$ per cent. of dry muriatic acid; according to Gronvelle it consists of 7 atoms oxide united to one atom of chloride of antimony.* Dumas † gives as its composition 82 of chloride and 18 of oxide of antimony; while Mr Philips found it to contain 7.8 per cent. of muriatic acid, and 92.2 of oxide of antimony, or to consist of one atom of acid to $5\frac{1}{2}$ of the base.‡ From results so discordant, it is impossible to draw any conclusion in regard to the true nature of the compound, or whether there be any constant and definite compound of the chloride with the oxide of antimony. That oxides and chlorides do unite there is now no doubt, but the difficulty of obtaining these compounds in a crystalline form has hitherto pre-

* Gmelin's Handbuch, I. p. 985. † Traité de Chimie, iii. p. 399.

‡ Turner's Chemistry, p. 697.

vented their composition from being investigated so accurately as their interesting nature requires.

When the powder of algaroth is first thrown down, it forms a beautiful white precipitate; but if allowed to stand some time, or be collected on the filter, it not unfrequently changes in appearance, becomes granular, and assumes a yellowish-grey colour. In this state acid is separated from it by washing with water, but its whiteness is not restored. These grains sometimes possess a slight degree of lustre; they are minute crystals.

If an acid chloride of antimony, prepared by digesting muriatic acid in the sulphuret or by any other process, be diluted with 20 or 30 times its volume of water, and set aside, the light white powder which at first falls gradually contracts in bulk, and at the end of two or three days has nearly all assumed the crystalline form. These crystals are grey, yellowish-grey, or, if the chloride has been prepared from the sulphuret and any sulphuretted hydrogen is present, of an orange-red colour. They exhibit occasionally a high degree of lustre, and, according to the measurement of Professor Miller of Cambridge, are oblique rectangular prisms, of which the terminal obtuse solid angles are replaced by planes. The crystals are generally microscopic, but from their brilliancy the faces are very distinctly observable. Only on two occasions have I observed them form radiated needles, brilliant, almost pure white, and half an inch in length; the method above described, however, seldom fails to give distinct crystals of a lesser size.

When these crystals are washed with water, their brilliancy diminishes from the surface undergoing decomposition; they must therefore be collected and dried on bibulous paper without washing. That these constitute a definite compound there can be no doubt.

At a temperature considerably above 212° Fahrenheit they lose no weight; farther heated in a close vessel they decrepitate and give off white fumes of chloride of antimony; 31.86 grains heated to redness in a glass-tube with twice its weight of dry carbonate of soda, and the gas given off made to pass over chloride of calcium, gave only .12 of moisture = 0.38 per cent. This small quantity of moisture was obviously hygrometric either in the soda or the salt.

By boiling with a solution of carbonate of soda, or by heating nearly to redness with the dry salt, it is decomposed. By saturating the solution with pure nitric acid, filtering and, precipitating with nitrate of silver, I obtained for the amount of chlorine per cent. in four experiments 11.32, 11.26, 11.22, 11.215, respectively. Notwithstanding the close agreement of the last two results obtained by different methods, the highest probably comes nearest the truth, as by washing a minute portion of the chloride present in the crystals may be decomposed.

It requires great care and considerable practice to be able to determine the amount of antimony within half a per cent. Some discussion has lately arisen as to the possibility of approximating nearly to the true quantity by precipitating it from its solution in muriatic acid by sulphuretted hydrogen; and Rose has stated, that when the gas is transmitted in large excess, the sulphuret of antimony may be completely freed from chloride, and the metal determined to about half a per cent. This result, however, is not always to be depended upon. From solutions perfectly saturated with sulphuretted hydrogen, I have several times collected precipitates, which, when dried and then gently heated in a close tube, gave off white fumes of chloride. Though therefore, the antimony *may*, by this process, be pretty nearly determined, the result obtained should if possible be checked by recourse to some other method of analysis.*

As the amount of oxygen in the oxychloride is determined from the loss, the estimation of its quantity is liable to a double error, arising from the weights both of the chlorine and antimony obtained by analysis. I had therefore recourse to two other methods in order to verify and control the per-centage of antimony obtained by precipitation from the solution containing it. 1st, 30.32 grains dissolved in muriatic and diluted with a solution of tartaric acid, gave with sulphuretted hydrogen 32.02 grains of sulphuret = 76.82 per cent. of metallic antimony. 2d, digested with pure nitric acid, it is decomposed with evolution

* The iodide of antimony (3I + 2 Sb) seems to have a similar affinity for the sulphuret as the chloride has, or a similar tendency to mix with it and resist the action of sulphuretted hydrogen, for if the iodide be dissolved in muriatic acid, diluted largely with water and decomposed by excess of sulphuretted hydrogen, the dry sulphuret, when heated in a close tube, gives a coloured vapour which condenses into a red crystalline crust of the iodide.

of chlorine, and, by cautious evaporation and heating to redness, the metal may be obtained in the state of antimonious acid. By the most careful procedure, however, it is difficult to obtain it entirely free from a trace of chloride or oxide, which causes a small loss when heated to redness. By this process I obtained in three experiments 75.93, 76.506, 75.98, for the per-centage of metal. 3d, Gently heated in an atmosphere of sulphuretted hydrogen, muriatic acid is disengaged, a little chloride of antimony is carried over with it, and the black sulphuret remains. By a cautious application of the heat so as to prolong the process for two or three hours, the quantity of chloride volatilized may be very much diminished, so as to reduce the loss below a quarter per cent. Should any notable quantity of white fumes make their escape, they may be decomposed by causing them to pass through water, and the antimony afterwards collected in the state of sulphuret. In two experiments, I obtained by this method 76.558 and 76.6 for the amount of antimony. In these results I have most confidence; in both, however, there was a trifling loss, so that they ought to be rather under the truth.

I endeavoured to determine the oxygen directly by heating the salt to redness with charcoal in a glass tube and collecting the carbonic acid evolved, but the approximation obtained was very rude. Reckoning the loss as oxygen, therefore, we have for the composition of the salt,—

Chlorine	=	11.32	=	2.55 atoms.
Antimony	=	76.6	=	9.498 —
Oxygen	=	12.08	=	12.08 —
		100		

Where the number of atoms of antimony is to this sum of those of chlorine and oxygen as 2 to 3.08, very nearly the relation which the electro-negative element bears to the metal in the oxide and first chloride of antimony.

The atomic constitution which agrees most nearly with these numbers is the following:—

			By calculation.	By experiment.
	$\frac{3}{2}$ Cl	= 6.639	= 11.49	= 11.32
	Sb	= 8.064	= 76.72	= 76.6
4.5	Sb	= 36.290		
	$\frac{3}{2}$ O	= 6.75	= 11.79	= 12.08
		57.743	100	100

Or two atoms of chloride are combined with 9 of oxide, the formula being $2(3\ \mathrm{Cl} + 2\ \mathrm{Sb}) + 9\ \dddot{\mathrm{Sb}}$. The quantities of chlorine and antimony found by experiment are, as was to be expected, a little less than is indicated by theory, causing the amount of oxygen to appear something greater than it ought to be.

Other compounds of chloride with oxide of antimony may probably exist. The composition of the powder of algaroth, whether in the form of a dull grey sandy powder or of regular crystals is very constant. In making the above analyses I employed the crystals obtained at many different times, and the results agree very closely. By supposing a portion of the acid to have been washed away, it is easy to reconcile with the composition above given all the results found by other chemists, with the exception of that given by Dumas. If any confidence is to be placed on that result, there must be at least one other analogous compound, differing very much in composition from the common powder of algaroth, the chemical constitution of which it is said to represent.

There exist many other compounds of fluorides, chlorides, and iodides with oxides, in which the ratio of the haloid compound is to that of the oxide, so far as they have been examined, as 1, 2, 3, 5, to 1. None of them, however, I believe, has yet been obtained in a crystalline form, with the exception of the oxychloride of antimony, and it is therefore not improbable that considerable errors may hereafter be found in the atomic constitution at present assigned to them.

The difficulty of entirely decomposing the iodides of antimony and arsenic even by long boiling with water, renders it exceeding probable that these iodides unite with their respective analogous oxides in some definite proportion, which, of course, cannot be investigated till they are obtained in a crystalline or some other constant form.

Observations upon the Salmonidæ met with during an Excursion to the North-west of Sutherlandshire, in June 1834. By Sir William Jardine, Bart., F. R. S., M. W. S., &c. &c. Communicated by the Author.

The investigation of any tribe of fishes is always difficult, from the uncertainty of procuring specimens at every season, and from the impossibility of tracing the habits of the creatures themselves in their native element. In those genera which have the species closely allied to each other, the difficulty is much increased; and in the family of the Salmonidæ it has been long felt and acknowledged, and various theories have been started, which, from the difference of opinion expressed, have led to the proposal of questions yet unanswered. Induced by the expectation of novelty in different departments of natural history, and encouraged by a liberal permission granted by the Duchess-Countess of Sutherland, to examine the valuable fisheries upon her extensive properties, a short excursion to the north-west of Scotland was undertaken in June last.* The fishes inhabiting the lakes and rivers formed a particular object of research; and without attempting to clear up the doubtful and mysterious points of their history, I shall endeavour to notice shortly those species which were met with during the above mentioned excursion.

Migratory.—Most naturalists have divided the true salmon of our waters into two sections, " those which are migratory," and " those which are not migratory to the sea." At present, and for the sake of simplicity, is retained this apparently natural division. Of the first section, " those which are migratory," I feel pretty confident in placing four species, Salmo salar, trutta, eriox, and albus. †

1. *Salmo salar, or Common Salmon.*—Of those, the first, the common Salmon, will stand at the head; first in commercial value and importance, first in size, and first in

* The gentlemen composing the expedition, were Mr Selby, Mr James Wilson, Dr Greville, Mr John Jardine, and myself.

† I am not sure that the three last specific names will stand; although our species are so limited, the unravelling of the synonyms is extremely difficult, but I trust ere long to accomplish this, and to affix more recognisable characters to those which belong to this country.

the estimation of the sportsman. The salmon fisheries of Scotland were of very great value, but for the last twelve or fifteen years they have rapidly decreased, some having fallen so much as two-thirds of their rent. The county of Sutherland having a large extent of sea coast, indented with innumerable bays, and the country being nearly a succession of mountains and valleys, each with their lakes and rivers, was a favourite resort for the salmon, and the fisheries were valuable, and carried on extensively. They were, however, let to tenants, (or kayners as they are there termed,) and being much over-fished, shared the fate of the others; so much so, that the late Duke of Sutherland, anxious to restore them, two years since took them entirely into his own possession, built extensive curing houses, preserved the rivers during close-time, and so regulated the fishing, that free access was given to the heavy or breeding fish, and the kelts or spawned fish were allowed to return unmolested to the sea. The consequences of this good management have already shewn themselves, and in some rivers the produce has been this year doubled. In the examination of these fisheries one or two facts presented themselves.

It has always been a subject of dispute whether the fry returned to the rivers as grilse in the same season which they descended. I have had no doubt of this for several years, but it was very difficult to prove. In the Tweed, I have killed grilse early in the season, so small as only to weigh two pounds, and seen them gradually increase in size as the season advanced; the intermediate size, however, between the fry and the two pound grilse was wanting. During the two years which the fisheries of Sutherland have been in possession of the Duke, a set of experiments have been instituted by his factors, one of which leaves no doubt upon the subject. Last spring, several thousands of fry were marked in the different rivers, among others, by Mr Baigrie in the Laxford and Dinard, on the west coast. In the Laxford, the first grilse (marked in April as fry) returned on the 25th June, and weighed three pounds and a half. Many others were got during the season from this weight to six pounds and a half, returning to the rivers where the fry were marked, which was known by a particular mark being used in each, and shewing that a return to their breeding ground was as frequent, or rather as constant, as among the higher animals. This size and weight exactly agrees with that of the grilse upon their first running elsewhere; and I think that very few attempt to enter the rivers before attaining a weight of 3 lb. These marked grilse were unfortunately killed; but next year it is proposed to return them again to the river, with an additional mark, and endeavour to retake them a second season. Several other experiments are also proposed, and as the nature and situations of the rivers present every facility, I have little doubt of their success.

Some rivers are what are called early, others late; or, in other words, the clean or high conditioned salmon commence to ascend in spring, and the fish come into breeding condition, and begin to spawn at an earlier period. The causes influencing this seems yet undecided; and where the time varies much in the neighbouring rivers of the same district, they are of less easy solution. The northern rivers, with little exception, are, however, the earliest (a fact well known in the London markets); and going still farther north, the range of the season and of spawning may be influenced by the latitude. Artedi says, "In Sweden the salmon spawn in the middle of summer."

It has been suggested that this variation in the season depended on the warmth of the waters, and that those highland rivers, which arose from large lochs, were all early, owing to the great mass and warmer temperature of their sources, that the spawn there was sooner hatched. There are two rivers in Sutherlandshire, which shew this late and early running under peculiar circumstances. One the *Oikel*, borders the county, and springs from a small alpine lake, perhaps about half a mile in breadth; the other, the *Shin*, is a tributary to the *Oikel*, joins it about five miles from the mouth, but takes its rise from Loch Shin, a large and deep extent of water, and connected to a chain of other deep lochs. Early in the spring all the salmon entering the common mouth, diverge at the junction, turn up the Shin, and return as it were to their own, and warmer stream, while very few keep the main course of the Oikel, until a much later period.

It is a mistaken opinion to suppose that the spawning season is only between October and February. In many rivers it would commence in the end of August, if the grounds and entrance to the rivers were left open and unmolested; and in some of the Sutherland streams which have been left undisturbed for the last two years, the spawning season has been advanced by a month or six weeks. It varies in almost every river, and hence will be seen the impropriety of a general or common close-time, some waters in fact being open when they should be closed, and the reverse.

It is a common remark with fishermen, that no food is ever found in the stomach of the salmon taken in the sea; and this circumstance has been handed down by almost all writers for a long period. This saying, for it deserved no farther credit, has only lately been examined into by an anatomist, in the Transactions of the Royal Society of Edinburgh, that the only and peculiar food of the salmon in the salt water consisted of small monoculi and entomostraca, with the ova of star-fish.* In the north of Sutherland a mode of fishing salmon is sometimes successfully practised in the firths, where sand-eels are used for bait: a line is attached to a buoy or bladder, and allowed to float with the tide up the narrow estuaries. The salmon are also said to be occasionally taken at the lines set for haddocks, baited with sand-eels. At the mouths of rivers they rise freely at the artificial fly within fifty yards of the sea, and the common earth-worm is a deadly bait for the clean salmon. All the other marine salmon are known to be very voracious; and there is nothing in the structure of the mouth or strong teeth of the common salmon, to warrant us to suppose that there is any material difference in their food.

2. *Salmo Trutta* or *Sea Trout.*—The fish next of importance in Sutherland, is what there, and indeed in the whole North Highlands, is called the *Sea Trout;* but under this general name two fish at least seem to be included. By the taxmen or fishers, they are, however, only distinguished as the larger and smaller kinds, and by the different season at which they run. The first or early running kind was considered to be *Salmo trutta.* The run of these fish commences about the first week of June, and is at its greatest height towards the middle of the month, the numbers decreasing with the advance of the season, until they are succeeded by the later running fish. In approaching the entrance of rivers, or in seeking out, as it

* Faber, in his Natural History of the Fishes of Iceland, remarks, "The common salmon feeds on small fishes, and various small marine animals."—Fleming says their favourite food in the sea is the sand-eel.—*Edit.*

were, some one which they preferred, shoals of this fish may be seen coasting the bays and headlands, leaping and sporting in great numbers, from about a pound to three or four in weight; and in some of the smaller bays, the shoal could be traced several times circling it, and apparently feeding. In these bays they are occasionally taken with a common hang-net stretched across; and when angled for in the estuaries, with the ordinary flies which are used in the rivers of the south for grilse, rose and took freely so eagerly, that thirty-four were the produce of one rod, engaged for about an hour and a half. They enter every river and rivulet in immense numbers, and when fishing for the salmon are annoying from their quantity. It is scarcely possible at present to arrive with any certainty at the numbers of this fish. They are a perquisite to the fishermen or kayners, who naturally may not be willing to expose their whole profits, and nothing but a salmon net of large mesh being used, the greater part of the smaller fish escape. Two hundred are frequently taken at a draft, and three hundred have occasionally been counted. The food of those taken with the rod in the estuaries, appeared very indiscriminate; occasionally the remains of some small fish, which were too much digested to be distinguished, sometimes any flies, beetles, or other insects, which the wind or tide had carried out, and of which *Phylopertha vulgaris*, or brachen-clock, in one district, formed a great part; but the most general food seemed to be the *Talitrus locusta*, or common sand-hopper, with which some of their stomachs were completely crammed.

3. *Salmo albus* or *Herling*.--Our time did not permit us to remain in Sutherlandshire, until the run of what the fishermen call the *smaller sea-trout*, which commences about the middle of July; but by the attention and kindness of Mr Baigrie, factor for the Scourie district, specimens put up in spirits were forwarded to us from the Laxford, and, upon comparison, were found to be identical with the herling of the Solway Frith, the fish which Dr Fleming has given under the title of *Salmo albus*. This is by far the most abundant species in the northern rivers, and indeed, wherever it is found, as far as could be estimated by Mr Baigrie, they enter the rivers in the proportion of about ten to one of the first or early running fish.

4. *Salmo eriox* or *Grey*.—There is only another of the migratory salmon enumerated, viz. Salmo eriox, but no specimen

was met with. A large fish is, however, occasionally taken on the north coast, which is known by the name of Norway trout; this may either prove the large square-tailed bull-trout of the Tweed, or one of the North European species, which appear not yet to have been met with in Scotland.

5. *Not migratory. Salmo Fario* or *Common Trout.*—In Northern Europe most of the lakes and rivers are inhabited by this section of the salmonidæ. The north of Sutherland is a county peculiarly adapted for them, and in the ample rivers, and rugged mountain torrents which water her valleys, and in the lakes which so thickly stud her wild and Alpine districts, we find these fish almost the peculiar inhabitants, and abounding in the greatest profusion. None of these waters, I believe, have been previously visited, with the view of examining their productions,—those which had been visited had only been so by the sportsman, but many have never been looked at except by the shepherds who tended their masters' flocks on their sides. In all these lochs, the most casual observer is at once struck with the dissimilarity and variation which exists among the fish. The guide whom the stranger has engaged to conduct him to some unexplored waters, will boast of the different kinds which his loch possesses, anxious to show its superiority over some others; and trout are frequently taken in different little bays, separated only by some narrow promontory, of appearances totally distinct. The causes which produce this variation in the trout (S. fario) of our lakes and rivers, has not yet been attended to, and the possibility of its being the consequence of different species inhabiting them, seems not to have been thought of (at least in this county), as the reason for so great differences appearing in their shapes and colour.

Situation, the quality of the rock or soil forming the bottom of the loch or rivers, and composing the surrounding country, with a difference of food, will all conduce to alter considerably the aspect and colour of the fish. The seasons have also their influence, and at that time when the great business of spawning is in preparation, the form of the jaws becomes lengthened, and the colours of the scales become much heightened in brilliancy,—the latter a change analogous to the nuptial plumage in birds, while at the completion of the breeding season, another change is exhibited, incident to the then thin and transparent structure of the new scales.

During the excursion, several very distinctly marked varieties of trout were met with, which we shall notice in succession; and it may be observed, that although a certain change of variation occurred in each, yet an arrangement of the markings and colours always prevailed, by which they could be pointed out from each other. There was a corresponding (slight, but apparently constant) variation, of the form of the stomach and some other of the internal organs, and there was a similar difference in the form of the scales. A variation of habit was also perceived, with a different manner of swimming and of action, similar to what may be noticed in the flight of two closely allied species of birds, from which a practised eye would make them out before either the colours or shape could be distinguished.

The *first variety* is from Loch Craigie, on the southern borders of Sutherlandshire. The country immediately surrounding it, is composed of black and white granite, the bottom of the loch of large boulders of granite gravel, or fine sand, and, except at the edge of one or two small bays, no indication of moss appeared. The colour of the water was clear sienna-brown, and more limpid than that of any of the lochs in the same district. The fish found here were upon an average about one pound in weight, but one or two instances of trout from five to six pounds being taken were mentioned, and a single specimen weighing two and a half pounds was taken by the party. The form approached very near to the generally accepted idea of symmetry in a trout,—remarkable for the small size of the head, the arched back, and great perpendicular depth. The colours of this fish were of the highest brilliancy, the upper parts of a rich brown, the lower half and belly of a deep golden orange, the spotting numerous but ill defined, and often assuming a cruciform shape. At this period (beginning of June) the fish were in the height of perfection or season, the flesh high-coloured,—when hooked remarkably active and powerful.

In the immediate neighbourhood of Loch Craigie, there are three or four other lochs abounding with trout. The edges and bottoms of these lochs are, however, weedy and mossy, the water very dark coloured. The trout of these has all the appearances in general form and distribution of spots, but want entirely the beautiful brilliant tints, and high season of the others, but are evidently the same variety, inhabiting a particular district, and having the appearance changed by circumstances.

It is not so, however, with the *second variety* to be noticed. It is from Loch Shin, a loch of great extent and great depth, lying only at the distance of about three or four miles from the other, but on a much lower level. The bottom is for the most part rocky, gravelly, or sandy, but a great extent of its banks are mossy, and the water is of a very deep brown. The trout taken here were all apparently in good condition, but were remarkable for the lengthened and graceful form not only of the body, but of all the members,—the head lengthened rather attenuated towards the nose—the fins all lengthened, very sharp-pointed, and very powerful, the dorsal fin rising high in front,—the anal fin, with the first ray double the length of the last, the tail deeply forked, the outer points turning inwards and sharp. Following the same lengthened proportions, we found the accessary pinnula of the ventral fin very lengthened and sharp-pointed, and the form of the scales under the microscope longer in proportion, and considerably narrower than in any of the others. The colours were not so brilliant as in the last, but very chaste and beautiful, shading from deep olive-brown to a greyish-yellow,—the spotting large and distinct, round, and placed in a pale field, not numerous; average weight from $\frac{3}{4}$ to 1 lb.; though a few 2 lb. weight were taken.

The *third variety* is from a small alpine loch upon the Benmore range, at a very considerable elevation. It is situated in a tract of moss, but the bottom (which is the subsoil, the moss apparently washed away) is rocky or gravelly, the water rather transparent, but of a dull tint; the rock of the immediately surrounding country is limestone. Compared with either of the former, the distinctions of shape were very evident. The head was very round, the nose blunt; while the length to the extremity of the gill covers was proportionally great; the body very thick, deep, and round; the fins thick and muscular, the lower ones rounded at the extremity; the tail square. The ground colour was deep purplish-olive, shading from greyish to golden yellow, the whole, including the fins, glossed over as it were with a rich shade of pale purple; the upper parts and gill covers were thickly spotted with well defined round sapio-coloured spots, some placed in a pale space; below the lateral line they become thinner and more scattered, but extended in the centre of the fish almost to the ventral fins. This trout was in extremely fine condition, the flesh red and firm; when hooked, extremely powerful, but not exhibiting the great activity of the Loch Craigie variety. The food found in the stomach was exclusively a fresh water Talitrus, they nevertheless took gaudy flies, and salted minnows, the latter they had not probably tasted even in their original state.

The *fourth variety*, of a much less size, is from the district of Assynt, on the west coast of Sutherland. Loch Assynt is a considerable sheet of water, running nearly from east to west. From the western extremity to the sea there is a gradual descent, the intervening country dispersed in a series of low rugged hills of moor and moss. Every hollow or narrow valley is studded with lochs of various sizes, from half an acre to forty or fifty in extent, sometimes communicating with each other, and some without any apparent outlet. They form a complete chain or series to the coast, and are said to be above 200 in number. It was in these lochs that we found, and I may say exclusively, this variety, in immense abundance, eagerly taking any bait that was presented. In weight none exceeded ½ lb., but the greater proportion were only from five to six inches in length. It is rather thickly formed, the fins of moderate strength, the lower ones rather sharp-pointed at the extremity, the tail complete, and much forked; the colours were beautiful and brilliant, the upper parts of a rich olive-brown, which changed to a bright king's yellow beneath; the upper two-thirds of the body, gill covers and dorsal fin thickly covered over with large round black spots standing in a pale circle; on the ridge of the back these spots often united, and then appeared in a lengthened form. This variety is remarkable, as occurring in so wide a district, with so much regularity of form, colour, and markings; the distribution of them all peculiarly similar.

The *fifth variety,* and the only other to be noticed, is from a series of lochs between Richkonich and Laxford, and in the river Laxford which issues from Loch Stach. In form it is comparatively short, but remarkably deep, the fins very short in proportion, rounded and muscular, and of a tench-like shape different from any of the others; while on the other hand, the head was remarkable for its great length. They seemed to attain considerable size,—one of four pounds weight was taken, several from two to two and a half. The flesh white and soft, the colours not brilliant, and the spotting large, but placed widely asunder. By the fishermen on the Laxford they were termed *loch trout*, in contradistinction to the commonly marked trout of the river. The osteology of the head of the large specimens appears to differ considerably from that of the common river variety, but has not yet been compared with a fish of a similar size. The maxillary bone is extremely strong but narrow, in length it exceeds that of an 18 lb. salmon.

Having thus noticed the principal varieties which occurred of the fish generally placed as S. fario, it may be remarked, that I am by no means satisfied that they all belong to that one species; but I do not yet possess sufficient materials for comparison, and to form a decided opinion by.

6. *Salmo ferox.*—The next fish which occurred in these wild waters, is, however, a trout not only distinct from any British fish, but has been pronounced by an eminent ichthyologist to be different from any of the large continental species, which I have never had an opportunity of seeing: it is the great grey or loch trout, *Salmo ferox*, Jard. and Selby.

This fish, as far as can be traced, seems to have been first noticed in the Scotch lochs about forty-five years since, by a gentleman of Glasgow, who used to exhibit them to his friends as the trophies of his expeditions. By several of our late ichthyologists they were, however, noticed as large trout inhabiting the lochs of Scotland and Ireland; but they appear only to have looked upon them as very large individuals of the common trout, and have given no description or character.* In Scotland they seem generally distributed in all the larger and deeper lochs. Loch Awe, Loch Laggan, upper end of Loch Shin, Lochs Loyal and Assynt they certainly inhabit, roving indiscriminately, and feeding nearly entirely upon the smaller fish. By persons residing on the banks, they are taken only by set night lines, few rising at the artificial fly; but they may always be taken by strong trolling tackle, baited with a small trout. They are extremely voracious, and having seized the bait, they will allow themselves

* Mr Selby and myself considered the first specimens which we took in Loch Awe in Argyleshire, as a species undescribed and new to Britain, and gave it the name of S. ferox, from its extreme voracity and rapacious habits.

to be dragged by the teeth for forty or fifty yards, and when accidentally freed, will immediately again seize it.

Salmo ferox appears to be entirely confined to the lochs, seldom ascending or descending the rivers running into or out of them, and never migrating to the sea. In the spawning, they ascend for a short way up the rivers or streams entering the lochs, but never for the same purpose descend those running out of them, though in Loch Awe, a favourite resort at this period, is a shallow bank of gravel at the narrow gorge where the loch commences its exit to the river, and here during the spawning, which commences about the end of September, they rise eagerly at the common large gaudy salmon flies.

The largest specimens that I am aware of being taken were 28 lb.; a greater weight is given to it, but I cannot with certainty refer to any beyond this: from 10 lb. to 20 lb. is the most common weight. It is a remarkably powerful trout, but does not possess the agility of a salmon of the same weight.

The characters which principally distinguish this trout are found in the larger size,—the square tail in all its stages of growth,—the form of the gill-covers and teeth,—the relative position of the fins,—the form of the scales, particularly those composing the lateral line, and in the generally delicate skin which is spread over the outside of the body, being extremely strong and tough, and from under which the perfectly transparent scales can be extracted. The fins may be stated nearly thus, though a greater variation may occur:—dorsal, $\frac{2}{11}$ to $\frac{4}{11}$; pectoral, 14; ventral, $\frac{1}{10}$; anal, $\frac{1}{11}$; gill-covers, 12. The greatest variation occurs in the dorsal fin. In Loch Awe, most of the specimens had the full compliment of 15 rays.

In Loch Loyal we met with what was considered a singular variety of this fish. Two specimens of 5 lb. each were taken. The general ground colour was deep purplish-brown, shading into blackish-grey, the whole upper parts of the body spotted with dark sapio-coloured spots, which were continued of a smaller size also over the whole of the under parts. In ordinary species, the under parts are generally of a uniform greyish-yellow.

7. *Salmo salmulus* or *Parr.*—This little fish was met with sparingly in a few of the rivers which had an uninterrupted intercourse with the sea, but it evidently decreased to the north.

The difference of opinion among all our ichthyologists, or rather the difficulty which they appear to have in forming one, whether this fish is distinct, or only the young of some others, has rendered the solution of it interesting. The greatest uncertainty, however, latterly resolved itself into, whether the *parr* was distinct, or a variety, or young of the common trout, *S. fario*,—with the migratory salmon it has no connection whatever. What follows is the result of examination and comparison made last month from Tweed specimens.

Among the British salmonidæ, there is no fish where the habits are so regular, or the colours and markings so constant. It frequents the clearest streams, delighting in the shallower fords or heads of the streams having a fine gravelly bottom, and hanging there in shoals, in constant activity, apparently day and night. It takes any bait at any time with the greatest freedom, and hundreds may be taken when no trout, either large or small, will rise, though abundant among them. That part of its history only which is yet unknown is the breeding. Males are found so far advanced, as to have the milt flow, upon being handled; but at that time, and indeed all those females which I have examined, had the roe in a very late state of forwardness, and they have not been discovered spawning upon any of the shallow streams or lesser rivulets like the trout.

In the markings they are so distinct as to be at once separated from the trout by any observer. The row of blue marks which is also found in the young trout, and in the young of several salmonidæ, in the parr are narrower and more lengthened. The general spotting seldom extends below the lateral line, and two dark spots on the gill-cover are a very constant mark. On a still closer comparison between the young trout and parr of similar size, the following distinctions present themselves: The parr is altogether more delicately formed, the nose is blunter, the tail more forked; but the chief external distinction is in the immense comparative power of the pectoral fin:—it is larger, much more muscular, and nearly one-third broader; and we will at once see the necessity of this greater power, when we consider, that they serve to assist in almost constantly suspending this little fish in the most rapid streams. Scales of the parr taken from the lateral line below the dorsal fin, were altogether larger, the length greater by nearly one-third, the furrowing more delicate, and the form of the canal not so apparent or so strongly marked towards the basal end of the scale. The osteology of the head was still more convincing. The general greater delicacy of the bones in the parr were still kept up very distinctly. The *opercule** forming the outer edge of the gill-covers is much more rounded than in the trout, approaching in this respect to the salmon ; in the trout the lower angle is decidedly *angular*. The *inter-opercule* in the parr is longer and narrower. The *maxillary* bone is broader at the posterior corner, but much shorter in the parr ; the *vomer* is much weaker ; the bones or *rays* of the gill-covers are longer and much narrower than those of the trout. The teething of the parr is weaker ; the bone of the tongue longer, weaker, and not so broad ; the under jaw much weaker, and the distance between its *rami* in the parr about one-third less. These are the most conspicuous distinctions, but every bone varies ; and not in one only, but in the many specimens which I have lately examined, the distinctions were the same, and at once to be perceived. In this state, therefore, I have no hesitation in considering the parr not only distinct, but one of the best and most constantly marked species we have, and that it ought to remain in our systems as *Salmo salmulus* of Ray.

The easiest distinguishing marks to a person who has not leisure to dissect them, are the great size of the pectoral fins, the shortness of the maxillary bone, and consequent diminutive gape, compared with the same sized trout, and the breadth between the rami of the lower jaw.

8. *Salmo alpinus* or *Char*.—This was the only other species belonging to this family which was met with during the excursion, but from the want of proper nets, many specimens could not be procured. Those taken were the Salmo alpinus. It appears to be in many of the northern lochs, but is only taken when coming to the mouths of the rivulets in spawning season. They reach a considerable size. These char appeared to be more exclusively a night-feeding fish than any of those denominated trout. They also feed near the bottom. In their stomach we found the remains of aquatic insects, with a mass of digested matter, which, if examined by the microscope, may have been found to contain more minute food.

* The names of the bones are taken from the osteological plates of Cuvier, which should be kept as the key to such descriptions.

Memoir on the Inquiry, Whether any Terrestrial Animals have ceased to exist since Man's creation; and whether Man was cotemporaneous with Species which are now lost, or which at least do not appear to have representatives now upon our globe. By M. Marcel de Serres. (Concluded from vol. xvii. p. 285.)

III. *On the different Animals and Vegetables which are represented upon the Mosaic on the Pavement of the Temple of Fortune of Palestrina.*

Of all the antique monuments which afford a representation of a great number of animals and vegetables, there is none that is more curious than the Mosaic of Palestrina. Whatever origin is ascribed to it, and whatever may have been its object, certain it is that the artist to whom we owe it, has represented the various animals and vegetables with a precision and accuracy which cannot fail to command our utmost confidence. Before endeavouring to prove this, let us attempt to give some idea of the object of the artist in the construction of this beautiful and singular monument.

We find that this mosaic formed the pavement of the Temple of Fortune, in the ancient Præneste, a town of Latium, upon the ruins of which was built the town of Palestrina, distant about twenty-one miles from Rome. This mosaic, about 20 feet in length by about 15 in breadth, was placed in the sanctuary of the Temple of Fortune. As through the agency of the damp to which it was exposed, it was unceasingly wasting away, the Commandeur dal Pozzo caused it to be represented in eighteen drawings, which imitated the original colours; and Saurés, Bishop of Vaisar, gave a short description of it in his History of Præneste, printed at Rome in 1655 *.

Somewhat later the Cardinal Baberini, wishing to withdraw this mosaic from the accidents to which it was exposed, had it removed into the palace of the Princes of Palestrina †. It was

* Prænest. Antiquit. Hist., tom. i. cap. xviii.

† See the explanation of the Plate of 1721.

then engraved, in 1671, in the Latium of P. Kircher *; and, in 1690, M. Ciampini published another engraving of it, which differed considerably from the former. It was on account of this discrepancy that the Cardinal Francis Barberini, grand-nephew of the former, caused the mosaic to be again copied in 1721 in new plates of a much larger size; though some errors appear to have crept even into these. It was to rectify these that Montfaucon, and, later still, the Abbé Barthélemy, have both published delineations, in which this mosaic is represented in such dimensions, and with so much accuracy, that we can form determinate ideas respecting the different animals and vegetables which are represented, points to which we shall solicit the particular attention of our readers †.

The different authors who have studied the purpose and object of this antique, seem to have inferred it from a passage which occurs in Pliny. According to this author, the mosaics denominated *Lithostrata*, were in use at Rome under Sylla; and there is yet, he adds, to be seen at Præneste the one which he caused to be formed in the Temple of Fortune ‡. It has been concluded from this passage, that we must discover, either in the vicissitudes of fortune, or in the life of Sylla, marked references to the mosaic of Palestrina. Kircher has adopted with ardour the first of these opinions §.

But others have discovered in it Alexander arriving in Egypt at the time when the oracle of Jupiter Hammon had legalized his conquests; believing that, under this emblem, Sylla desired to recall those oracles which warranted his own elevation ¶. Others, among whom is Father Valpi, have seen in the figures no traits but those which characterize the Romans, and have chosen to believe that Sylla caused himself to be re-

* Latium Vetus Roman. 1671, p. 100. Also Monim., tom. i. p. 82.

† Montfaucon, L'Antiquité expliquée, tom. ii. du Supplem. 1754.—Explication de la Mosaique de Palestrine. Paris, 1760.—Mem. de l'Académie des Inscriptions, tom. xxx. p. 505.

‡ Pliny, l. 34. cap. 25. Ed. Harl.

§ Veter. Latium, tom. ii. p. 150 and 152.

¶ This opinion has been maintained by Cardinal Polignac, as may be seen in his *Dissert. in Calc. delineat. Edit. a* Card. Baberin.

presented *. Others again, and Montfaucon is one, not being able to recognise either the journey of Alexander or the vicissitudes of fortune, have supposed that Sylla was satisfied with there presenting the shores of Egypt and Ethiopia, and especially the course of the Nile †.

On the other hand, many of the learned have advanced very different opinions. Thus, in the eyes of the Abbé Dubos, the mosaic of Palestrina is nothing more than a kind of geographic chart of Egypt, or of the country watered by the Nile ‡. Whilst, according to the Abbé Barthélemy, it was destined solely to commemorate the voyage which the Emperor Adrian made into Egypt. Winckelman discovered in it the meeting of Helen and Menelaus, a meeting which took place in Egypt after the tragedy of Euripidus; Chaupy, that it was intended to represent the exportation of grain from Egypt to Rome §; whilst, according to Nibby, its object was to represent the festivities which they were in the habit of celebrating in Egypt during the inundations of the Nile ‖.

Amidst all these contradictory opinions, there is evidently agreement as to one fact, viz. that the scene represented upon the mosaic of Palestrina was enacted in Egypt and in Ethiopia. If there were any doubt on this point, that doubt would be effectually dissipated by a study of the animals and vegetables that are found represented upon it. This examination, therefore, will be found useful, not only as connected with the inquiry which now engages us, but also as it is an antique, which antiquarians with reason have regarded as one of the most curious which have been preserved, and one which Poussin has in part copied in many of his pictures.

Another particular which seems to be unanimously established is, that the under part of the pavement of this mosaic, that which lies to the north, has reference especially to Egypt. This is easily determined, not only because we see the Nile repre-

* *Veter Latium*, tom. ix. p. 51.

† *L'Antiquité expliquée.* Supplem. tom. iv. p. 148.

‡ Reflexions Critique sur la Poésie, tom. i. p. 347.

§ Maison de Compagne de Horace, tom. ii. p. 301.

‖ Il, Tempio della Fortuna, Prænestiana Roma, 1825, p. 12.

sented, but still more on account of the several productions which we find there, such as the crocodile, the hippopotamus, the lotus, and the peculiar kinds of reeds. The upper part of the pavement, that which lies towards the south, is intended to represent the wild and mountainous districts of Ethiopia, infested with savage animals which are more or less dangerous. Amongst these there are many which, according to Montfaucon, are unknown, as well by the names which are attached to them, as by their shapes; they are unknown both to historians and naturalists. There is so much truth in this proposition, that we have been astonished to find it made by this great antiquarian, who, but slightly occupied with the natural sciences, could not be expected, as we supposed, to announce a proposition so profound and so true. However, as the remark has been made, it proves to us that animals, whose names are found in different writings, must have really existed. If, since that time, therefore, they have disappeared from off the surface of the earth, their races, like those of many other species, must have diminished and become extinct. Respecting the Greek names attached to the animals, there are some that hold their particular situation only because they have been displaced in the removal which the mosaic has undergone*. Thus the animals which are designated θωαντες, which may now be seen on the side of the upper part of the mosaic, formerly constituting a part of the same group with the animal Ηονοκενταυρα, which is now to be found on the opposite side. This derangement implies others; and we can easily understand how sometimes the names traced upon the half destroyed margins of a fragment, might be so altered as to correspond to other animals when the different parts of the mosaic were removed or reunited. It thus happens, that many of these names are more likely to mislead than to instruct us. It is with the greatest caution, therefore, that we shall attempt the interpretation of those Greek names that are placed in juxtaposition to some of the animals. That we may furnish the clearest apprehension, we shall describe them according to the order established in natural history.

* See upon this subject the work of Josephus Furetius a Secretis de Mussaic, published at Rome in 1752.

TERRESTRIAL MAMMALIA.

1. QUADRUMANA.

We find many of the quadrumana represented in the mosaic of Palestrina. We can recognise at least five species, which are all placed towards the upper part of it, that is to say the south side, which refers to Ethiopia. These different species of apes seem to belong, 1*st*, the Chimpansé; 2*d*, the Callithrix; 3*d*, the Magot; 4*th*, the Papio; and, 5*th*, the Mandrill varieties.

The first of these kinds is found seated upon a rock, at the side and to the left of the camelopard, above which we read these words, Καμελοπαρδαλι . . . . This kind is known by the form of the head, and the great size of the facial angle, and also by the paucity of black hairs which covers its body, especially in front. These are the characters which distinguish the Chimpansé (*Simia troglodytes*, Lin.) It is still found in Guinea and in Congo.

According to our view, the second variety is the Callithrix (*Simia sabœa*, Lin.), an inhabitant of the old world, and principally found at Senegal. Near to this animal we find placed the word Ηονοκενταυρα, a name which does not at all agree with it, and which probably has reference to quite a different kind of animal. In fact, the onocentaurs were monsters represented with the form of men from the waste upwards, and all beside apes. This at least is what we must conclude from the description Ælian has given in his work on animals *, where he expressly says, that the Onocentaurus retains man's nature in all the anterior parts of the body, whilst the posterior parts approach to that of the ape.

But Ælian also adds, that there are certain onocentaurs which indifferently employ their hands in running and as instruments of prehension. This part of the description of Ælian agrees perfectly with these apes, and especially with the callithrix, which, according to Prosper Alpinus, still lives in Egypt and Ethiopia †. However this may be, this second variety must apparently be referred to the callithrix of naturalists.

* De Natura Animalium, lib. xvii. cap. 9.

† Rerum Ægypt. lib. iv. cap. 11.

The third kind, placed on the extremity of a rock to the right, and quite close to the preceding variety, very much resembles the Magot (*Simia sylvanus*, Lin.), which is still to be found in Barbary. Its head is narrower than that of the preceding race, and the hair which covers its body is also more abundant.

The fourth variety, which is likewise placed at the end of a rock, and below the magot, at the same side of the mosaic, connects itself with the Papio (*Simia sphynx*, Lin.) This baboon is characterized by a prolonged snout, which is, as it were, snipt off at the point, where the nostrils are placed ; and which gives it some resemblance to the muzzle of a dog. The name which designates this variety in the mosaic, has now altogether disappeared ; but M. Saurés assures us, that he had seen it on the drawings of the Commandeur Dal Pozzo. These drawings represent, in the same fragment, the tiger, the land crocodile, and an animal named Σατυρον. It is extremely probable that this name was not accurately decyphered, and that it should have been read Σατυρος, a name which remarkably corresponds to such an ape as that now under our observation. It is known that naturalists have reserved the name *Simia satyrus* to the orang-outang, probably on account of its formation.

The last variety of ape which is represented in this mosaic is the Tartarin (*Simia hamadrius*, Lin.), which inhabits Arabia. This ape is at the left of the antique, and above the lion. Near to him is written the word Κηιπιν, which comes near to the Κηβος, or Κηπος, or finally Κοιπος, by which appellations the ancients designated a kind of ape with a head not unlike that of the lion. It is perhaps on account of this circumstance that this ape has been considered by Montfaucon as a peculiar species of lion. At the same time this respected antiquarian is astonished, and, according to his view, with reason, that the able artist to whom we owe this mosaic, has placed such a dreadful carnivorous animal upon the branch of a tree. But his astonishment would without doubt have ceased, if he had recognised that this animal was nothing more than an ape with a great mane, and a tail as long as a lion's, to which, therefore, it had some kind of resemblance.

II. Feræ.

A. *Plantigrada.*

The first animal we refer to the order Feræ, is evidently a *bear*, with a short body, thick limbs, and a short tail. This bear, placed in the upper part of the mosaic, above and to the left of the animal named Ταβους, is there designated by the name of Κροκοττας, or Κροκουτας. According to Diodorus Siculus (lib. iii. p. 168), and Pliny (lib. viii. cap. 21), those animals named *crocottar*, which, according to them, combined the nature of the wolf and that of the dog, were found in Ethiopia. It is certain that the bear was very common at Rome; for Caligula caused four hundred of them to be destroyed in the Circus, with nearly an equal number of panthers. It was for long a matter of astonishment how Ptolemy, in the celebrated entertainments which he gave in honour of his father Ptolemy Soter, caused a considerable number of white bears to be killed, because it was not known that this variety occurs any where else than in the frozen seas. But since Ruppel has found this species near Mount Libanus, we can understand how Ptolemy could easily have brought them from that region. It is at the same time true, that Dionis and Pliny himself, have given a different origin to the animal which we refer to the genus bear (*Ursus*, Lin.), without at the same time being able to determine the variety with any kind of accuracy *.

B. *Digitigrada.*

The first of the Digitigrada of which we shall speak, according to most writers, represents the otter (*Mustela lutra*, Lin.). The general form of this terrestrial quadruped, which besides holds a fish in its mouth, further demonstrates the correctness of the opinion. There are two of them, placed in the upper division, near two fresh-water tortoises. Near these otters we read the word Ενηυδρις, or Ενυδρις, a name which was common to the otter, and to a kind of serpent.

Herodotus has also spoken in many parts of his works of these aquatic mammalia. He says (lib. ii. cap. 72) that these

* Dion. Cass., lib. lxxvi. p. 360; and Pliny, lib. viii. cap. 30.

animals, named *Enhydris*, were looked upon as sacred by the Egyptians; and he adds (lib. iv. p. 9) that they were taken in the marshes, along with the beaver and other aquatic animals. After this authority and that of Montfaucon and the Abbé Barthelemy, there can be no doubt the artist who represented these animals wished to depict the otter.

The second of the Digitigrada to which we shall direct our attention is of much more difficult classification. This terrestrial quadruped obviously belongs to a Digitigrada, characterized by long ears, and a tail not less conspicuously long, characters which perfectly correspond to the dog kind, so that it is very possible it might be referred to an animal of this class. But we should not be surprised if the artist wished to represent the black wolf (*Canis lycaon*, Linn.) a variety which still inhabits Europe. Near this animal we read the words, Κροκοδιλος χερσαιος, which is to be translated "Land crocodile." Since this writing does not appear to have been displaced, it connects very well with the animal it indicates. According to Herodotus, land crocodiles exist in Africa; and are met with in the rivers. These animals were all more than three cubits long, nearly five feet, and their ears were very large. Besides the true water crocodile, which is figured upon the antique, and which has no kind of resemblance to the terrestrial animal which now occupies our attention, is constantly designated by Aristotle under the name of Κροκοδιλος ποταμιος.* From this we perceive that the ancients have delineated very different animals under the common name of Κροκοδιλος, adding thereto epithets proper to distinguish them from each other. It is thus that the panther or the leopard has received the denomination of Κροκοδιλος παρδαλις, a name which serves to distinguish it from the red wolf, and from the true crocodile (*Lacerta crocodilus*, Linn.).

The terrestrial quadruped which is placed at the uppermost part of the mosaic, and which is pursued by Ethiopian huntsmen, is the civet-cat (*Viverra civetta*). This animal, according to the ancients, a native of Egypt, still inhabits the hottest parts of Africa.

The mangouste of Egypt (Pharaoh's rat), so famous under

* Hist. Anim. lib. ii. cap. 10. Also, De Part. Anim. lib. iv. cap. 2.

the name of ichneumon, is represented in the mosaic of Palestrina. It is found placed under two camelopards. It is figured upside down, probably on account of the displacement of the fragment on which it was designed. This variety ought, as it appears to us, to be referred to the *Viverra ichneumon* of Linnæus.

We shall next mention the hyena, which, with a lion, may be seen at the superior extremity, and towards the left of the mosaic. Near these two animals is written the word Θωαντες, or Φωαντες, and not Ωαντε, as it is printed in the engraving of 1721. "One might believe," says the Abbé Barthelemy, that these animals represent a kind of wolf-lynx;" but this conjecture is contradicted by the form of the name and by the figure of the animals, which rather represent, the one to the left a hyena, and the one to the right a lion. Besides, we must not forget, as we have before remarked, that the animals beneath which we now read the word Θωαντες, at a previous period formed the same group with the animal called Ηονοκενταυρα, which is now found at the opposite side. From this it happens, that the word Θωαντες having been displaced, it can teach us nothing concerning the true names of the animals, which according to their form have the greatest resembance to the hyena and the lion, to which we have referred them.

Underneath, and to the right of the two camelopards, is to be seen a lioness and her cub, under which is written the word λεαινα. There can be no doubt as to the animal to which this appellation refers, and all commentators are agreed upon the point.

On the right of the mosaic, and near to the sheep, are to be seen two great carnivorous animals, near to which is written the word Τιγρις, a name which would express the tiger. The Abbé Barthelemy has found no difficulty about it, and has regarded these animals as truly tigers. We do not, however, see how we can adopt this opinion, for these mammalia do not present upon their skin regular black bands, but spots of the same shade, disposed in the most irregular manner. No more can these animals be regarded as the panther or the leopard, which have no bands, more than the tiger, but only spots.

There is another carnivorous animal,of the tribe *Felis*, which represents an animal, underneath which we read the word Δγελαρς, or Δγελαρτ, according to the Abbé Barthelemy; and Αγελαρου, according to Montfaucon. This word, so read by these two commentators, is not to be found in Sauré's description of the mosaic. Barthelemy remarks, that as the word is situated upon the edge of a fragment, it has probably suffered from the removal to which it has been subjected. This able antiquarian, being ignorant of its meaning, refers it to the animal near which it is written, which is an ape. But the form of its feet, not less than its other characters, oppose this idea. It is also to be observed, as Montfaucon remarked, that this animal must have been very formidable, since the mosaic represents that several Ethiopians are occupied in attacking it, armed with spears and bucklers, whilst others are placed in ambush, to shoot it with their arrows should it pass near them. These observations, joined to the characteristics of this species, induce us to consider it as having belonged to a formidable carnivorous animal, as, for example, the guipard, or hunting tiger of India (*Felis jubata*, Linn.), or perhaps to the black panther (*Felis melas*, Peron.), or some other great feline species.

Finally, the panther, which is placed above the Ethiopians who are wishing to strike the guipard with their arrows, and above which is written the words Κροκοδιλος παρδαλις, is also so well depicted, as to be readily recognised. We have seen that, with the help of various epithets conjoined to the word Κροκοδιλος, the ancients have designated animals very different from the true crocodile, which they invariably named Κροκοδιλος ποταμιος. As, besides, this animal differs from that beneath which we read the word Τιγρις, it is probable that this rather represents the leopard than the panther.

III. Pachyderma.

The animals of this family which are represented upon the mosaic of Palestrina, belong to a very considerable number of species, and these very important, such as the hippopotamus and the rhinoceros. There can be no doubt as to the first of these animals, which is represented with really more accuracy than upon the greater part of the other monuments of antiquity. These animals are here designed entire, with the exception of a single individual, of which we do not see much more than the head raised above the waters of the Nile. The characters of the hippopotamus are so well indicated upon the mosaic, that it cannot be confounded with any other animal.

As to the rhinoceros, it is not so well drawn; and as it has only one horn, it must be regarded as one of the Indian species. The word Ρινκερος, written underneath, still more indicates, if there had been room for doubt, the animal to which it must be referred.

Two other pachyderma, placed to the right of the rhinoceros, have the Greek word Εφαλος, or Εφαδος, written over them. This word is found at the margin of one of the pieces of the mosaic, and perhaps, in the act of moving, some of the letters had been lost. It is still, however, possible that this figure represented an animal which, according to Pliny and Solinus, was found in Ethiopia, where it was known under the name of "Eale" (lib. vii. cap. 21.—Solin, cap. 55.). This species, as to size, comes near to the hippopotamus; it was fawn-coloured; its tail resembled that of the elephant, and its jaw that of the wild boar. Its head was furnished with horns, which sometimes pointed downwards. The majority of these characters correspond with the pachyderma, and particularly with the wild boar, some of which have tusks so long as to resemble horns. The Latin word Eale, and the Greek word Εφαλος, differ only in the termination, and the addition of one letter, which was perhaps forgotten in the text of Pliny, or, more probably, added in the mosaic of Palestrina. However this may be, the animal to which the term Εφαλος refers is evidently an animal of the order Pachyderma, and of the genus wild-boar. All that remains, therefore, is to determine the species. A large tubercle, supported upon a bony protuberance, exists only in the Madagascar hog, the *Sus larvatus* of Cuvier; and this variety now exhibiting it, there is much probability that it is to this species that we ought to refer the animal under review.

The second species of the genus, near to which we read, accord to Montfaucon, the word Χοιροποταμον, or, according to Barthelemy, Χοιροπιθηκος, is of much more difficult determination. According to the first of these antiquaries, the expression by which the artist who constructed the mosaic would have designated this boar, was the river-boar; whilst, according to the other, it simply signifies the pig-monkey, "owing, perhaps," he observes, "to the figure partaking of the nature of both these animals." But this animal has nothing of the monkey in it; it is wholly of the boar kind, and consequently has no relation to the species of which Aristotle speaks, and of which the head resembles that of the chameleon (lib. ii. c. 2). Barthelemy, also, has himself remarked that he has not been able to perceive this last resemblance as corresponding to the figure. This last species is characterized by a pointed and very long snout, by a heavy and thick body; it is low in its limbs, with a short tail, but little coiled upon itself, and especially, it has tusks which do not protrude from its mouth. These characters do not appear to agree with those of any of our present races of the boar, and therefore it possibly may belong to some lost race of this genus, or of some other analogous to it.

The mosaic supplies us with another Pachyderma, near to which is written the word Ξιθιτ, a name which is unknown to Barthelemy as much as the animal it is intended to represent. According to Montfaucon, on the other hand, the animals named "Xithit," were very common in Egypt; and, according to him, it was the same as the rhinoceros, denominated by the Ethiopians Ara or Harisi; so at least says Comas the Egyptian. If this animal ever existed, there can be no doubt it is destroyed; for now we are not acquainted with any Pachyderma with teeth that are pointed, long, and sharp. This species would even constitute a new and distinct genus, if all is true respecting the several particulars represented. It should be added, that the existence of this animal seems so much the less doubtful, inasmuch as Kircher, in describing the mosaic of Palestrina, observes that the animal named Ξιθιτ is a boar which is famous in Egypt, because it is only found in the neighbourhood of the town of Χνθιν. From this we may readily judge how easily this species, so circumscribed in its abode, might become extinct.*

* Latium, id est, Nova et parallela Latii, tum veteris, tum Novi, descriptio. Amsteldami, 1681, p. 100.

IV. Solidungula.

Two species of Solidungula are figured upon the mosaic. The first represents the common horse (*Equus Caballus*, Linn.); whilst the second, under which is written the word Λυνξ, seems to be a race which is lost or destroyed. The orthography of the name proves that the antique is to be dated in the first ages of the empire. Previous to this epoch it would have been written Λυγξ. The animal to which this name is erroneously attached appears to be a species of horse, between the dzhiggtai and the quagga. It has nothing in common with the lynx of the ancients, which was the wolf-lynx, as it has been well remarked by Perrault.* In fact, the slightest examination suffices to show that the animal named lynx in the mosaic has solid feet, or but a single hoof; with the body, head and tail peculiar to the horse. In conformity with these characters, this specimen then, is neither the dzhiggtai nor the quagga, and still less the ass or the zebra. According to this, then, it would constitute a species which is now lost; if this race has really existed with the form and the proportions which are bestowed on it in the antique. On this point we may again remark, that this is the more probable, since the figures of the mosaic are generally so well delineated as to lead us to conclude that they have been copied from nature.

V. Ruminantia.

Four species of the Ruminantia are found on the pavement of the Temple of Fortune; and they all belong to the Ruminantia with horns. The first is the camelopard, distinguished on the mosaic by the word Καμελοπαρδαλι. According to Belon, Aldrovande, and Gesner, this animal received its name on account of its form and its skin; because that, with the head and horns of a stag, it had the neck of a camel, and a skin spotted like a leopard. Its tail was small, its feet very unequally forked, and its fore feet much longer than its hind ones. Its horns, which were at the upper part of its forehead, were not above

* Memoirs de l'Acad. des Sciences depuis 1666 jusqu'a 1699, tom. i. prem. part. p. 131.

six inches in length.* This description, in conformity with the mosaic, agrees too accurately with the camelopard to allow us to doubt that the artist had not designed to represent these animals, the most curious of Africa, and which had been brought on different occasions to Rome, in the triumphant processions, and for the games of the Circus.†

The second species, near to which we read the word Ταβους, is more difficult to determine. Let us first attend to what has been said by the two antiquarians who have given us an explanation of the pavement. Montfaucon observes that the last syllable of the word Ταβους signifies "bos," an ox. But as the name is Ethiopic, there is no propriety in dwelling upon the conjectures that this coincidence might suggest. Barthelemy, by adding to the first letter a limb which had disappeared, converts Ταβους into Ναβους. Under this denomination the Ethiopians designate an animal which, with the neck of the horse, the feet and legs like an ox, has a head like that of the camel. The reddish colour of the nabum, intermingled with its white spots, had led them to bestow upon it also the name camelopard. And thus, under this denomination, the ancient authors have confounded two distinct species, which the author of the mosaic has very well distinguished.

It results then, from these observations, that the animal named *Nabum* in Ethiopia, really existed in that country, and at an epoch which, if it was not cotemporaneous, was at least little distant from that of the artist of the pavement. But if this species be now lost, its destruction must have taken place within the times of the records of history. For where do we now find an antelope, or an ox, having a hunch on the anterior and superior part of its back, with short and straight horns like the camelopard, with a head like a camel, whilst the limbs re-

* Belon, Observat. cap. 49. p. 263.—Aldrovande, Hist. Quad. p. 927.—Gesner, Quad. tom. i. p. 147.—Dapper, Description de la Haute Ethiopie, p. 420.

† We may here remark, that the camelopard which is figured on the mosaic much more resembles that of the Cape than that of Sennar, which at the present time is living at Paris. This latter, as is well known, has a more finely streaked coat than the Cape one, and a form which more corresponds with the variety figured on the antique.

semble those of the ox? Such a species, which on the authority of the mosaic and the commentators is far from being monstrous, since it did live in Ethiopia, having been no where found in our days, we must thence conclude, that, like many other races, it has disappeared from the surface of the earth; or, at least, that the interior of Africa, so far as it is yet known, has none of them.

The two other Ruminantia which are found in the Mosaic are well known. The first is the sheep; and as to the second, which is led by a peasant along the banks of the Nile, it is evidently a representation of the common ox (*Bos taurus*, Lin.) Close to the sheep is seen the words Αρος, probably for Δορκος—the wild-goat. Notwithstanding, the animal near which the word is written is certainly a sheep. Barthelemy is with reason astonished that, in the engraving of 1721, they have substituted the word Απρος, a boar, which in no degree resembles the figure in the mosaic. This mistake is also fallen into by Montfaucon, though he could not trace in this animal any of the peculiar characters of the Aper or wild boar.

BIRDS.

Numerous birds are represented on the mosaic of Palestrina. They belong to three different families; 1*st*, The Gallinæ; 2*d*, The Echassiers (Cuvier) (Grallæ, Lin.); and, 3*d*, The Palmipedes. The last are the most numerous, both as it regards species and individuals; and this arising from the mosaic representing the course of the river Nile.

I. Gallinæ.

A. The domestic peacock (*Pavo cristatus*, Lin.). This bird has been represented on an immense number of antique monuments, often with its tail expanded, and in other positions.

B. The common pigeon (*Columba livia*, Lin).

II. Grallæ or Waders.

A. The white stork (*Ardea ciconia*, Lin.).

This bird has been represented upon the top of one of the cradles, which is constructed of twisted rushes, which are to be found on the mosaic, probably with the intention of pointing out its habits, which, according to their notions, kept it at no great distance from their dwelling-places.

B. The common heron (*Ardea cinerea*, Lin.).

C. The sacred ibis (*Ibis religiosa*, Cuvier).

This bird, as is well known, was much venerated in Egypt, where it was embalmed after its death. It is not astonishing therefore that a monument, on which we find the greater number of the productions of Egypt, should transmit a memorial of it.

D. The green ibis (*Scolopax falcinellus*, Lin.).

III. Palmipedes. Webfooted Birds.

Anseres. Many of the swan and duck tribes are represented on the mosaic, swimming for the most part in the Nile. It appears that a great number of species are collected; but, lest we should be incorrect, we shall not attempt to refer each to its particular kind.

REPTILES.

The reptiles which are observed on the pavement of the temple belong to three different orders, viz. to the Chelonia, the Sauria, and the Ophidia. Of these we find numerous individuals.

I. Chelonia.

The fresh-water tortoises are represented as placed upon a rock, near which two others are swimming. The form of their feet manifests it was the intention of the artist to represent fresh-water tortoises, rather than land or marine tortoises.

II. Sauria.

The first of the Sauria refer to the genus Crocodile. These crocodiles, represented of a great size, are those of the Nile, the *Lacerta crocodilus* of Linnæus. These animals have been so often represented upon the ancient medals, &c., that no doubt can exist as to the determining of them.

The other great species of Sauria represents some great species of the monitor of Africa—the great lizard. It may be remarked, that we read close to this animal the word Σαυος; the letter ϱ is probably left out, which would make it Σαυϱος, signifying a lizard.

III. Ophidia.

The largest of the Ophidia which is figured upon the mosaic has been considered by all commentators as the giant serpent, so named, they state, on account of its enormous size. In truth, according to Diodorus Siculus (lib. ii. p. 149; also lib. iii. p. 169; and also lib. i. p. 29), it existed to a very great size in Ethiopia, and also in the islands which are formed by the Nile. But the question occurs, To what precise species are we to refer this gigantic serpent? It is unquestionably of the python or boa kind, genera in which we find the largest known species. As respectable naturalists have affirmed that the serpents to which the name boa has been given all came from America, if this be true, the species represented on the mosaic must necessarily be one of the great pythones of Africa, similar to that which Augustus exhibited at Rome in the games of the Circus, and which, they assure us, was sixty feet long, or like to that which was besieged by Regulus' army.

Finally, the last of the Ophidia, which is found on the mosaic, was known to the ancients under the name of *Ophilini.* It appears that it may be referred to the variety Haje, or the *Vipera haje* of Geoffroy de St Hilaire. It is known that this species is still frequently met with in Egypt, and that jugglers have the art of taming it.

There are still some other animals represented upon this antique of Præneste; but as they are invertebral animals, and more particularly crabs, regarding the classification of which there can be no great certainty, we think we need not say more upon the subject. However, that we may still exhibit the care which the artist has taken accurately to copy the different objects he has introduced into the picture, we shall say a few words on the plants that are found on it.

We may, in the first place, remark, that these vegetables have been already recognised by M. de Jussieu, whose very name carries authority with it. At the side of the porch, where the Emperor Adrian is standing, we observe a cocoa-palm tree loaded with its fruit. Behind the porch there stands a juniper tree, between cedars; whilst near the portico, where the priests are, there is another individual of the same class. Regarding the tree which is placed near the great round tower, nearly in the centre of the mosaic, it evidently belongs to the Cassia family; and those which are seen in the same row, running to the right of the mosaic, are date-palm-trees. This tree, occurring in other parts of the picture, is so easily distinguished that we need say no more concerning it. We may, however, observe, that this species is often represented in antiques; also that it was very common in Upper Egypt, since Girgé observed it in Nubia, at Thebes, and especially near Elephantina.

The tree above the lioness very much resembles a tamarind; as is also true of the one which is near to the gigantic serpent. Upon the right of the mountain may be seen the large Euphorbium, whilst near the top of it there is an Acacia growing, the tree which stands in front of the animal called in the mosaic the Onocentaur. There is also to be seen a great thicket of reeds near the building intended to represent the Nile. Other plants also spring up at the side of the thicket, round which crocodiles and hippopotamuses are swimming. These plants appear to be the millet, which, according to Diodorus Siculus, the Ethiopians much cultivated in many of the islets of the Nile (lib. i. p. 24). Finally, under the thicket, and all round it, appear, on the surface of the water, many flowers of the lotus, some of which are blue, and others red. Athenæus has long ago distinguished these varieties (Deipnos, lib. xv. p. 677), and the French expedition to Egypt has made us acquainted with others which had escaped the attention of ancient authors.

Besides this, we shall add, that other rare animals are likewise figured in the mosaics that are copied in the work of Jean Cimpini, entitled *Vetera monumenta, in quibus præcipue musiva opera, sacrarum profanarumque ædium structura*, &c., and printed at Rome in 1790. The mosaic of Palestrina is there represented, but in a manner far from accurate. In plate xxx. may be seen a bustard (*Otis tarda*, Lin.), and also a fish of the trigla or mullet kind. In plate xxxiv. of the same work there is a mosaic, on which we observe the common and the large lobster, also a turtle-dove, a Guinea fowl, and the variegated helix shell of our gardens.

RECAPITULATION.

In reviewing the facts which have now been dwelt upon, it seems clear that many species of the terrestrial mammalia have disappeared from the surface of the earth within the period of historical record. It is also true that one of those species now lost is found in bogs and estuaries, in which are also discovered species which, up to the present moment, have been considered fossil; and hence, these fossil species must have been extinct at the same epoch as the former. It is thus true of the hyena, the rhinoceros, the elephant, and the hippopotamus, as it is of the Irish elk, which is often associated with them;—these should no longer be considered as fossil, but only as inhumated *, since these last named have ceased to exist posterior to man's creation, and the entrance of the seas into their present receptacles†.

In this memoir we have only enumerated among the lost races of which the ancient monuments have preserved traces, five species of the terrestrial mammalia; but we could easily have increased their number, had we not been most scrupulous in our determinations. Thus, for example, we see in plates lxiv. and lxiii, of the works of Micali, which we have already referred to, one of the carnivora engaged with a leopard in devouring a stag and a bull, which carnivorous animal appears to differ from all races actually living. Nevertheless as this animal has some resemblance to the streaked hyena, we have preferred saying nothing about it, though it may probably be a real being, since these plates exhibit more than half a dozen of specimens of it, all drawn with the same characters.

We might have done the same with a great number of other animals which we find represented upon very many other antiques, which so much the more merit our confidence, that the animals whose traits they represent are pourtrayed with fidelity,

* It seems right to express the differences which exist between such organized bodies as have become extinct cotemporaneous with, or posterior to, the creation of man, and consequently the collecting of the seas in their respective receptacles, and the fossils which have been destroyed apparently before these great events.

† We take this opportunity of correcting a grave error, which occurs, however, in the original Memoir, at page 163 of vol. xvi., where we should *read*, in line 2d, *inhumated*, in place of *human* varieties.

and sometimes with their real colours. Such, for example, are the peacock, the partridge, the parrots, the ostrich, and the horse, which are to be found in the mosaic discovered among the ruins of Italica, in Spain. The horse is represented as he is found in his wild state, that is to say, with a uniform bright bay coat.

What we have just said of the works of Micali, might also be said of many others, amongst which we shall only quote the *Museum Etruscum* of Gorius, the different works of Augustini and Montfaucon, of Caylus, of Hancarville, of Vaillant, and of Mariette. The treatises respecting the various monuments which have been discovered in Pæstum, Pompeia, and Herculaneum, also deserve to be mentioned in relation to the same point.

Lastly, we may remark, that, according to the opinion of M. Schweighæuser, Greek Professor at Strasburgh, there is a lost species, engraved in a work of Millin (Galerie Mythologique), which we have not in our possession, and which we have not been able to procure. According to this able antiquarian, this animal is not intended, as Millin has supposed, to represent the Trojan horse, but rather a species of goat or antelope, quite different from the known races. This supposition is confirmed by the inscription which is found in close contact with this animal: in fact, whether we read it Αεγσα, or Γεγσε, it ever brings us back to goat, or sort of antelope, for the Greek word Αἴξ signifies goat, and in the German dialects they still employ the word *Gegse* to distinguish a variety of this genus.

If this observation be correct, as its author's name would induce us to suppose, it would hence result, that the terrestrial mammalia which have disappeared from off the surface of the earth since the times of history, and of which antiques have preserved the recollection, would belong to the same families as those species which are buried in the quaternary deposits, linked to the same epoch, and which are extinct the same way as are the former. It is, in truth, only with the Pachyderma, the Solidungula, and the Ruminantia, that the lost races brought under our notice in historical monuments connect themselves, and it is known that these are also the families which abound most in all quaternary formations whatever.

To recapitulate, the lost species of the terrestrial mammalia, the traces of which are preserved on the antiques, are reduced, according to our observations, to the number of five, and if the opinion of M. Schweighauser be adopted, they will mount up to six.

These six species may be distributed so as to present, 1*st*, Two pachyderma, the native country of one of which, viz. that known by the name of Ξιθιτ, according to Kircher, is known ; 2*d*, A variety of the Solidungula, intermediate between the dzhigglai and the quagga ; and 3*d*, Two Ruminantia,the one of which is the great Irish elk, and the other the nabum of the Ethiopians, designated in the mosaic of Palestrina under the name of Ταβους ; 4*th*, The last would be the goat or antelope, figured in the Galerie Mythologique of Millin.

Nor are the terrestrial mammalia the only animals of which certain species have been lost since the times of historical record ; for we know that M. Geoffroy St Hilaire discovered in the catacombs of Egypt two races of crocodile, which have not been found elsewhere, and which at present appear lost. It may be said, without doubt, that it is of these races, as it is with the crocodile, the snout of which is furnished with a kind of horn, which Ælian had described, and which he said he saw in the Ganges. For a long time it was regarded fabulous, and the more so because the specimens which were found in the Ganges did not present that horn which Ælian had given them. Within these few years, however, Messieurs Diard and Duvaucelle have afresh discovered this horned crocodile of Ælian, and which the individuals that had been previously seen had accidentally wanted.

And if there are thus reptiles, of which species have been lost within the period of historical record, still more must there be birds and fishes which have become extinct since the same epoch. Regarding fishes, there are a great number of varieties described by naturalists, for example, by Opian, of which we know nothing. In particular, we are ignorant of his *anthias*, which was used to catch the fish called barble, and which consequently was of very small dimensions. This fish is not therefore, as has been long supposed, the red-dory fish of the Mediterranean. As to birds, there is an equally great number of them depicted on antique monuments ; and as the greater part appear to have been designed after nature, we can already state, that, among these species, there are many which have been lost. This, then, is a branch of the subject to which we may return at another time, if the investigation is not undertaken by some naturalist more favourably situated than we are. In truth, all that we have said on the subject of lost races ought only to be considered as a sketch of a work which will doubtless be finished by those who, having the use of grand museums, will thus have under their eyes the originals of those objects of which we have only seen more or less faithful copies.

The facts to which we have just been alluding certainly enable us to judge how many causes there are which unite in producing the loss and annihilation of a great number of the wild animals. We see that, besides natural causes; politics, religion, and even honour, engaging the grandees of Rome to vie with one another in the amusements of the Circus, also co-operated to the same effect. Though less active and less powerful than natural causes, these others have certainly exercised a very considerable influence upon the disappearance of certain animals; and the more so because that sacrifices, and the games of the Circus, and triumphant feasts, led to the slaughter of vast multitudes. To these causes are to be added those which, at a later period, have resulted from the benefits brought about by civilization, which by culture have cleared away forests, and moors, and fens, and which consequently have destroyed the tribes that dwelt there, where they, at the same time, found an asylum and shelter. Thus the destruction of numerous species of wild animals may very well have been produced by very simple causes, altogether in the natural course of events; and to explain these great changes, it is not at all necessary to have recourse to inundations or to violent and terrible revolutions.

Nor, finally, let it be forgotten, that the living races must have had a great tendency to decrease and disappear whenever their mortality was greater than their reproduction. This circumstance must certainly have occurred whenever the individuals of the same race, whether through the influence of man, or by any other cause, were so widely separated from each other, that they could not congregate together so as to breed. This cause, joined to those we have formerly enumerated, has very probably produced the loss of many different races, of which now-a-days we find traces only in the bowels of the earth, or in the writings of the ancients, or finally in those antiques which we owe to artists of a former day.

On the History of Fossil Vegetables. By M. Alph. De Candolle.

I. Historical Introduction.

The vegetables which are now flourishing on the surface of the globe, have been preceded by others, the mere traces of which are now found in the bowels of the earth, and especially in coal-mines. This fact, so important to the geologist, is not less so to the botanist, inasmuch as it belongs to the history of the vegetable kingdom; and the determination of these vegetable fossils, on the accuracy of which all the consequences deducible from these researches rests, is a subject clearly belonging to the province of the botanist.

Animal petrifactions have been noticed in all ages; but it was only during the last century that vegetable fossils have received serious attention; probably because none of the parts of plants being so solid as bones and shells, they have not been so well preserved in the interior of the earth.

M. Anthony Jussieu* was one of the first who recognised the difference between the vegetable fossils of coal-mines, and those plants which now flourish in the same localities. He also observed the unexpected resemblance they bear to the plants of the equatorial regions. From that period, different memoirs have been published on this interesting subject; and Scheuchzer, in a distinct work (Herbarium Diluvianum) gave tolerably accurate figures of several vegetable fossils. But it could not be expected that this branch of science should make any real progress so long as geology and botany themselves were but in their infancy. It was necessary that observation should previously have placed geology on a firm foundation; and as it regards botany, that it should not be fettered by artificial systems, which often rendered all comparison between allied species really difficult;—that the majority, at least, of species now existing should be known, and that those of warm climates should especially have been studied.

At the beginning of the present century such progress had been made, that labour might advantageously be bestowed upon

* Mem. de l'Acad. des Sciences, 1718.

the subject; and since that time, and more especially during the last ten years, a vast number of treatises have appeared.

In 1804, M. de Schlotheim * published some engravings, which were much more accurate than any which previously appeared; with more minute details and comparisons with the existing species, which were often very happy. The naming of the plants which he described was, however, a great desideratum.

In 1830, the publications of M. le Comte Sternberg† began to appear, and they constitute an epoch in this part of the science. From that period a great number of works and memoirs, which are principally to be found in the transactions of various societies, have every year supplied additional information. A great number of coal-mines have been examined with an especial relation to fossils, especially in France, Germany, England, Sweden,‡ and America,§ a circumstance which enables us to institute interesting comparisons between contemporaneous vegetations which were widely separated.

The documents supplied by many scientific men, had thus accumulated in different works, when M. Ad. Brongniart undertook the task of reviewing and comparing them in his *Prodrome d'une histoire des vegetaux fossiles.*|| In it he has collected, with the most scrupulous care, all the known facts; and, with much clearness of compilation and elegant simplicity of style, has drawn the attention of scientific men to the important consequences which result from the study of fossil vegetables. He considers them first in a botanical, and then in a geological point of view. In the former part, he points out how we are to compare fossil vegetables with the plants that are now existing, and how they had best be named and classified; he then takes a survey of all the families, the genera, and species which were known at the time, and mentions their geognostical

* *Beschreibung Merkwürdiger Krauterabdrucke and Pflanzenversteinerungen.* Gotha. 1804.

† *Versuch einer geognostisch-botanischen Darstellung der Flora der Vorwelt.* 4 fasc. in fol. Leipzig, 1820–26. A work which has been translated into French by M. le Comte de Bray.

‡ Nilson. *Mém. de l' Acad. des Sc.* de Stockholm, 1820 and 1824.

§ Memoir of Mr Steinhauer in the Transactions of the American Phil. Soc. vol. i.

|| 8vo. Paris, 1828.

position, which points out, at the same time, the epoch of their existence, and their habitat on the ancient surface of the globe. In the latter part, he examines the fossils found in every formation of stratified deposits, in a variety of places; he gives the proportions of the great classes of vegetables which are contained in each of these formations, and finishes by drawing curious conclusions concerning the condition of the earth's surface at the epochs, indicated by the relative position of the formations.

The Prodromus of Mr Brongniart has become the groundwork of all the more recent investigations concerning fossil vegetables. Since 1818 he has himself published additional descriptions.* In England, Messrs Lindley and Hutton, who combine all the requisite botanical and geological knowledge, have conjunctly undertaken a fossil flora of Great Britain, comprising figures of vegetables found in a fossil state in that country.† Though usually adopting the views of Mr Brongniart, they still sometimes differ from him, and this naturally gives rise to researches of an interesting nature. By means of these very recent works, there is no difficulty in arriving at a very exact apprehension of the present state of this branch of science.

II. On the best mode of ascertaining, naming, and classifying Fossil Vegetables.

1. *On ascertaining Fossil Vegetables.*—As the more minute and delicate portions of vegetable organization have not been preserved among the stratified formations of the earth, we are obliged, in the examination of fossil vegetables, to confine ourselves to the examination of those parts that were possessed of a firmer organization, as, for example, the trunks and stems, the leaves and certain fruits. The more delicate plants in the act of growing, flowers, and the majority of fruits and grains, are not found at all. The more herbaceous plants also, and those most analogous to the confervæ, mushrooms and lichens, &c., if they existed at all, have likewise disappeared, or are found in a more or less altered condition.

The ligneous trunks are converted into stone, the result of the gradual substitution of earthy particles for those which

* Hist. des Veget. Fossiles, in 4to. now appearing in numbers.

† Fossil Flora. 8vo. London. Has appeared in quarterly numbers since 1831.

formed the wood and the bark. The shape is in no respect altered. Leaves, however, are recognised more as mere impressions, and may be separated, of a black or grey colour, from the rest of the stone.

That we may profitably compare these remains with species which are now flourishing on the earth's surface, we must select from these latter specimens of the same parts, and consequently of the trunks and leaves. The arrangement of the ligneous layers of dicotyledonous plants, and that of the fibres of monocotyledonous also, may be easily recognised in fossils, if we make the comparison with specimens taken from trunks of these two classes. And this shews the utility of those collections of wood, where the bark and the wood are in their natural connection, and where a fixed nomenclature may assist in the comparison. The texture of the wood also, made more evident by the microscope, and more distinct still by having the surface polished, is also a great help in recognising the analogy between a fossil remain, and any of the classes of existing vegetables.

By a little management of this sort, it but rarely happens that we cannot discover some analogy, which enables us to associate the fossil with some presently existing family. Sometimes a great number of specimens ally themselves with forms which are now exceedingly rare.*

2. *On the Nomenclature of Fossil Plants.*—The nomenclature of fossil vegetables is as much as possible founded upon their alliance with living ones. Originally they sometimes received names, whose termination in *lithis* indicated that they were fossil; and it is perhaps to be regretted, that this custom has not been continued, and so all risk of compounding fossil and living plants been avoided. At present, all that is done is to name the genera and species in the same manner that living plants are named, and they are referred, either with certainty, or with more or less hesitation, to the great classes and families now living. Thus *Lepidodendron insigne* is a species of a fossil genus of the family *Lycopodiaceæ*, and *Equisetum columnare*, is a fossil species of the living genus *Equisetum*. In this last

* M. De Candolle appears to be unacquainted with the interesting observations which have been made on fossil plants at Edinburgh.—*Edit.*

instance, it would be desirable to add to the specific name the epithet *fossil*, or some equivalent sign.

When the resemblance to an existing genus is made out, and yet, on account of the absence of the organs of fructification, it is not ascertained if the fossil specimen belongs really to the same genus or to a neighbouring one, the termination *ites* is added to the name of the living genus. Thus *Zamites*, is a fossil genus allied to *Zamia*, Lycopodites to Lycopodium, &c.

3. *The Classification of Fossil Vegetables.*—Vegetable fossils are classed, either according to the epoch of their existence, or their botanic characters.

The former of these methods is, without doubt, the most important. The vegetables, which are found in the same strata, must needs have lived under the same conditions, and must exhibit a certain resemblance, similar to that found in the existing races. It is expedient, therefore, to compare these among themselves, previous to examining them with vegetables of a different epoch. As it regards fossils, therefore, botanical classifications ought to be subordinated to geological arrangements.

As to the distinction of strata, the superposition of which, at successive eras, has gradually formed the crust of the globe, it is known that geologists are not as yet agreed as to the best method of classifying them. Characters are often deduced from the nature of the fossils; but in the study of the distribution of the fossil bodies themselves, it is necessary, on the contrary, to avail ourselves of the mineralogical distinctions alone.

M. Brongniart* has proposed the classification of strata into *formations and terrains.*

A formation is composed of many strata, which present common characters, appearing to indicate a common origin and an analogous mode of formation. This is seen in the coal measures, and in the beds of chalk, &c. All the formations which have followed the primitive series, in which no traces of organized beings have been found, may be arranged in four classes, viz. 1st, the *transition* formations; 2dly, those of the *inferior* deposit; 3dly, of the *middle;* and 4thly, those of the superior deposits.

* Ann. des Sc. Natur. Nov. 1828, p. 5; and Prod. des Veg. Foss. 1828.

Each formation corresponds to an epoch, or a certain lapse of years; and each general series, or *terrain*, to a more extended period.

III. An Abridged History of the Vegetable Kingdom, at different Epochs, and Geological Periods.

§ 1.—*First Period of Organized Beings—Transition Formation.*

First Epoch—Limestone below the Coal Formation.—This formation so rich in madrepores and animals of the inferior classes, is very poor in fossil vegetables. M. Brongniart, in 1828, only knew of fourteen species which could be described.

These belonged exclusively to the Cryptogamia, and to a species, the botanical class of which is doubtful. Four Algæ, marine plants, were remarked, of a genus denominated Fucoïdes; and of terrestrial plants, two Equisetaceæ, of a calamite genus, three Filices, and many Lycopodiaceæ, most of which were in bad condition.

All these species are different from those which now exist. Some of them are also found in the following formation:—

Second Epoch—The Coal Formation.—Coal, the relations of which are so well known, on account of its utility, is entirely composed of the debris of mineralised vegetables. In the thickest beds the trunks of trees are sometimes still found in a vertical position.

There is a great number of known species in this formation, so that, in 1828, M. Brongniart enumerated no less than 258; but the small number of the families to which these species belong, is very remarkable; as is also the extremely different proportion in the great classes, with those which now exist in the same regions.

The class of Ætheogameæ (viz. Filices, Marsileaceæ, Equisetaceæ, Lycopodiaceæ) abounds in a most extraordinary proportion. It alone forms two-thirds or five-sixths of the vegetation, whilst in the present day it does not exceed a thirtieth. The most part were arborescent, similar to the tree-ferns of our tropical climates. Many arborescent equisetaceæ would give to the prospect a character very different from that of which we have now any conception. The other cryptogamia are wholly wanting at this epoch; so also are marine plants, or at all events they are very rare, as none have hitherto been discovered. Of monocotyledons, scarcely one-fourteenth part exist, in which three palms and some gramineæ are found. It is known, that this class now forms a sixth part of vegetables. Regarding the dicotyledonous plants, the number of which is so remarkable in our epoch, it is to be doubted, whether the formation of which we are now speaking possesses more than a third part. M. Brongniart points out 21, though somewhat doubtfully; but Mr Lindley* endeavours to demonstrate that the genera *Sigillaria* and *Stigmaria*, linked to the Ætheogameæ by M. Brongniart, are dicotyledons, and analogous to the Apocineæ, Euphorbiaceæ, or Cacteæ. There are 49 species of these two genera, among the 258 enumerated in the Prodromus of Fossil Vegetables, so that even including the 21 doubtful ones already alluded to, this would only make 70 dicotyledonous species.

After transposing these two genera, and then adopting the four great classes proposed by M. De Candolle†, the flora of coal-mines would exhibit the following results, noting the species which were known in 1828:—

				Proportion in the 100 Species.
CRYPTOGAMEÆ.				
Amphigameæ.			0	0
Æthéogameæ,	Equisetaceæ,	14	170	66
	Filices,	89		
	Marsileaceæ,	7		
	Lycopodiaceæ,	60		
PHANEROGAMEÆ.				
Monocotyledons,	Palms,	3	18	7
	Canes	1		
	Indeterminate,	14		
Dicotyledons,	Sigillaria,	41	49	19
	Stigmaria,	8		
Species whose class is doubtful,			21	8
		Total,	258	100

* Fossil Flora. Sciences et Arts, Juillet, 1834.

† Bibl. Univer. 1833. T. iii. (liv.) p. 259.

Subsequent researches will unquestionably modify these proportions; but it is not probable that they will alter the principal characteristics of this epoch, viz. *the predominance of the woody atheogameæ*, and *the gigantic height of these species*, when compared with those which exist at the present time.

The most remarkable discovery which has been made in the fossils of coal mines, since the publication of M. Brongniart's work, has been that of some coniferæ,* a family which attracts much attention in subsequent epochs, and which, in a botanical point of view, is amongst the dicotyledons, one of those which approaches the nearest to the ætheogameæ.

Third Epoch—Magnesian Limestone.—This formation contains few fossils belonging to the vegetable kingdom. The schists of Mansfeld, and the coal measures of Höganes at Schonen in Sweden, which geologists regard as very similar to schists, have furnished M. Brongniart with only eight species. They are all marine; seven belong to the Fucoides, and one to the Naiades.

§ 2. *Second Period—Inferior Deposit Series.*

Fourth Epoch—Variegated Sandstone.—M. Brongniart enumerates nineteen species in this formation, which have been principally found at Soultz-les-bains. Their discovery is principally due to M. Voltz, Engineer of Mines at Strasbourg. They may be classed as follows:—

			In 100 Species.
CRYPTOGAMEÆ.			
Amphigameæ,		0	0
Ætheogameæ, Equisetaceæ,	3	9	48
Filices,	6		
PHANEROGAMEÆ.			
Monocotyledons,		5	26
Dicotyledons (Coniferæ)		5	26
Total,		19	100

So far as a judgment may be formed from the relative pro-

* Fossil Flora.

portions of these few figures, it would appear, that the number of Phanerogameæ exceeds that of the Cryptogameæ, which is the opposite of what occurred in the earlier formations.

The genera are exceedingly different from those in the coal measures. It appears not one is common to the two formations, and certainly no one species is so. All the plants are terrestrial.

Fifth Epoch—Shell Limestone.—" This formation," says M. Brongniart, " which appears to be nearly wholly marine, has hitherto supplied very few fragments of vegetables, and these can be considered only as traces of the vegetation which previously covered some portions of the land, and the greater part of which was not buried until the formation of the arenaceous and clay beds which overly the limestone." The best characterized of these debris is a fern, and one of the Cycadeæ, discovered near Lunéville by M. Gaillordat. There are also some fuci.

3. *Third Period—Middle Deposit Series.*

Sixth Epoch—Keuper, Marles and Lias.—The predominance of Cycadeæ is the characteristic trait of this epoch, for of twenty-two species which have been recognised, they form the half. No others of the dicotyledons have been found in it, and only one monocotyledon and ten of the ætheogameæ. No aquatic plant has been found.

Seventh Epoch—Jura formation.—M. Brongniart comprehends under this name the oolitic rocks of English geologists, and some of the strata that separate them from chalk, as for example, the ferruginous sands and sandstones of the forest of Tilgate. The greensand, however, is excluded.

The Jura district furnished only one species of the enumeration of 1828; the greater number was supplied from Whitby, Portland, and Stonesfield in England.

Of fifty-one species enumerated by M. Brongniart in 1828, and obtained from a great number of geologists, three species were marine.

The number of Cycadeæ is very remarkable. There are seventeen of them, eleven of which belong to the genus Zamia;

so that this family, which now forms scarcely a thousandth part of the existing vegetation, and which flourishes only near the equator, at that period formed one-half of the European vegetation. We also observe in the Flora of this epoch six Coniferæ, two Liliaceæ, and, as in all the preceding epochs, a great number of ferns.

Hence the proportion of the great classes is as under.

		In 100 species.
CRYPTOGAMEÆ.		
Amphigameæ, (Algæ) . . .	3	6
Ætheogameæ, (twenty-one of which are Ferns,)	23	45
PHANEROGAMEÆ.		
Monocotyledons, (Liliaceæ) . . .	2	4
Dicotyledons, (Cycadeæ and Coniferæ,) .	23	45
	51	100

The species of ferns found in this formation are very different from those found in the other formations.

Eighth Epoch—Chalk formation.—M. Brongniart combines under this head the fossils of the chalk properly so called, and greensand formation of the English geologists.

The vegetables which were known in this formation in 1828, were marine plants to the number of seventeen, and one terrestrial, (Cycadeæ) from the lower chalk of Scania. The greater part were found in the Isle of Aix near Rochelle, and in the mountain of Voirons near Geneva, &c.

We may presume, that the solitary terrestrial species which has hitherto been discovered, grew as it were on the margin of the two formations, or upon the margin of a vast ocean which at that time covered a large portion of Europe.

The seventeen marine species are made up of two confervæ, eleven Algæ, four Naiadeæ, (genus Zosterites). Hence,—

		In 100 species.
CRYPTOGAMEÆ.		
Amphigameæ, ...	13	72
Ætheogameæ, ...	0	0
PHANEROGAMEÆ.		
Monocotyledons, ...	4	22
Dicotyledons, ...	1	6
	18	100

§ 4. *Fourth Period. Superior Deposit Series.*

Ninth Epoch—Plastic Clay.—This formation includes plastic clay, mollase sandstone, and the brown coal or lignite deposits which often accompany them.

The vegetable remains in this formation are scarcely ever to be distinguished, either on account of their fragile nature, or because they have been bruised and triturated in some great convulsion on the surface of the earth. The brown coals especially sometimes present such an accumulation of vegetables in their natural vertical position, and sometimes a heap of fragments of wood and leaves, and different kinds of fruits, such as now-a-days we observe that rivers and currents of water occasionally bring together in certain localities.

The nature of these vegetables is wholly different from that of those which appeared in the beds of chalk. Those in this formation are dicotyledonous, as is attested as respects a considerable number of them, by the fruits, which are found detached from the stalks; there are also many palms and some ferns. No marine plant has been found in it.

A maple, a walnut tree, a willow, and an elm have been found, as also cocoas, pines, and other species which can be associated with the existing genera. There are many coniferæ, but no cycadeæ. This vegetation much resembles that with which we are surrounded at the present day.

The proportions cannot be given, but we may safely conclude there is a great preponderance of the dicotyledonous plants.

Tenth Epoch—Coarse Marimc Limestone Formation.—This formation, of marine origin, has been discovered near Paris and at Monte Bolca. It contains a great many algæ, and some terrestrial plants of various classes, which appear to have been carried into the ocean from the neighbouring land. They scarcely differ from the terrestrial species of the preceding formation. Many dicotyledons of a genus of Phyllites have been discovered.

Eleventh Epoch—Palaotherian Formation.—The presence of enormous mammalia, named *Palæotherium*, has given a name to this formation, in which some fossil vegetables are found, as at Aix in Provence, at Paris, and elsewhere.

They are analogous to those of the brown coals or lignites as to genera, but they differ as to species. They are all terrestrial.

Of seventeen species enumerated by Brongniart, there is one moss, an equisetum, a fern, two chara, a liliaceæ, a palm, two coniferæ, and many amentaceæ.

Twelfth Epoch—Upper Marine Formation.—But very few vegetable fossils have been found in this formation, which forms certain sub-apennine hills. They are also in a very injured condition. There is one nut, which is very common on the hill in the neighbourhood of Turin (Juglans nux taurinensis.) It is always detached from the plant, and without doubt, floated into the neighbouring waters.

Thirteenth Epoch—Upper Lacustrine Formation.—The millstone of Montmorency contains five or six different plants, which all appear to be aquatic, and analogous to those which still grow in shallow ponds. The frequency of chara, and the presence of a nymphæa, give evidence of the formation of a deposit, in which the waters were shallow.

Fourteenth Epoch—Formation contemporaneous with the present living Vegetables.—Beds of peat are still forming under our eyes, and contain solely the debris of vegetable species which still exist in the same regions. In Scotland, where this formation is still forming very rapidly, seeds of chara occur preserved in the peat, exactly as in some of the anterior formations. The lignites are only peats of an earlier epoch.

The point of transition between the peats and the antediluvian deposits, is of the greatest importance in natural history, since it is there we find the change from actual living species to forms of an earlier date.

IV. Respecting the Alliances among the Vegetables of the different Regions at each Epoch.

The question naturally suggests itself—Whether at each geological epoch the same species, genera and families of vegetables existed simultaneously and uniformly in all countries; or whether, as at present, there were peculiar formations of plants peculiar to certain regions, and natural groups confined to districts of a limited extent, whilst others, on the contrary, were spread over spaces of a vast extent?

In answering these questions, it is first of all necessary that geologists should have thoroughly ascertained that similar or analogous beds, which are situated in distant regions, were formed at the same epochs on the surface of our globe. The circumstance that certain strata of a similar nature are similarly placed, in relation to each other, in America, for example, as well as in Europe, unquestionably makes it probable that they were formed at the same time, and in a corresponding manner. When, moreover, they contain the same kinds of fossils, geologists deduce from this circumstance a new proof of identity. Not so, however, with the naturalist; when, on the contrary, inquiring whether, if the species are similar in cotemporaneous or successive beds;—were he to use this as proof, he would be moving in a circle.

Another difficulty arises from this circumstance, that vegetable fossils have hitherto been examined but in a very few countries, and even there in a very incomplete manner. Thus, absolutely nothing can be concluded as to the geographical distribution of vegetables belonging to the transition series, since only fourteen species of this epoch are known, and thirteen of these were collected in Europe, and the remaining one in North America. In this point of view, it is manifest, we can only compare epochs, a considerable number of whose species are known, and which, moreover, have been collected in regions which are very distant from one another.

It is this consideration which confers a peculiar interest on the 258 species of the coal formation, which have been enumerated by M. Brongniart: they have been obtained not in Europe only, but also in North America, in New Holland, and in India.

In examining M. Brongniart's table, and also the fossil flora of England, we immediately perceive that all the coal-mines in Europe, and especially those of St Etienne in France, and those of the north of England, those of Belgium and Bohemia, very frequently present the same species of fossils. Nor is this very surprising, inasmuch as the present flora of all these countries very much resemble one another. One fact which is well worthy of remark is this, that of the twenty-three species supplied by the coal-mines of North America, fourteen have been discovered in Europe. This proportion, which unquestionably is greater than that which now exists between the living specimens of the two regions, proves a very remarkable similitude. Possibly these two continents of our globe were not separated from one another at that early epoch, or possibly there were then islands between them. Of the three specimens from New Holland, one has been found also in the coal-mine of Rajmahl in India. Of this last locality, M. Brongniart, in 1828, knew only two species, one of which, a fern, is the same as one of the specimens from New Holland, and the other belongs to a distinct genus of palm.

These facts seem to prove, that at this epoch there was a greater uniformity of the vegetation on the surface of the earth, than exists in the times in which we are now living.

Not only did many species flourish indiscriminately, in countries widely separated from each other; but it is also to be observed, that the proportions of the great classes were wonderfully uniform. Then the ætheogamea, (ferns, lycopodiaceæ, &c.) predominated equally in Europe, America, and Australia. In all these localities they constitute about two-thirds of the species.

As now, the phanerogameæ had, upon the whole, a more confined range than the cryptogameæ, for of nine of the former class in America, four only, *i. e.* forty-four per cent., were common with the European species; whilst of fourteen of the latter there were eleven, *i. e.* seventy-eight per cent. which were common.

The succeeding formations, down to the Jura one, present too small a number of species from different localities, to enable us to institute any corresponding comparison among them. In the Jura series, as examined in Germany and in France, it is surprising how few of the same species have been discovered in different localities. Out of fifty-one species which are enumerated by M. Brongniart, I see only two which are marked as occurring in the two countries. The same remark might be made of the subsequent formations; from whence it may follow, that since the epoch of the coal-measures, the diversity in contemporaneous regions has become more evident.

V. On the Connection between the Vegetables of the several Epochs and the successive Periods.

An important fact pervades the history of fossil vegetables; it is this, *That the same species has been rarely to a certainty found in two different formations, and never in two formations which are separated by two or more formations.*

It would appear that the revolutions of the globe, which at different epochs have suddenly produced a change in the nature of the soil, have destroyed all, or nearly all, the kinds of vegetables which were then flourishing: and that after every commotion of this sort, new varieties have appeared above the older strata. Throughout the whole thickness of the same bed, little variety of the same kinds are found; and nothing indicates that there have been gradual modifications of forms, by which the species would have passed insensibly from the one formation or epoch to another.

Between the vegetable species of two successive formations, it often indeed does happen that there are sufficiently striking alliances. They usually belong to very nearly the same genera, or to the same families; and the proportion of the species of each great class differs but little. Sometimes the same species has been found in two superimposed and analogous formations. But this is a coincidence of very rare occurrence. The prodromus of M. Brongniart contains three species common to the formations of the transition and coal series, four common to the lias and the Jura formations, and one to the Jura, and the chalk formation.

Occasionally we find a formation covered by a stratum of a totally different nature, which usually contains a very few organized beings which have lived in salt water; then above this stratum other and very different formations commence, in which the proportions of the great classes of vegetables is no longer the same, and where the species never resemble those which have preceded. M. Brongniart has availed himself of these remarkable facts to group the whole of the formations into four great periods. Within the limits of each of these periods, the vegetation only presents gradual and limited changes. Some of its species have supplied the place of other analogous ones, in a manner more or less rapid, more or less complete. On the contrary, the transition from one period to another period is always exceedingly apparent, in every point of view: even the genera are rarely the same; the numerical proportion of the classes is very different, and the species are never the same.

These four periods correspond to four great series of formations, an arrangement which many geologists admit as the result of entirely different considerations.

The *first period*, extending from the first transition, rises to the termination of the coal formation, is characterized by an enormous proportion of cryptogameæ, especially by these arborescent varieties of ferns, equisetaceæ, and lycopodiaceæ, of which we now scarcely can find any examples, and solely in the hottest climates. The ocean has covered this remarkable vegetation, since in the magnesian limestone, very few species are found, and these are marine.

The *second period* presents a peculiar vegetation, which, as yet, is little known. To the variegated sandstone, which contains a few more phanerogameæ than cryptogameæ, and all of which are very different from those of the first period, has succeeded a long salt water inundation, as indicated by the shell limestone.

With the *third period* commences the reign of the cycadeæ—of that anomalous family, which botanists have alternately tossed from class to class, and which appears to form now a class of dicotyledons very near to the cryptogameæ. This family alone constitutes the half of the vegetables of this period · the true cryptogameæ at first form only a third, then they mount up to about a half of all the species; and then again the sea appears to have destroyed this extraordinary vegetation. The thickness of the chalk bed shows that this submersion had continued for many ages.

Finally, the *fourth period*, of which our epoch forms a part, is characterized by the predominance of the phanerogameæ over the cryptogameæ. It would appear that one salt and three fresh water inundations have four times prevailed over the surface during that period, and destroyed at four different times the vegetable species, previous to the appearance of those which exist at present. The proportion of dicotyledonous plants has always continued considerable. It is the characteristic trait of the existing development of the vegetable kingdom, ever since the chalk formation.

The following Table presents a summary of the vegetation of the four periods. It is formed from the tables of the prodromus of M. Brongniart, at the same time placing the genera Stigmaria and Sigillaria amongst the dicotyledons, according to the opinion of Lindley; and by again reducing the six classes recognised by Brongniart to the four which we admit.*

	1st period.	2d period.	3d period.	4th period.
CRYPTOGAMEÆ.				
Amphigameæ, . . .	4	7	3	13
Ætheogameæ, . . .	176	8	31	9
PHANEROGAMEÆ.				
Monocotyledons, . .	18	5	3	25
Dicotyledons, . . .	52	5	35	117
Total, .	250	25	72	164
So, there is of Cryptogameæ,	180	15	34	22
And of Phanerogameæ, .	70	10	38	142
Again giving totals of .	250	25	72	164

With these results before us, we can recognise with M. Brongniart, that the more perfect vegetables, that is to say, those with the greater number of organs, and those the most distinct, have succeeded to the less perfect ones; in other words, that the vegetable kingdom appears to have been gradually becoming more perfect.

I am aware that the authors of the Fossil Flora of England have rejected this theory,† but, as I conceive, on insufficient grounds. The circumstance that they have not found the lower

* The cycadeæ and the coniferæ are considered as a group (Gymnospermeæ) of dicotyledons, closely allied to the monocotyledons and the ætheogameæ. We join the mosses also to the ætheogameæ. But these alterations can but in a trifling degree affect M. Brongniart's opinions on the development of the vegetable kingdom.

† Introduction to Vol. I. Lond. 1831. Sciences et Arts, Juillet 1831.

varieties of the cryptogameæ, such as mosses, mushrooms, &c., in the coal formation, is not to be regarded as an objection ; for, considering the extreme smallness of the plants, they, more than others, must have escaped observation, and besides, they must also, more than others, have been destroyed in the revolutions of the globe. The entire absence, or the small proportion of the herbaceous monocotyledons, in comparison of palms, banana-trees, &c., in the more ancient formations, is in part explained by the same causes, and also by the nature of the localities: coal-mines, those at least which are worth working, are petrified forests, and in our present forests, there are but few grasses, rushes, and analogous plants. If they existed at these periods, it is only in very thin seams of the coal series that they are likely to be found. And even admitting with Mr Lindley, that the stigmaria and the sigillaria are dicotyledons, still a predominance of ætheogameæ in the first period continues,—it is only not quite to the extent which M. Brongniart supposed.

If we were disposed to argue upon details, it might be maintained, that the first dicotyledons which appear, chiefly belong to a class which has a very doubtful form, (cycadeæ, ferns, and certain anomalous genera), which assuredly are not perfect dicotyledons. But in questions so extended as this, and when we are in possession of so few facts, and when it is moreover recognised that the higher classes of families cannot regularly be formed into a scale or linear series, as at one time was attempted, it is better to confine ourselves to a general comparison of the proportions of the great divisions of the vegetable kingdom, during certain periods which are widely separated from each other.

None deny that the phanerogameæ are more completely organised, and more perfect in the eyes of the naturalist, than the cryptogameæ. Some transitions of forms, indeed, some groups of the phanerogameæ, may only be equal, or even may be inferior to certain groups of the cryptogameæ, but this will not alter the general truth. Besides, if we compare these two great divisions of the vegetable kingdom, it must be recognised, that during the four geological periods admitted by M. Brongniart, the proportion of the phanerogameæ has always been increasing.

This law of gradual development would hence appear to exist in the vegetable, as it has been supposed to exist in the animal kingdom. The only difference, as it appears to me, is, that the great divisions of the vegetable kingdom have always had representatives, whilst the vertebratæ, for example, appear to be wholly wanting in the more ancient periods. But this difference may not excite much astonishment, when we think on the immense distance which separates the inferior from the superior animals, and the comparative homogeneous character of the great classes of vegetables.

Some philosophers have thrown out the idea, that organised fossil beings, served as a kind of compliment to beings now existing, in filling up the gaps which may be remarked between certain classes, and in giving a complete symmetry to a table of affinities which is now irregular. But this bold hypothesis does not require our examination; for if the present period is a perfectioning of former organized beings, one might with quite as much reason, and drawing support from a probability grounded on the past, regard these present organized beings as a stepping-stone for yet future improvement. So that if that which is here assumed to have often happened, were again to be repeated, all the existing species would one day be placed lower, as to other species, and some would be in a higher state of organization, so that the entire whole would be superior to the whole of that which had previously existed. This is the hypothesis which this analogy would indicate, and in matters of this nature, suppositions founded on what has already happened, should unquestionably be the least hazardous which can be made.

VI. On some Consequences which result from the Study of Fossil Vegetables.

The study of fossils generally leads to important consequences, as it regards the history of our globe. It belongs to the geologist more especially to examine them; whilst, at the same time, the deductions drawn from fossil vegetables, are connected with considerations which are purely botanical, and hence some of them may be pointed out here.

The physical conditions in which a locality must have existed, are often better indicated by fossil vegetables than by fossil animals. We cannot have much doubt respecting the history of a fresh-water or a salt-water plant, requiring a dry or a moist situation, a very warm or a merely temperate climate. We easily judge of these circumstances by the conditions which are necessary to plants of analogous forms, which exist at the present time.

M. Brongniart has supplied us with many of these indications with remarkable sagacity.

The arborescent ætheogameæ of the first period, must have lived in an atmosphere which was hotter and more humid than that of islands now situated immediately under the equator. We know that the ferns and lycopodeæ of temperate and northern climates are always little plants, with a creeping stem, which frequently hides itself in the earth. Towards the equator, tree-ferns and lycopodiaceæ are found. Their number is the greater as the region is hotter and more moist. M. Brongniart has concluded, and apparently with reason, that the forests which formed the coals must have probably existed upon islands, and at a time when the temperature of the globe was higher than at present. The islands of Ascension and St Helena, where the ferns and analogous plants form about a third, or even the half, of the number of phanerogamous plants, approach somewhat to this antique vegetation, only the sizes of the species are far more diminutive.

The islands or archipelagoes which have formed the basins for the coal, were surrounded by an ocean, of which the transition series is the index.

Some geologists have thought that the fossil trees of coal mines have been transplanted thither from the neighbouring lands; and they have endeavoured to support this opinion, inasmuch as there are examples of the vertical position of trunks of trees which have been thus transported: but this hypothesis is quite rejected by other naturalists. M. Brongniart supports, quite to demonstration, the opinion of De Luc, that the trees of coal-mines have been covered over in situ; and Messrs Hutton and Lindley, who have recently discussed the question *, are of the same opinion.

In explaining the carbonized nature of coal, M. Brongniart

* Introduction to second volume of Fossil Flora.

thinks it necessary to suppose, that the atmosphere then contained a much larger proportion of carbonic acid gas than it does now. As it might happen, there was then much less mould, plants must needs have lived by absorbing, through the leaves, and appropriating to themselves, much carbon taken from the air. M. Th. de Saussure has demonstrated, that a proportion of two, three, four, and even eight, per cent. of carbonic acid gas in the air, was favourable to vegetation. In this method the gigantic height of the plants of the first period might be explained. The simultaneous existence of many reptiles, and the absence of the mammalia, also accords with this hypothesis. After an epoch so distant as this, the flourishing of so many vegetables, and perhaps other causes, may have greatly reduced the quantity of carbonic acid gas contained in the atmosphere, at the same time augmenting the thickness of the soils that are favourable for the vegetation of the plants of the present time.

The authors of the first volume of the Fossil Flora of England, draw our attention to the singular fact, that the coal-mines of Canada and Baffin's-Bay contain plants analogous to those of other coal-mines, and consequently to those which now flourish under the equator. Mastodons, and other animals analogous to those of intertropical climates, have also lived at Melville Island, close to the pole. The difference of temperature, from that of the present day, may be attempted to be explained in different methods, and, among others, by the gradual and continued refrigeration of the internal heat of the globe ; but the authors of the Fossil Flora, with justice, remark, that the plants of equatorial countries require light, and that equably distributed, as much as heat. There are very few vegetables which can withstand the privation of light for a few months. This is one of the causes which prevents the progress of plants of temperate regions towards the north, and which prevents them from thriving in the hottest greenhouses in high latitudes.

It must have been the same with the fossil plants which are analogous to those of our equatorial regions. Besides, as the inequality of our days depends upon the position of the earth to the sun, it would appear that, ere tree-ferns could flourish where the pole now is, the inclination of the ecliptic must have been different.

It is thus that matter-of-fact observations sometimes lead towards points of the very deepest importance.

I shall add, that repeated researches upon fossil vegetables, may possibly indicate eventually, the positions of the poles and the equator of each geological epoch. It would for this suffice to discover in which direction the number of the species which require the most heat and the most uniform light, increases or diminishes.

M. Brongniart, in the remaining part of his work, enters largely into detail concerning the action of light on plants. A knowledge of the first elements of botanical physiology, is sufficient to shew that this agent determines the evaporation and the respiration of plants by their leaves—functions whence result the green colour, the fixation of carbon in the plants, the direction of the branches, &c. The intensity and the regularity of the solar influence are in the highest degree important to vegetables.

So much, then, we now supply, to demonstrate the interest which is connected with researches regarding fossil vegetables; and the gratitude we owe to the distinguished naturalists, who, during forty years, have prosecuted this branch of study with unlooked-for success.—*Bibl. Universelle*, July 1834.

On the Quantity of Solid Matter suspended in the Water of the Rhine. By Leonard Horner, Esq. F.R.S.L. and E., and F.G.S. (Communicated by the Author.)*

The attention of geologists has been more particularly directed of late to the importance of ascertaining the quantity of solid matter held in suspension in the water of different rivers, as affording a measure of the amount of abraded stone transported to the sea, there to constitute the materials of new strata, now in progress of formation.

During a late residence at Bonn, I began a series of experiments on the quantity of solid matter suspended in the water of the Rhine, in that part of its course. Several interruptions

* Read before the Geological Society 26th February 1834.

prevented me from advancing beyond the first steps of my proposed inquiry; but having no immediate prospect of being able to resume it, I venture to offer even this small contribution to science, as the facts I ascertained may not be considered without value.

I made two sets of observations, the one in the month of August, and the other in November. The apparatus I used was very simple, but answered the purpose perfectly; as it may be constructed in a very short time, and almost in any situation, the facility of making the observations ought to increase the chance of others of the same sort being made elsewhere. It consisted of a stone bottle, capable of containing about a gallon, and furnished with a cork covered with leather, and greased; a weight of about 10 lb. was attached to the bottom of the bottle by a rope, of such a length, that, when the weight touched the ground, the mouth of the bottle might be at the desired distance from the bottom of the river. A rope was attached to the ear or handle of the bottle, by which it was let down, and a string was fastened to the cork. As soon as the bottle had reached its destined position, the cork was withdrawn by means of the string, the bottle became filled with the water at that particular depth, and was then instantly drawn up. The water, as soon as drawn up, was emptied into glass jars, on which I had previously marked a certain measure. The quantity of water on which I intended to operate, was a cubic foot, or 1000 ounces, and I collected it at different times; for instance, after one-third of a cubic foot had stood in the jars for some days, I drew off the clear water with a syphon, and another third of water, fresh taken from the river, was added to the sediment left at the bottom of the jars from the first; that was allowed to stand, the clear water was again drawn off, and the last third was added in the same way. When this had stood a sufficient length of time, the accumulated sediment was removed to an evaporating dish, (a common saucer will do quite well), and carefully dried in a gentle heat. The dried mass was the amount of solid matter held in suspension in a cubic foot of water, and now in the state of indurated mud.

First Set of Observations.—The water was taken at the distance of 165 feet from the left bank, and at a depth of six feet from the bottom of the river, the total depth of the river at that place being thirteen feet. It was in the month of August, and the Rhine was unusually low. The water in the river had a yellowish tinge, and was turbid ; taken up in a glass, it was like the New River water in London after rain. The residuum, when dried in the manner above mentioned, weighed 21.10 grains. It was of a pale yellowish-brown colour, smooth to the feel, not gritty ; and it effervesced briskly, but was not wholly dissolved, when dilute muriatic acid was poured upon it. In appearance and properties, it was undistinguishable from the Loess of the Rhine valley.

A cubic foot of distilled water weighs 437500 grains, therefore the solid matter amounted to $\frac{1}{20734}$ part of the cubic foot of water.

Second Set of Observations.—The water was taken up in the middle of the river, and from about a foot below the surface. It was the month of November, and a great deal of rain had fallen some time before and during the observations. The Rhine was of a deeper yellow, and more turbid than in August ; but when taken up in a glass, it was not very different in appearance from what it had been then. The cubic foot of water, in place of being collected on three different occasions, was taken up on seven different days, with intervals of three days between each.

The residuum, when dried in the same manner, weighed 35 grains, which is $\frac{1}{12500}$ part of solid matter in one cubic foot of the water.

It was my intention to have repeated these observations at different seasons of the year,—to have made a profile of the bed of the river from shore to shore at Bonn, and to have ascertained the velocity at different parts of the stream, so as to get a mean velocity ; the depth of the river I had an opportunity of seeing, for there is a guage at the port ; but I was obliged to leave Bonn suddenly, and could not accomplish my designs.

The above experiments shew, that the quantity of solid matter suspended in water, which, in the mass, has a turbid appearance, may be very trifling. But the extent of waste of the land, and of the solid materials carried to the sea, which even such minute qualities indicate, is far greater than we might be led to imagine possible from such fractions. It is only when we take into account the great volume of water constantly rolling along, and the prodigious multiplying power of *time*, that we are able to discover the magnitude of the operations of this silent but unceasing agency. In the absence of more accurate data for my calculations, for the sake of shewing how large an extent of waste is indicated by water holding no more solid matter in suspension than is sufficient to disturb its transparency, I shall assume that the Rhine at Bonn has a mean annual breadth of 1200 feet, a mean depth throughout the year of 15 feet, and that the mean velocity of all parts of the stream is two miles and a half per hour. These assumptions are probably not far distant from the truth. I shall take the average amount of solid matter in suspension to be 28 grains in every cubic foot of the water.

If we suppose a mass of water of a foot in thickness, 15 feet in depth, and 1200 feet in length, we shall have a column across the river containing 18,000 cubic feet; and 18,000 × 28 give 504,000 grains of solid matter in that column.

A cubic foot of distilled water weighs 437,500 grains, and if we take the solid matter as having a specific gravity of 2.50, a cubic foot of it would weigh 1,093,750 grains.

If the river run with a mean velocity of two miles and a half in the hour, 13,200 such columns would pass a line stretched across the river every hour, and 316,800 such columns every twenty-four hours;

(1760 yards in a mile = 5280 feet, × $2\frac{1}{2}$ = 13,200
and 13,200 × 24 = 316,800.)

If 316,800 columns be multiplied by 504,000 grains, and the product 159,667,200,000, be divided by 1,093,750, (the number of grains in a cubic foot of the solid matter), we have 145,980 cubic feet of stone carried down by the Rhine past the imaginary line every twenty-four hours,—a mass greater in bulk than a solid tower of masonry sixty feet square, and forty feet in height. If we multiply 145,980 by 365, we have 1,973,433 cubic *yards* carried down in the year; and if this process has been going on at the same rate for the last two thousand years,—and there is no evidence that the river has undergone any material change during that period,—then the

Rhine must in that time have carried down materials sufficient to form a stratum of stone of a yard thick, extending over an area more than thirty-six miles square. How much farther back we may legitimately carry our calculations, I leave it to those to fix, who consider that there are any data to enable us even to guess at what epoch the Rhine was different from what it now is, either in respect of the volume or the velocity of the stream, in that part of its course at least to which the present paper refers.

Ascent to the Summit of Mont Blanc, 16*th*–18*th of* 9*th Month*, (*September*) 1834. By Martin Barry, M. D. With two Plates. Communicated by the Author.

On reaching the Col de Balme, on the 15th, in passing from Martigny to the Priory of Chamonix, Mont Blanc presented itself for the first time. It came suddenly and magnificently into view in its whole extent. Though inferior to Chimboraço in its elevation *above the sea*, Mont Blanc is to be considered as the higher mountain of the two; as it rises 12,300 feet above the valley of Chamonix; Chimboraço not more than 11,600 above the plain of Quito. There is another important feature in Mont Blanc; its line of perpetual snow is nearly 7000 feet *below the summit;* that of Chimboraço only 2400, according to Humboldt.

On my arrival at the Priory in the evening, guides were consulted as to the probable practicability of an ascent. It was objected, in the first place, that the season was too far advanced, and secondly, that some snow had recently fallen, which had not had time to harden: as a consequence of the first obstacle, that the days were too short, and that the fissures had probably widened; of the second, that the way would be rendered not only more difficult, but more dangerous also, from the recent snow lightly covering the smaller crevices. On the other hand, the weather had never perhaps presented a more favourable opportunity, the moon was nearly full, I was in excellent "training," from having lately climbed some of the heights in Switzerland; and additional interest was given to the undertaking, from the lapse of four years since the last ascent: which, according to a list seen at the Priory, was made by my countryman Capt. E. B. Wilbraham, in 1830.

Taking all circumstances into consideration, I concluded to make the attempt: and having procured six guides, I set out the next morning (16th), at half past 8 o'clock. The occasion appeared to create quite a sensation in the valley, as well among the strangers who were there, as among the inhabitants; and in consequence, a number of persons assembled at the Union Hotel, to witness our departure.

Passing through the pine-wood, eastward of the Buissons glacier, we reached successively the Chalet de la Parraz, Pierre Pointue, and Pierre à l'Echelle: the latter point by 12 at noon. Here we overtook some men, employed by the guides to carry thus far part of the baggage, consisting of wood, charcoal, extra clothing and blankets, with several culinary utensils, and provisions for three days. After accompanying us a short distance, they took their leave, and returned to Chamonix. Several chamois were now seen, for a few moments, passing fleetly over the rocks just above us. We dined at this spot, and soon afterwards entered upon the ice, at the foot of the Aiguille du Midi.

Crossing the glacier de Buissons, and obliquely ascending, we proceeded in a south-west direction, to the Mulets, an isolated chain of rocks, on one of which we hoped to pass the night.

The difficulties usually met with in crossing the glacier, have been particularly described by several preceding travellers, who have been up the mountain.* On this occasion, the great width

* The following is a true picture:—"It was the avalanche alone that we had hitherto to fear, but now new dangers arose, from the crevicés, those deep clefts in the ice formed by the constant movement of the body towards the valley, which separates immense parts of it. The higher masses, meeting with some slight opposition, remain stationary; the lower, proceeding in their course, widen the breach; and thus throughout the whole glacier, in every direction, are formed tremendous fissures." * * * * * * "We were surrounded by ice piled up in mountains, crevices presenting themselves at every step, and masses half sunk into some deep gulf; the remainder raised above us seemed to put insurmountable barriers to our proceeding: yet some part was found where steps could be cut with the hatchet, and we passed over these bridges, often grasping the ice with one hand, while the other, bearing the pole, balanced the body, hanging over some abyss into which the eye penetrated, and searched in vain for the extremity. Sometimes we were obliged to climb up from one crag of ice to another, sometimes to scramble along a ledge on our hands and knees, often descending into a deep chasm on the one side, and scaling the slippery precipice on the other."—*Narrative of an Ascent to the Summit of Mont Blanc, on the 8th & 9th August* 1827, *by John Auldjo, Esq. of Trinity College, Cambridge, 2d Edition.*—A volume which I recommend to those who may desire to see a more particular account.

of the fissures, as had been anticipated, constituted a principal one; often compelling us to retrace our steps, or to pass by ridges of uncertain solidity, on each side of which there yawned an abyss of tremendous and unknown depth.

The immediate approach to the Grand Mulet having become intercepted by an almost perpendicular wall of solid ice, we found it an exceedingly laborious task to reach it. However, at length, two of the guides, with the greatest difficulty gained the rock; and then, by means of cords, drew up the rest of the party, as well as the baggage. In this perilous undertaking, the guide who took the lead, in ascending the ice cliff, did so by a circuitous course, secured with a rope held by those below; as a false step would certainly have otherwise proved fatal, from the proximity of a precipice, over which he must have fallen, (See the two Plates). Our pioneers on this, and indeed on all occasions, where the greatest coolness, intrepidity, experience, and judgment were required, were Joseph Marie Couttet, and Michel Balmat. Of these brave men I cannot speak too highly: without them, the undertaking would undoubtedly have proved a failure, at this as well as at other difficult parts. Couttet, the principal guide, had been up eight times before; he was one of the four, swept away by an avalanche in Dr Hamel's attempt of 1820, and the only one of them whose life was saved. These remarks respecting the guides may be of service to some future traveller; and having mentioned two of them, I may as well give the names of the rest. They were, Pierre Tairraz, who had been up three times; François Desplan and Simon Tournier, each up once before; and Jean Tairraz, up for the first time. They all had their good qualities, and each of them had an opportunity of rendering me assistance in difficult and dangerous places, and performed his part in the most faithful manner. The one last named, is a courageous, enterprising, and very obliging guide, whose attentions, during our sojourn upon the rock, contributed much to my personal comfort.

Having at length gained the Grand Mulet rock, *but at a point much lower down than usual,* and as it appears by a memorandum which Couttet afterwards handed me, with a degree of difficulty, that he had seen equalled on no former occasion;*

* The following, (some alterations having been made in the orthography),

a long and dangerous climb was required, over its almost perpendicular layers, to bring us to that part proposed as our resting place for the night, a narrow ledge, usually selected, as being out of the reach of avalanches. We reached this spot by half-past six. It consisted in a flat surface, of a few square feet, forming a sort of open shelf, on the south-west side of the rock; its margin a precipice. Our batons, inclined against the rock, served as rafters for the roof of a little cabin, which was completed with canvass; two or three blankets having been spread on its floor. I found the height of the barometer *here*, at three-quarters past six o'clock, to be = Eng. inches 21.235; the *attached* thermometer = 45°.50 F. A fire was made at a short distance from the tent, and we supped with good appetites around it. At nine o'clock, having tripled some parts of our clothing, and provided particularly for the feet, we crept into our cabin, and soon found, that, lying very closely together, we were sufficiently warm.

Awaking at twelve, I got up, and regretted to find, that two of the guides, Couttet and J. Tairraz, were lying in the open air, from want of room in the tent. The cold, however, was not intense; for a thermometer which at nine o'clock indicated 39° F. had risen to 42°; a smart breeze from the south-west having entirely subsided. At half-past one A. M., the thermometer had again fallen to 41°. It was a brilliant night. The full-moon had risen over the summit of the mountain, and shone resplendent on its snowy surface. The guides asleep, I stood alone at an elevation of ten thousand feet; just below me, lay piled, in the wildest confusion, the towering masses of ice we had been climbing, and whose dangers we had narrowly escaped; around and above, was a sea of fair but treacherous snow, whose hidden dangers we had yet to encounter. The vale of Chamouny was sleeping at the foot of the mountain; and, interrupted only by the occasional thunder of an avalanche, the profoundest stillness reigned. The scene was exquisite: and I re-

is a copy of part of the memorandum received from Couttet. "Je soussigne et certifie avoir été 9 fois au sommet du Mont Blanc. Je n'ai jamais rencontré autant de difficultés que cette fois-ci (avec le Docteur Barry, que j'ai accompagné jusq'au sommet du Mont Blanc) pour arriver au Grand Mulet: et la néige nouvelle nous a beaucoup fatigué. Malgré toutes les difficultés, notre voyage a été heureux.—*Chamonix, le* 20 *Septembre* 1834.

(Signed) COUTTET JOSEPH, Guide."

mained contemplating it, until at the end of an hour and a half, a recollection of the coming day's fatigues, rendered it prudent again to take repose.

At 5 on the morning of the 17th, we left the Grand Mulet. Proceeding at first across the icy valley, that lay between us and the Dome du Gouttet, we reached almost the base of the latter; and then ascending more directly, often by a zig-zag course, arrived at the Grand Plateau by 9 o'clock: another great stage of the journey being thus accomplished.

The newly fallen snow, from a foot to 18 inches in depth, had rendered the way fatiguing: it had been needful for our leader to ascertain the safety of every step with the baton, and we had proceeded in a line united, two or three together, with cords, following carefully the same track. Latterly our way had lain over vast fields of snow, but the early part of it had presented scenery even more magnificent than that of the preceding day. Chasms of unfathomable depth,—towers of ice,—caverns with almost crystal walls,—splendid "stalactites" guarding the entrance. Such scenes live in the memory, but cannot be adequately imparted by word. No wonder if I often turned, and turned again, not knowing how to leave them *.

Very different feelings, however, soon took the place of the admiration which this scenery had excited. Difficulties occurred, that it required all the experience and intrepidity of Couttet and Balmat to overcome. At one point, indeed, it was found absolutely impossible to proceed further in the same course; and from the top of a block of ice, obstacles were discovered requiring an extensive change of route. After having been foiled in several attempts to proceed in other directions, we commenced a long ascent that afforded the last forlorn hope. Four years having elapsed since Mont Blanc was last ascended, we knew not but that from the shifting nature of the snow masses, changes had occurred to render the undertaking hopeless; and, thus dispirited, the labour of the way was felt to be much more arduous. The ascent of this part having at length been gained, a great fissure next presented, that would certainly have obliged

* The blue-green colour of the ice, when occurring in large masses, is here seen on the grandest scale; a phenomenon not less interesting than beautiful.

us to return but for a bridge of snow, or rather of ice, discovered at some distance. We made for it,—it bore us over, and our hopes brightened. But we had now to pass some very treacherous ice, among holes covered up with recent snow, concealing the dangers of the track. On reaching the Grand Plateau, however, we felt pretty confident of success, as the difficulties that then lay before us were not expected to be insurmountable, in the existing state of the weather: and we therefore sat down to breakfast at this spot in very good spirits.

There are three plains of snow, called the first, second, and third Plateau. The third is the highest or Grand Plateau. It was on the second or middle one that De Saussure, with eighteen guides, passed the second night in his ascent in 1787. Speaking of it, he says it is 90 toises (= 575 English feet) higher than the Peak of Teneriffe.

We left the Grand Plateau before 10 o'clock. Above it are the Rochers Rouges, where the fatal avalanche occurred in Dr Hamel's attempt of 1820. De Saussure's course lay to the west of these rocks: we went eastward of them, by the new route discovered in 1827, when my countrymen C. Fellowes and W. Hawes ascended, and by which a very dangerous part is avoided.

Great dryness of the skin was now observed, thirst became intense, and it seemed scarcely possible even to alleviate it. Not being disposed to give up the prospect around me, a veil that had been taken was not used; and this omission perhaps was the cause of some decutication of the face, and not a little soreness around the lips and nostrils, which occurred a few days after. Possibly this excessive desiccation of the face might be prevented, by using some unctuous matter during the journey. The inconvenient glare of the snow is obviated by the use of green spectacles, which indeed were found almost indispensable.

A dipterous insect was found dead on the snow, at about 1500 feet below the summit, and a living hymenopterous one 300 feet higher; both having probably been carried up by the wind. Professor Bronn of Heidelberg, has been so obliging as to examine these for me, and reports, that the first, which had lost some important parts, corresponds most nearly with the description of *Syrphus arcuatus* of Fallén and Meigen; and that if it be this, the vicinity of Mont Blanc is a new station for it, as, according to Meigen's monograph, it had previously been found in Sweden only. On the day after my return from the mountains, I saw two or three of what appeared to be the same insects alive near the "Jardin," about 9000 feet above the sea. They were extremely vigilant, and rapid on the wing. I could not catch one. The second, which is very small, is so much injured and crushed, that Professor Bronn informs me it would not be possible to determine it, except in a very perfect collection.

Two large birds were seen at a distance passing over the shoulder of the mountain, from Piedmont to Savoy.

Our progress after leaving the Grand Plateau, at first obstructed by the passage of some very formidable cliffs of ice, had latterly been impeded only by the depth of the soft snow; but now we reached the foot of a declivity of 35° to 40° with the horizon, and many hundred feet in length. It was the "épaule droite" of the summit. The snow here had hardened sufficiently to prevent our advancing a single step, without holes being first cut with the hatchet; yet it had not become so hard as to render firm the footing thus obtained. It was found continually giving way; and when we had reached a tolerable height, this became exceedingly dangerous. In no part of the ascent were the cords, by which I was attached to the guides, more serviceable than here. Our progress, too, was so slow, that I suffered not a little from the cold; a keen breeze prevailing at the time. My feet felt as if all but frozen, on which account the footing became doubly insecure. This ascent brought us above the Rochers Rouges; the next, a slope of 28° to 30°, apparently not very difficult, was to take us to the summit.

But we had now reached an elevation, where I had to verify the testimony of preceding travellers, by experiencing the exhaustion, consequent on very slight exertion, in an atmosphere whose density is so exceedingly reduced. This inconvenience had not been felt, by me at least, before arriving at this point (about 14,700 feet above the sea), and I had not observed it in any of the guides. Only a few steps could now be taken at a time; and these became both fewer and slower. Two or three deep inspirations appeared sufficient at each pause to enable me to proceed ; but, on making the attempt, I found the exhaustion returned as before. I even felt a degree of indifference, which a sight of the summit just within reach did not suffice to remove. Slight faintness also came on, so that I had at last to sit down for a few minutes : when a little wine having been taken, one more effort was made, and at a quarter past 2 o'clock we stood on the highest summit, having been seen to reach it, as we afterwards found, both from the valley of Chamonix and from Mont Bréven opposite*.

After a few minutes of rest on the summit, all the exhaustion, faintness, and indifference had ceased, and I felt fully prepared to contemplate the magnificent and all-repaying prospect around and beneath : but of which, as it would be vain here to attempt any description of a panorama whose centre is the highest point in Europe, I shall say little more than that it was not obscured by a cloud. As, however, the nearer objects, at such an elevation, are necessarily much diminished, distant ones, by the human eye, can be but indistinctly traced. I dwelt with peculiar satisfaction on the host of inaccessible aiguilles, projecting darkly through seas of snow, immediately around, and forming, indeed, part of the range of Mont Blanc, their summits now lying at our feet. There were pointed out to me the Maritime Alps, the chain of the Jura from end to end, the Lake of Geneva, the Buet, the Gemmi, the St Gothard, the Furka, the Matterhorn, the beautiful Mont Rosa, the chain of the Appenines, Mont Cenis, the mountains of Tuscany, and other heights, with the valleys and plains between. All the mountains of the Bernese Oberland, the Finster-aar-horn, and the Jungfrau, together, formed but an inconsiderable portion of the mighty whole.

The height of the mountain, according to the calculation of De Saussure, is 14,700 French, or 15,666 English feet (one French foot being = 1.06575 English). The extreme summit is a ridge nearly 200 feet in length, its direction east and west ;

* "It requires seventeen hours' march to reach it (the summit), but the difficulties which are met with lengthen the route, retard the march, and render this calculation of the distance very uncertain. Indeed, it is generally estimated at eighteen leagues." (Appendix to the *Narrative by J. Auldjo* already quoted.)

the slope of the north side forming an angle, estimated by De Saussure (in 1787) at 40°–50°; that on the south 15°–20°. This estimate, which applies to the covering of snow, may be considered as not materially different at the present time.

I found the height of the barometer to be = 17,052 English inches, the attached thermometer indicating 32° F., suspended, and screened by the incasing wood from the sun's rays: a breeze blowing from the south.

De Saussure found the boiling point of water at the summit of Mont Blanc to be 68°,993 R. (= 187°,234 F.) Naturally wishing to repeat this interesting experiment, I had a fire lighted in a chauffer, provided for the purpose. With the aid of bellows, our materials, wood and charcoal, were kindled with less trouble than had been anticipated (Couttet assuring me that this had never been done before).* In a culinary utensil of water, in full ebullition, I immersed a thermometer, which I had procured at Chamonix (my own thermometer having been broken), and carefully observed the height of the mercury when it ceased to rise. I am sorry, however, that I am prevented from here inserting the temperature indicated. The scale was found to be loose, and the graduation very inaccurate, as since discovered on comparing it with a standard. It did not bear the maker's name.

The report of a pistol, twice fired, was found very feeble. It may be worth noticing, in connection with the subject of sound, that when within a few hundred feet of the summit, in ascending, the snow being hard and its surface glossy, and some of the guides considerably in advance, the creaking noise produced by the points of their batons in the snow, as it reached me, could be compared to nothing but the distant lowing of cattle.

While on the summit, Couttet fetched me specimens from the Rochers Meridionales, the highest rocks on its south side. One of these, marked (A), is a granite; two (B) are sienites, consisting of a blackish hornblende and white felspar, in intimate aggregation; the fourth (C) is hornblende, with veins of

* I have since found, that De Saussure had a charcoal fire made on the summit; but finding it very difficult to support it, he used it only for the purpose of melting snow. A spirit-lamp was employed by him for the boiling of water.

asbestos; and the fifth (D) a compound of hornblende and felspar, one of the "Rochers à bulles vitreuses" of De Saussure, who attributed to lightning the glassy bubbles presented by their surface.

In our way down I procured specimens of the Derniers Rochers (E), two little masses of granite or protogine, projecting through the snow near the middle of the last slope, and therefore very near the summit on its north side. Fragments, doubtless the effect of lightning, lay around them on the snow. The felspar, generally whitish, forms about three-fourths of the mass; the quartz is grey, with a tinge of violet; and chlorite and talc occupy almost exclusively the place of mica. De Saussure has given a most minute description of the composition of these—the highest rocks which at that time had been examined by naturalists;—he stated also the dimensions of one of them, to enable future travellers to ascertain whether the snow continued to deepen on the summit. From what I recollect, this rock projects just about as much now, as it did at the time of De Saussure's visit, which was nearly half a century ago.

I intend sending specimens of all these rocks, marked as above, to Professor Jameson, for the Royal Museum of Natural History in the University at Edinburgh. They are interesting, as being the highest visible rocks in Europe.

The observations of others were verified regarding the blackish-blue colour of the sky, particularly in and near the zenith, as seen from these lofty regions. I was particularly struck with the depth of this colour, when in a valley many hundred feet below the summit, with high walls of snow around. It appears to result from the simultaneous reception of rays from the snow, for when the latter were purposely excluded from the eye, *the tinge of black more or less completely disappeared.* To make this observation, I lay on my back, and closed my eyes for some moments; then opened them on the zenith, the snow being shut out from view, by a cylinder formed with both hands. I do not find a shade in "Werner's Nomenclature," corresponding with the colour, as seen either with or without the snow; and of course it is not easy to speak from recollection on this subject; but probably an approach to the blackest tint observed might be made by taking from "Pansy Purple" a little of its carmine red, and adding a very little more of raven-black. As viewed without the snow, "China blue," with the addition of a very little more of Prussian blue, might perhaps represent the colour. It did not insensibly pass into the pale whitish-blue of the horizon, but, what deserves remark, *terminated by a well marked border at some ten degrees above it.*

We had all left the summit by half-past three; several of the guides having descended sooner, a few hundred feet, to a more sheltered situation. One of them had headach, probably from some brandy he had taken. The rest individually assured me that they were perfectly well, and they all said that their breathing had never been affected while *at rest* on the summit. Observations on the pulse of several had been made in the valley, with the intention to repeat them on the top of the mountain; but in prosecuting the other objects, it was forgotten. I may remark, that I did not find it needful to take any stronger drink, during the journey, than wine, a little better than the "vin ordinaire," or table beverage of the country. Lemonade was found very refreshing. No inclination was felt to eat while on the summit. I have already mentioned that unquenchable thirst was experienced.

The descent, in parts impeded by its steepness, and on this account attended with not a little danger at the "épaule droite," was, upon the whole, very rapid,—the guides sometimes sliding down fields of snow, supported by their batons; and, as the steel points with which my shoes were armed prevented my following their example, I was sometimes drawn after them with cords in a sitting posture. In passing over a dangerous part we had crossed in the morning, I stept with one foot into a hole concealed by snow, and communicating with a cavity of unknown depth. This shews the necessity of two or three persons being constantly attached together with cords.

We returned to the Grand Mulet by a quarter past six, i. e. in little more than one-fourth of the time it had taken to ascend from this rock to the summit. It was afterwards found that a spectator, a near relative of mine, descending from the Bréven, had, with the assistance of a glass, counted us—seven in number—into these our quarters for the night. The scene at sunset, both on this and the preceding evening, was splendid, the sun's disk appearing, as noticed by others, very much smaller than when seen from lower regions. At half-past six o'clock, the barometer was = 21.225 inches English, its attached thermometer being = 44°.37 Fahrenheit.

A fire was again made, the cabin re-constructed on the same ledge as the preceding evening, we supped, and retired to rest. Two of the guides again passed the night without a shelter (but without sustaining any harm). Had a storm arisen, it is probable that we should all have done the same, for a gust of wind would have blown away the batons and sheet, which formed our cabin.

As many of the attempted ascents of Mont Blanc have been unsuccessful from bad weather, extreme cold, or fatigue, it seems exceedingly desirable that a more substantial shelter should be provided, into which a party could retire for even a few days, if requisite; and as additional interest would be given to Chamonix by any thing facilitating the ascent of Mont Blanc, it might be worth the consideration of the Sardinian Government to employ some men a month or two in hewing out a cavity in the Grand Mulet rock for this purpose.

The next morning, 18th, on this rock, the barometer, at a quarter past six, stood at 21.198 inches English, the *attached* thermometer being = 39°.87 F. Specimens were collected of the plants within reach. Among them were *Aretia alpina*, *Saxifraga bryoides*, *Poa laxa* and *nemoralis*, with several lichens and mosses not yet determined. Specimens also were taken of a micaceous rock occurring here, containing iron-pyrites; also of gneiss with asbestus. A small bird was observed on the rock, which, however, I did not see. We were gratified, just before starting, with the sight of a splended avalanche, which occurred at a distance, as estimated by one of the guides, of "une demi-heure," (= $1\frac{1}{2}$ mile English,) and in a few moments a shower, resembling sleet, that resulted from it, reached us.

We left the Grand Mulet at half-past seven A. M., and retraced our steps as nearly as possible across the glacier; here and there, by a shorter passage, saving part of the distance. At the foot of the Aiguille du Midi, numerous fragments of ice, very newly fallen, covered the ground for a considerable distance, and we hastened over it in dread of more.

Having safely re-crossed the glacier, all serious danger was past. The undertaking had been particularly well-timed : it was not until De Saussure's *third* attempt, and after he had contemplated the ascent for six-and-twenty years, that he succeeded ; and the indefatigable Bourrit was obliged to return at *five* different times, and never accomplished his object.

It was very interesting to me, just before reaching the valley, to meet with Jacques Balmat, an old man of 73, who, in an attempt to ascend this mountain in the year 1786, having passed a night alone and unsheltered in a storm upon the snow, discovered a way—probably the only way—of reaching the summit, and the same year conducted Dr Paccard to it. He was De Saussure's principal guide in 1787, and has been surnamed "Mont Blanc."

Between three and four o'clock in the afternoon, we arrived at the Priory, not having met with any accident, and having had three days without a cloud. The barometer brought down from Mont Blanc stood at 26.918 English inches at 5 P. M., the attached thermometer = 71°.37 F. ; hence I found that it had sustained no injury, and that the observations taken at the summit, &c. might be relied on.

It appeared, by the list at the Priory, that mine was the 16th ascent, and later in the season by seven days than any former one. By the same document, I found myself to be the 20th person (guides not included), and the 12th Briton, who had reached the summit. A certificate of having accomplished the ascent was, as is usual, received from the Sindic of Chamonix, attested by the guides.*

* Extract of the certificate :—"Nous, Sindic de la Commune de Chamonix, province de Faucigny, Duché de Savoie, certifions et attestons à qui de droit, que Monsieur *Martin Barry*, Anglais, Docteur en Medecine et en Philosophie, a fait, l'ascension du Mont-Blanc, le dix-sept du Courant, accompagné des six guides de nommés Tairraz Jean Pierre, Couttet Joseph Marie, Balmat Jean Michel, Despland François, Tournier Simon, et Tairraz Jean. Qu'ils sont partis de Chamonix le seize du Courant pour aller coucher au *Grand Mulet*, et parvenus le lendemain dix-sept du Courant sur la *cime* du Mont-Blanc, à deux heures aprés midi, avec, un beau tems, ou Mr le Docteur Barry est resté accompagnés de ses guides plus d'une heure de tems, et où il a fait diverses expériences phisiques, et observations barometriques. Qu'il sont successivement redés cendus coucher au Grand Mulet, où ils sont arrivés à

Of those who have reached the summit up to the present time, there appear to have been 1 Savoyard, 2 Swiss, 12 Britons, 1 Courlandais, 1 German, 1 Pole, 2 Americans,—in all, 20.

On the day after my return from the mountain, I visited on foot *Montanvert* and the *Jardin*, returning to the Priory in the evening, a distance estimated at 14 leagues, (a tolerable proof of my not having suffered excessively from fatigue). The observations with the barometer* and thermometer at these places, as well as those already mentioned, are given in the following table.

					Eng. Inches.		
Mont Blanc.	Summit,	Sept. 17.	P.M. $2\frac{1}{2}$.	Barom.	17,052.	Therm. attached	32°.00 F.
...	Grand Mullet	... 16.	P.M. $6\frac{3}{4}$.	...	21,235.	...	45°.50 ...
		... 17.	P.M. $6\frac{1}{2}$.	...	21,225.	...	44°.37 ...
		... 18.	A.M. $6\frac{1}{4}$.	...	21,198.	...	39°.87 ...
Priory.	Chamonix, (After descent from M. Blanc,)	... 18.	P.M. 5.	...	26,918.	...	71°.37 ...
	Jardin,	... 19.	P.M. 3.	...	22,034.	...	58°.44 ...
	Montanvert,	... 19.	P.M. 8.	...	24,334.	...	61°.25 ...
Priory.	Chamonix, (After returning from Jardin,)	... 19.	P.M. 11.	...	26,973.	...	64°.62 ...

I have not yet seen the usual report of the barometrical observations taken at the Great St Bernard and Geneva, for the

sept heures du soir, et de retour ici aujourdhui à Chamonix à trois heures aprés midi, tous sains et sanfs, que pendant leur ascension, its ont continuellement [frequemment] été aperçus et observés par la multitude des voyageurs qui se trouvaient à Chamonix, et par les habitants de la Commune, même au moment où ils arrivèrent à la sommité de cette montagne dont l'élevation fait temerite? et la rend remarkable. * * * * * En temoignage de quoi nous lui avons délivré le présent que nous avons signés, avec les six guides de Mr Barry."

CHAMONIX, *le* 18. *7bre*, 1834.

(Signed) *Couttet Joseph.*
Michel Balmat.
Jean Tairraz.
Simon Tournier.
François Despland.
Pierre Tairraz.

Le Sindic de Chamonix,
(Signed) COUTTET.
Sindic.

* The barometer employed for these observations was an excellent one, by Gourdon, Geneva; and it appeared to be in good order. I had borrowed it upon the spot, just before the ascent. Although its graduation was according to the French scale, the observations are here reduced to English inches, for the reader's convenience. The instrument was suspended at a height to suit

month, or those made at these places on the 17th might have been added to the above; perhaps, however, Geneva is too distant a station,* as long ago foreseen by Sir George Shuckburgh.

MARTIN BARRY.

Heidelberg, 1st of 11th Month, (Nov.) 1834.

P. S.—Since the above, I understand that Count Tilly, an Austrian, has ascended Mont Blanc. He is reported to have reached the summit "on the 9th October," *i. e.* twenty-two days later; but, I lament to say, it is rumoured that his feet were frozen in coming down.

the eye, and shaded from the sun as already mentioned. It is a subject for regret, that the suddenness of my journey up the mountain,—tempted as I was, at its base, by the fineness of the season,—precluded me from obtaining additional instruments, with which the data might have been completed, for repeating the calculations of preceding travellers as to the height of Mont Blanc.

* It is a remarkable fact, that the *average* differences between the mercurial column at the Hospice of the Great St Bernard, and that at Geneva, are far from uniform from time to time, although these averages are deduced from observations of twelve months,—a period sufficiently long, one may suppose, to compensate the effect of any possible error. I am informed by a relative of mine, that the comparative heights of the mercury at these two stations, for ten years, as given in the Bibliotheque Universelle for 1833, tome i. pp. 27 and 32, if both be reduced to the decimal fractions of a "ligne," appear to be as follows; their differences, it will be seen, inserted n the last column, are not a uniform quantity.

	Geneva.		Gt. St Bernard.			Mean Annual Difference.	
Year.	Pouce.	Ligne.	Pouce.	Ligne.		Pouce.	Ligne.
1823	26	10.73	20	9.32	=	6	1.41
1824	26	10.98	20	9.54	=	6	1.44
1825	26	11.55	20	9.49	=	6	2.06
1826	26	9.93	20	9.70	=	6	0.14
1827	26	10.65	20	9.20	=	6	1.45
1828	26	11.10	20	9.74	=	6	1.36
1829	26	10.30	20	9.63	=	6	0.67
1830	26	10.91	20	10.59	=	6	0.32
1831	26	10.65	20	10.30	=	6	0.35
1832	26	11.48	20	11.07	=	6	0.41

PLATE II.

Reaching the Grand Mulet Rock.

Drawn by Th. Verhas, from a Sketch taken on the spot by Dr. Barry.

E. Mitchell Sculpᵗ

PLATE I.

Reaching the Grand Mulet Rock.

Drawn by Th. Verhas, from a Sketch taken on the spot by Dr Barry.

E. Mitchell Sculp^t

*On the Teredo navalis and Limnoria terebrans, as at present existing in certain localities on the Coasts of the British Islands.** By William Thompson, Esq. Vice-President of the Natural History Society of Belfast. Communicated by the Author.

The most recent notice which I have seen of the *Teredo navalis*, is in a paper "on burrowing and boring marine animals," published in the "Philosophical Transactions" for the year 1826, wherein the author, Mr Osler, remarks, "as a British animal I believe the teredo to be nearly and probably quite extinct. In the harbours of Falmouth and Plymouth, where some years ago it was so abundant, it is no longer to be found. In the royal dockyard at Devonport, I was shown two specimens which had been taken out of a pile many years before, but they were treasured as a curiosity; and I was assured by Mr Churchhill, the master shipwright, that at present they are never met with. The shipping of Swansea trade to every part of the kingdom, and we have nearly four thousand arrivals in the year, chiefly from coasting voyages; but, though very few of the vessels are coppered, we never see the Teredo."

All parts of the kingdom have not, however, since the period of Mr Osler's communication, been exempted from the ravages of the *Teredo*, as four or five years ago it was observed that some of the piles used in the formation of the pier at Portpatrick on the coast of Ayrshire, had been materially injured, and some of them indeed destroyed by its perforations. Since that time, the evil has most materially extended, as has been evinced by pieces of timber a very few years under water, being, at various times, but more especially during the late gales, cast ashore, having previously been rendered useless by this destructive animal.

For specimens of the *Teredo*, and pieces of wood containing its shell and perforations, I am indebted to the kindness of Captain Fayrer, R. N. (of H. M. steampacket *Spitfire*) who is ever forward to communicate whatever is within his reach, that can in any way tend to advance the knowledge of natural history.

* Read before the Royal Society of London, 15th June 1834.

From such authors as describe the size of the *Teredo navalis*, I make the following extracts. In the Ency. Brit. and Rees's Cyclopædia, it is stated, that " this creature is wonderfully minute when newly excluded from the egg, that its utmost bigness is a foot long: three or four inches is, however, its more frequent length." Linnæus, and after him Gmelin, in his edition of the *Systema Naturæ*, remarks, that the shell of the *Teredo navalis* is from four to six inches in length: this is also the size assigned to it by Matten and Rackett (Linn. Trans. v. 8), who, however, add, " vel majis longa." Dillwyn (Desc. Cat. of Rec. Shells) observes, that it is " sometimes a foot long, and about three-fourths of an inch in diameter at the lower extremity, from which it tapers slightly to the summit; but the shell in these climates is rarely more than half so large." Home (Phil. Trans. 1806) informs us, that of a number of these animals sent him from Sheerness, the largest was in length eight inches. Montagu (Test. Brit.) says, " this part [the testaceous tube] is rarely above three-fourths of an inch in diameter at the larger end, and a foot in length in our climate; but exceeds that in the more southern parts." Baxter, in a paper communicated to the Royal Society of London (Phil. Trans. 1739–40, part 1), " On the Worms which destroy the piles on the coasts of Holland and Zealand," ascribes thirteen or fourteen inches as their greatest length. Denovan (Brit. Shells) states, that he has " seen one of them whose progress through the solid plank had not been interrupted, that had grown nearly to the length of eighteen inches;" and Turton, in his Conchological Dictionary, describes the tube as being " from a foot to two feet in length;" but neither he nor Denovan informs us whether they were British or foreign specimens that attained the greatest magnitude which he mentions.

In addition to what is just quoted concerning the general size of the *Teredo*, it may be added, that the current opinion of authors is, that the dimensions of the animal is much greater in the warmer regions of the east, than in the comparatively temperate climate of Europe. The specimens, however, received from the northern locality of Portpatrick at various times, equal, if not surpass, in magnitude the largest as yet stated to have been met with in the Indian Ocean, having almost attained the length of two feet and a half. In reply to certain queries respecting the size, &c. of the *Teredo* in the east, Captain Fayrer favoured me with the following remarks, dated *Portpatrick, 2d January* 1834. "Having been many voyages in command to India, particularly to Bengal, I have frequently there had opportunities of seeing the destructive effects of the Teredo, and so far as my memory serves me, without having actually specimens to refer to, should at once pronounce those at Portpatrick the same species. I do not think that I ever saw larger specimens in India than I have observed here."

Of the primary valves, the largest from Portpatrick are from the hinge to the pointed margin $\frac{7}{4}$ of an inch in length, diameter the same. The opercula vary much in form in different specimens, but are generally similar in length to the primary valves in the same individual, and like them are covered more or less with an epidermis. The greatest diameter of the testaceous tube or case at the larger end, is $\frac{7}{8}$ of an inch, at the smaller it varies from $1\frac{1}{2}$ to 3 lines. All of the specimens have from $1\frac{1}{2}$ to 2 inches and upwards of the smaller end of the tube greatly contracted within by laminæ, also the partition producing the double aperture extending but a few lines from the very extremity. The greatest thickness of the shell is at the smaller end, where, at the commencement of the laminæ, its consistence is from $\frac{1}{20}$ to $\frac{1}{40}$ part of an inch; from this it becomes gradually thinner towards the greater end, which, in the very largest specimens (those some inches above two feet) is found to be closed up, but in several others there is no deposition whatever of testaceous matter for some distance from the termination of the cell. In one perforation about 20 inches long, the body of the animal has had no testaceous covering for the last $3\frac{1}{2}$ inches; in two other cells of about 2 feet, no deposition appears for $4\frac{1}{2}$ and $4\frac{3}{4}$ inches from their termination.

All the timber at Portpatrick in which the Teredo had formed its habitation is pine,* and perhaps to this circumstance the superior size of the animal may chiefly be attributed. On this

* Captain Fayrer informs me, that at Calcutta he has seen the *Teredo* in Teak, *Sissoo*, *Saul* (both allied to the Teak, but of a harder quality), and other woods used in ship-building, and has known it in the Hoogly River to destroy the keel of a vessel afloat, in the short space of four or five months.

subject it is remarked in "Rees's Cyclopædia," (copied, I believe, from the "Historia Naturalis Teredines" of Sellius), that "the kind of wood in which these worms are lodged, makes a great difference in the appearance of their cells, as they work much more speedily and successfully in some kinds than in others. The fir and alder are the two kinds they seem to eat with the greatest ease, and in which they grow to the greatest size;" but in this same article their "utmost bigness" is said to be "a foot."

Though it is well known that the *Teredo* bores in the direction of the grain, it may be observed that it does so whether the position of the wood be perpendicular or otherwise. Captain Fayrer indeed remarks, that it "has a decided disposition to work horizontally." It is, however, often obliged to deviate from a straightforward course, and exert its power of working against the grain to avoid such obstructions as nails, timber-knots, and the tubes of its fellows, and make a winding or angular habitation, accordingly as such impediments occur; but these circumstances seem not eventually to impede the progress of the animal, or the formation of its shell, as some of the very largest specimens I have examined are the most tortuous.

Captain Fayrer states, that at Portpatrick the *Teredo* does not seem to have any preference to situations that are occasionally left dry (See Osler in Phil. Trans. v. cxii. p. 358), as it is found, taking medium for tides, at the depth of thirty feet, but that he has nevertheless obtained the largest specimens near the surface.

As I have never had an opportunity of seeing the animal *Teredo navalis* alive, I am only enabled, from an examination of specimens recently dead or preserved in spirits, and of timber subjected to its operations, to offer an opinion on that part of its economy, above all others the most interesting—the method by which it forms its cell, and thereby causes such vast destruction to shipping, and to timber exposed to its influence in the sea. On this subject, authors of eminence are directly opposed to each other in opinion. Sir Everard Home and Mr Osler attribute the perforation to the unassisted agency of the primary valves; whilst Colonel Montagu and Dr Turton* as firmly believe that

* The climax of the argument used by Dr Turton is, that "the internal termination of every perforation is spherically concave, and not abruptly trun-

it can only be effected by means of a solvent. I am not inclined to adopt either theory, but venture to advance what I believe to be a new view of the subject. I would ascribe the smoothly rounded termination of the cell to the action of a solvent* applied by the proboscis (so called by Sir E. Home, who mentions its vermicular motion, though he attributes to it a very different use), which thus acts as a pioneer in mining a passage, that is afterwards increased to its final dimensions by the boring action of the primary valves. The spherical termination, I am satisfied, could not be effected by these valves or boring shells, although, with the exception of this smoothly rounded part, they afford sufficient evidence of their rasure in the irregular transverse furrows which are more or less apparent throughout the entire circumference of the cell. With regard to Montagu's argument of the constant presence of an epidermis on the boring shells, the only part of the shell that I conceive to be requisite for the operation of cutting, is, in the specimens which have come under my observation, always free from such a covering, and so far from being "tender and fragile," is abundantly strong and sharp for the purpose here allotted to it.

During the nine or ten years that the *Teredo* has been established at Portpatrick,† it has not degenerated, as specimens

cate, which must be the case if it were effected on the principle of a centre bit." That of Colonel Montagu is, that "live shells are always covered with an epidermis, which must eventually have been removed by the necessary friction applied to the boring and piling of timber."

* Not having a knowledge of chemistry, I cannot pretend to say what this solvent may be. The most recent suggestions I am aware of on the subject of solvents is the following, which I extract from the last work of my friend Dr Drummond, entitled "Letters to a Young Naturalist." At p. 266 of the first edition of this work, it is asked relative to the power possessed by the *Pholades* of boring, "May it not be possible that the animal has a power of decomposing the sea-salt as its wants may require, and applying the liberated muriatic acid to the solution of the calcareous rock? The muriate of lime is particularly soluble in water, so much so, indeed, that it forms a deliquescent salt, and therefore it would be carried off as fast as it could be formed. This, however, is mere conjecture; but the subject is worthy of regular investigation by observation and experiment."

† This space of time is presumed from a comparison of the effects of the Teredo in the first piles in which it was noticed about five years since, with those now taken up, which are known to have been put under water at that period.

just received (January 1834), which were alive in their native element a few days ago, are of equal size to those sent from the same place five years since, when its presence was first discovered, shewing that it has not been affected by the cold of the winter season, as we might reasonably expect, were the animal truly exotic.

By Mr Hyndman (Member of the Natural History Society of Belfast), I have been favoured with some valves and opercula of the *Teredo navalis*, which he obtained from the bough of a tree, found imbedded in blue clay twelve feet beneath the surface, during the recent excavation of Dunbar's dock in this town. The greater number of these specimens are small, but one shell and the valves and opercula of another, or of its fabricator, are as large as any from Portpatrick. The shell of another of these is one-tenth of an inch in thickness. On consideration of the depth at which this tree was found, and the presence of several strata of shells above it and near the surface, I come to the conclusion that it was deposited in the place of its discovery at a very remote period, not only for centuries before there was any history of the *Teredo*, but before Europe enjoyed any commerce with either the East or West.

Though it should be said that we cannot reasonably conjecture what the final destination of a piece of timber containing the *Teredo* may be when once committed to the ocean, yet from the fact of its being discovered at Belfast, in the situation just described, added (without taking other circumstances into consideration) to its reaching the magnitude at Portpatrick which it does in India, I am disposed to consider its foreign origin very doubtful. If this animal has been originally introduced, and has been preserved only by occasional importations (See Osler in Phil. Trans.), should we not rather look for it in those ports of the United Kingdom, where vessels from every quarter of the globe are congregated, than in the obscure harbour of Portpatrick, which has never been visited by a foreign craft, and is only used as a secure station for His Majesty's steam-packets that ply thence to Donaghadee. *

* When visiting the western coast of Ireland in June 1834, accompanied by Robert Ball, Esq. of Dublin, we remarked that nearly all the timber used by the peasantry living near the shore was pierced by the *Teredo navalis*. This

The *Teredo* holds not undisputed sway over the piles at Portpatrick, as the disastrous effects of another species are but too apparent. This is a very minute crustaceous animal, first described about twenty years ago by Dr Leach (Edin. Encyc. vol. vii. p. 433, and Linn. Trans. vol. xi. p. 370), who made of it a new genus, and announced it under the appropriate title of *Limnoria terebrans*. Kirby and Spence, in their "Introduction to Entomology" (vol. i. p. 236, 4th edition), observe concerning it :—"If this insect were easily introduced to new stations, it might soon prove as destructive to our jetties as the *Teredo navalis* to those of Holland, and induce the necessity of substituting stone for wood universally, whatever the expense; but happily it seems endowed with very limited powers of migration, for though it has spread along both the south and east piers of Bridlington Harbour, it has not yet, as Mr Lutwidge informs me, reached the Dolphin, nor an insulated jetty within the harbour."

At Portpatrick the real is doubly worse than the imaginary danger contemplated by these benevolent authors, for the dreaded *Teredo navalis* and the *Limnoria terebrans* have here combined their forces; the former consuming the interior of the pile, whilst to the latter the exterior falls a prey. The result of these united efforts can hardly fail to be the utter and speedy destruction of all the timber in the pier.

A piece of sound pine timber which I examined, and which had been originally nine inches in diameter, when taken up after being five years and a half used as a pile, was so reduced by the continued operations of these animals, as to contain not more than about an inch in breadth of sound timber in any part, and in several places was pierced entirely through. This pile was placed fifteen feet below high-water mark, and only left dry during the low water of spring-tides.

In the "Introduction to Entomology," it is stated that "no other remedy against the attack of the Limnoria is known, than that of keeping the wood free from salt water for three or four days, in which case it dies." I remarked this animal to be much

was more especially the case in the island of Achil, where we in vain sought for a piece of even trivial dimensions, that had not formed an habitation for the Teredo, previous to being subjected to the use of man.

more tenacious of life than here represented; as on examination of a piece of wood received on the 10th of January, and then placed immediately on its end in a dry room, I found many of the *Limnoriæ* alive and active on the 18th and 20th, and one even on the 25th of that month, proving that it can at least subsist with very little moisture. The wood in which they were had been taken from the sea a week before it was sent me, but was occasionally during that time moistened with salt water. These animals were generally of the size assigned to them by Dr Leach, of from one to two lines in length, but a few exceeded his maximum by nearly a line. When touched, they contracted themselves nearly into a ball, as described by this author.

Dr Leach remarks, that "when interrupted in their progress by a knot on the wood, they pass round it," which they certainly do in the first instance; but it is evident, on the inspection of a piece of wood in my possession, that when the softer parts fail them, they return to the knot, and consume it also. On removing shells of the Teredo, I have observed that the *Limnoriæ* continue their operations until they come in contact with them.

After mentioning the belief of the inhabitants of Bridlington, that the Limnoria was left there a few years since by an American vessel, it is observed in the Introduction to Entomology, "that it is an imported insect, and, like the Teredo navalis, not originally an European animal, seems very probable from the fact, that I can find no description of any species of Oniscus, at all resembling it, prior to that of Dr Leach, who seems first to have given it a name; and it appears highly improbable, that if it had been an European species, it should not long since have attracted attention, and been described." It is truly singular that this animal should have become known to naturalists within so short a period; but respecting its foreign origin, I may observe, that the concluding remarks on the Teredo, relative to that species being indigenous, apply equally well to the Limnoriæ. I believe there is not yet evidence that the latter is found in foreign countries, and as to geographical distribution, it is recorded as occurring only on the eastern coast of Britain, in any work that I have consulted on the subject. In addition to the lamentable proof already given of the Limnoria's existence on the opposite coast of the island, I can vouch for its occurrence still farther west than Portpatrick, as there is at present near the beach at the entrance of Belfast Bay, a large birch tree (*Betula alba*), which was thrown ashore, after being for some time subjected to the sea, that, wherever decorticated, has been eaten away to the depth of some inches by this animal. The presence of incrustations of *Serpulæ*, *Balani*, *Clitia*, *Flustræ*, &c., all of native species, on such parts of the bark as remain, affords circumstantial evidence that the tree has not been washed from any foreign locality.

Since the above was written, I have received the following additional information on the Teredo and Limnoria, from my friend Mr Hyndman, who, at my request, gave attention to the subject during a visit to Donaghadee (in the county of Down), in February 1834. Mr Stephen, the overseer of the Harbour of Donaghadee, states, that soon after the works commenced in 1828, the building float was found to be perforated by the Teredo, but that the animal did not afterwards appear in any numbers. I myself examined two piles of pine timber that had been used in the works. They were put down in 1828, and taken up in 1832; one of them had a few perforations of the Teredo in it; they were both eaten away to a considerable extent by the Limnoria, which attacks all wood here exposed to the sea. Elm particularly suffers from it. Memel timber, as may be supposed, withstands it longer than the American pine. Mr Stephen informed me, that upon one occasion on examining the bottom of the steam dredge, the wooding sheeting was found to be almost totally destroyed by the Limnoriæ; indeed, to such a degree, that the men could almost thrust their hands through it. Buoys used about the harbour had occasionally to be renewed, in consequence of the destruction caused by the Limnoriæ alone, as they have not been yet attacked by the Teredo, nor has the latter so much injured any piles as to render them unfit for use. Its effects have not been thought of, compared with those of the Limnoria; and it has been against this species that any precautions have been taken. As an experiment, Mr Stephen once coated two sides of a piece of timber with the common mixture of tar and sulphur, and the other two with white paint; and having done so, placed them under water. The sides coated with the former were soon attacked by the Limnoriæ, but those which were painted remained uninjured. The plan successfully practised in some places against the Teredo, of studding the timber exposed to it, so closely with broad-headed nails, that the rust exuding from them soon covers all the wood, has been quite effective here when used against this animal. Mr Stephen states that the Limnoria is very destructive at Leith*, but it is unknown at Dundee. Can we attribute its absence from the latter place to the comparative freshness of the water there, as at the Bell Rock situated so near, the destruction it caused was so great as to be the means of first bringing the species to light.

In March 1834, I saw in the collection of Robert Ball, Esq. of Dublin, a specimen of wood pierced by the Limnoria, which my friend informed me he procured at Yougal, in the county of Cork, four or five years previously; specimens of the Teredo navalis, also shewn me by Mr Ball, were found by him in conjunction with the former species, in the timber of a sluice exposed to the influence of the sea. Mr Ball states, that about eight years ago, he saw several pieces of timber from the harbour of Dunmore, county of Waterford, that were perforated by the Teredo, which caused great destruction there at that time.

When on my way to England on the 27th March, I examined the jetty at Kingston (Dublin Bay), which I am informed has been seven years constructed, and observed that some of the timbers, originally about eight inches thick, and two feet in breadth, have been at the base, or where most under the influence of the sea, entirely eaten away by the Limnoriæ; and that in others, large nails project for nine inches from the present surface of the wood, thereby shewing that the intermediate space has fallen a prey to its ravages. During the two hours I remained there, which were those immediately before and after the extreme of ebb-tide, the part of the jetty which had most suffered, was left dry.

* The entire of this paper (excepting the note on the Teredo, as observed on the western coast of Ireland), was written previous to the publication of Dr Coldstream's excellent article on the subject of the Limnoria terebrans, in the Edinburgh New Philosophical Journal for April 1834, in which the destruction produced by this animal at Leith, is particularly mentioned, as well as (on Mr Stevenson's authority) its occurrence on the coast of France and the Netherlands.

*Audubon's "Birds of America *," and "Ornithological Biography †."*

The second volume of the splendid Illustrations of the Ornithology of the United States, published under the name of the "Birds of America," has been before the public for some time; and the second volume of the "Ornithological Biography," containing descriptions of the birds represented in the work just mentioned, has just made its appearance. This volume has been expected with impatience, and will be read with pleasure, by many besides the author's extended circle of personal friends and patrons; but, before offering our opinion respecting it, we shall make a few remarks on the volume of plates, which we shall view in the twofold light in which they require to be seen;—as scientific representations of birds, and as productions of art calculated to afford pleasure to those who are not ornithologists either in right or in courtesy.

The first plate contains the semblance of an old raven, sagacious, cunning, and mischievous, but withal grave and sedate, like many individuals met with in human society. We do not much admire this plate as the first of so splendid a series, and should have preferred seeing in its place some of those beautiful pigeons or grouse which we find in the volume, or, still more, the fine figure of the golden eagle, the drawing of which nearly cost the artist his life. We have no objection, however, to the rank which the raven here assumes, for he is certainly as *respectable* a bird as any that could be named.

The group of blue jays in the second plate is extremely beautiful. One of them has thrust his bill into a pigeon's egg; another having broken the shell is endeavouring to fix it with his foot, but the ladle has couped, and its savoury contents are streaming over the beard of another, who thrusts himself for-

* The Birds of America, from original drawings. By John J. Audubon, F. R. SS. L. & E. &c. Folio, Vol. II.

† Ornithological Biography, or an Account of the Habits of the Birds of the United States. By John J. Audubon, F. R. SS. L. & E. &c. Super-Royal 8vo. Vol. II.

ward to obtain a share of the plunder. The Canada jay, of which Mr Swainson's "whiskey jack" is the hopeful son, albeit he disclaims the connection, makes a very pleasing picture, backed as it is by the fine foliage of the white oak; and the pileated woodpeckers, grubbing and bickering on an old stump amid clusters of racoon grapes, make us almost forget that gas-light and coal-fire, with which we view them, are not a conflagration of the Ohio woods.

The next plate that strikes us, is that representing the nest of the ferruginous thrush, invaded by a villanous black snake, who is likely to pay for his temerity, for two good neighbours have come to the aid of the distressed birds, and, while one tears the hide of the ugly reptile, another aims a blow at his eye, and a third is ready to pull his tongue out by the root; but, alas! the female has been strangled by the serpent, the nest has been upset, and as yet the issue of the conflict is doubtful.

The snowy owls, perched on the frail twigs of a decayed tree, amid the gloom of a thunder-storm; the young white-headed eagle, screaming for his absent mother; the migratory thrushes, just arrived with a supply of food for their voracious younglings; the meadow-larks, with their nest embowered among the yellow-flowered gerardias; and the beautiful yellow-breasted chats, who have pitched their camp in a pleasant place, among the fragrant leaves and delicately tinted flowers of the sweet-briar, are all objects worthy of the most intense study of the ornithological painter, and the admiration of every lover of Nature's wonderful works.

We have passed over as many sparrows, finches, and fly-catchers, as would suffice to stock a little wood, not because they are not all beautiful and striking, but because where all is admirable it is difficult to select what is most so; and now, having arrived at the 141st plate, we are at once struck with something out of keeping. It is the figure, stiff and straight, of a Stanley hawk, perched on an island a hundred yards off, and yet represented of the natural size, while the tip of his tail covers a tongue of land not ten yards off. The engraver must have stuck this bird in the wrong place, or the artist must have meant it as a caricature, like Hogarth's famous print, in which a man on a distant hill is lighting his pipe at a candle held out of a window in the fore-ground. However this may be, Audubon can afford a bad figure, especially when it has been made, twenty years ago, from a bird which he has not since had an opportunity of seeing. The next plate of sparrow-hawks affords a perfect contrast; for there the most easy and graceful attitudes are exhibited.

The night-hawk, silently gliding among the oak leaves; the sharp-tailed finches, creeping along the stalks of the marsh-plants; the turkey buzzards, which we can almost imagine to smell of carrion; the pleasant nuthatches, ever busy, and therefore never dull; the suspicious crow, watching, from the top of a walnut-tree, the young rustic, who is advancing with an old musket charged with home-made powder and slugs large enough to kill a mammoth; the Caracara kites, making fierce love; and the lovely Zenaida doves, perched among the white and purple blossoms of the anona,—are objects on which we could look long without any abatement of admiration. The delicately-pencilled tawny thrush; the glowing Keywest dove; the loving barn-swallows, which, assuredly, none but Audubon could have so represented; the tiny wood-wren; the huge golden eagle, soaring aloft with a white hare, with which she intends to feast her young, anxiously expecting her in some chasm among the cliffs of the Hudson; and the little ground-doves, not larger than thrushes, are not less beautifully than faithfully pictured. We may expect a tough battle from the two prairie cocks; the boat-tailed grakles are meditating a descent on some swampy rice-field; the willow-grous spies a prowling Indian in the distance; the butcher-bird is burking an unlucky finch for dissection; the jerfalcons are talking of mangled puffins; the little Acadian owl is screaming over a poor mouse; and, lastly, the little horned-lark is quietly dosing close to his young, among a tuft of green moss, not far from American Harbour in Labrador.

All is life, and health, and beauty. Never before were birds so represented, and if ever again they shall be, still Audubon will be the chief of a school, of which it will be said, that it studied nature. Turn now to any volume of plates that you can find, and what presents itself?—not a bird surely, but an effigy stuffed with straw, and more worthy of being burnt than that of a tory statesman by a radical mob. But comparisons and contrasts are quite unnecessary now, and no ingenuous person, after studying the pictures of Audubon, can look with much pleasure on those of any other painter.

After the first volume of the "Ornithological Biography" was published, Mr Audubon returned to America, for the purpose of obtaining additional information respecting the species represented in the second volume of his "Birds of America." Landing at New York, he traversed the districts to the southward, examined a considerable portion of the Floridas, sailed up the sluggish and muddy stream, known by the name of St John's, and visited most of the singular and beautiful low islets that range along the dangerous shores of the peninsula. After this, he followed the coast from the southern point of Florida to the north-eastern extremity of the United States, travelled through the British province of New Brunswick and State of Maine, and returned to New York. His next excursion was, from that city to Eastport in Maine, where he hired a schooner and sailed to Labrador and Newfoundland, after examining the coast of which he returned by Nova Scotia and the Northern States. Among us a naturalist manifests his zeal by travelling from Edinburgh to John o'Groats, or taking a passage in a steam-boat to St Kilda; but the men who march from Cape Sable to Mirimachi must have tougher sinews or more enthusiasm. It is gratifying to find, that in his investigations he has of late been greatly aided by the liberality of the directors of affairs in his native country, who have allowed him the use of the different revenue cutters stationed along the coasts; but even with this aid, the expense incurred by him must be such as can scarcely be repaired by the proceeds of his publications. The result of these wanderings has been the accumulation of much interesting information respecting the habits and distribution of numerous species of birds. The mud flats and coral reefs of the Floridas in particular, abounding as they do in Grallæ and Palmipedes, have afforded much important information regarding the Ardeæ and other genera of these orders; and the granite and moss-clad ridges of Labrador, have supplied numerous facts relative to the birds which pass the summer in that desolate region.

In these volumes are delineated and described eight new species of birds, viz. Bachman's, Macgillivray's, Lincoln's, and Townsend's Finches; Bachman's and Swainson's Warblers;

the Carolina Titmouse, and the Wood Wren. Of birds new to the United States, but previously known, there are six, viz. the Key West and Blue-headed Pigeons, *Columba montana* and *C. cyanocephala;* the Caracara Eagle or Brazilian Kite, *Polyborus vulgaris;* the Mangrove Cuckoo, *Coccyzus Seniculus;* the Pipiry Flycatcher, *Muscicapa dominicensis;* the Hudson's Bay Titmouse, *Parus Hudsonicus;* and the Mango Humming-Bird, *Trochilus Mango.* The American Crow, *Corvus americanus*, has been satisfactorily distinguished from the carrion crow of Europe, with which it was previously confounded; the American Golden-crested Wren, which most authors have considered the same as *Regulus cristatus* of Europe, but which Nuttall has distinguished under the rather inapt name of *R. tricolor*, and Sir W. Jardine, under the strange one of *Regulus reguloides* (the Regulus-like Regulus), has also been clearly shewn to be distinct. On the other hand, *Sylvia Palmarum* of Bonaparte has been found to be *Sylvia petechia* in a particular state of plumage; *Falco niger* of Wilson to be the old bird of *Falco lagopus;* the American Crossbill of the same author and others, to be in no respect different from that of Europe, although Mr Audubon differs from Temminck and most ornithologists, in considering the red plumage to be that of the adult male; and the great Northern Shrike, *Lanius borealis*, to be in all respects the *Lanius Excubitor.* No specific differences, he says, can be pointed out between the American Barn Swallow, *Hirundo rufa*, and the Chimney Swallow of Europe, *H. rustica;* or between the American Barn Owl, and that of the latter continent, although several remarkable circumstances are mentioned with respect to the former, especially its breeding at all seasons, in the southern states at least.

The above results are those most easily pointed out in a notice like the present; but there are others not much less important, which it would be tedious to specify, and to estimate the value of which, we must not only read the work, but compare it with those of A. Wilson, Bonaparte, and Nuttall. Of these, the habits of the Boat-tailed Grakle, *Quiscalus major*, may be pointed out as among the most remarkable, the males deserting the females immediately after incubation commences, and not joining them again until the young and their mothers have come abroad in flocks. The nests of the Barn owl, the Canada Grous, the Willow Partridge, the Goshawk, the Mississippi Kite, the Fish Crow, the Rusty Grakle, the Tree and Fox-coloured Sparrows, the Pine Swamps, Black Poll and Hemlock Warblers, and the Pigeons of the Floridas, have not before been described, at least by any American writer. The migrations of numerous species have been traced to their northern limits; and, in short, much has been added to our knowledge of the hundred and one species of birds described in the volume.

The alleged dulness of the olfactory nerves of the carrion crow and turkey buzzard, the two vultures of the United States, which has brought upon Mr Audubon so much virulent and unornithological abuse, has been most satisfactorily established by experiments instituted by respectable persons in Charleston, and the taste which these birds have for fresh as well as for putrid flesh, which was also obstinately denied, has been testified by Dr Strobel and a number of planters. It will be recollected that the veracity of Audubon was absurdly considered as implicated in this matter. If it should still be doubted by any caviller, so must that of the most respectable individuals, who have subscribed their names to the declaration, that "having witnessed the experiments made on the habits of the vultures of Carolina, commonly called turkey buzzard and carrion crow," they "feel assured that they devour fresh as well as putrid food of any kind, and that they are guided to their food altogether through their sense of sight, and not that of smell." Even were the facts not proved, would it not be worse than absurd to assume the assertion of them as an instance of willing falsehood, and to pronounce the whole of Audubon's observations unworthy of credit, because his experiments on this subject were conceived to be liable to objection? Was Linnæus refused credit, because he alleged that swallows go under water? And is Audubon to be held up as an impostor, because he instituted experiments on the power of smelling in vultures, which experiments have been repeated by trust-worthy persons, and found to produce precisely the same results. O candour, whither hast thou fled?—surely not to Walton Hall.

The manners of the pinnated grous, *Tetrao Cupido*, which were before but imperfectly known, have been fully described, and were we desirous of pointing out the most interesting of Audubon's descriptions, we might select this as one of them. But there are few, indeed, devoid of interest, or such as a person having no special regard for ornithology might not read with pleasure. We shall therefore take the first on the list, that of the raven, as a specimen of the manner in which these biographies are written.

" THE RAVEN, *Corvus Corax*, Linn. Plate CI.

" Leaving to compilers the task of repeating the mass of fabulous and unedifying matter that has been accumulated in the course of ages, respecting this and other remarkable species of birds, and arranging the materials which I have obtained during years of laborious but gratifying observation, I now resume my attempts to delineate the manners of the feathered denizens of our American woods and plains. In treating of the birds represented in the Second Volume of my Plates, as I have done with respect to those of the First, I will confine myself to the particulars which I have been able to gather in the course of a life chiefly spent in studying the birds of my native land, where I have had abundant opportunities of contemplating their manners, and of admiring the manifestations of the glorious perfections of their Omnipotent Creator.

" There, amid the tall grass of the far-extended prairies of the West, in the solemn forests of the North, on the heights of the midland mountains, by the shores of the boundless ocean, and on the bosom of the vast lakes and magnificent rivers, have I sought to search out the things which have been hidden since the creation of this wondrous world, or seen only by the naked Indian, who has, for unknown ages, dwelt in the gorgeous but melancholy wilderness. Who is the stranger to my own dear country that can form an adequate conception of the extent of its primeval woods,—of the glory of those columnar trunks, that for centuries have waved in the breeze, and resisted the shock of the tempest,—of the vast bays of our Atlantic coasts, replenished by thousands of streams, differing in magnitude, as differ the stars that sparkle in the expanse of the pure heavens,—of the diversity of aspect in our western plains, our sandy southern shores, interspersed with reedy swamps, and the cliffs that protect our eastern coasts,—of the rapid currents of the Mexican Gulf, and the rushing tide-streams of the Bay of Fundy,—of our ocean-lakes, our mighty rivers, our thundering cataracts, our majestic mountains, rearing their snowy heads into the calm regions of the clear cold sky? Would that I could delineate to you the varied features of that loved land! But, unwilling, as I always am, to attempt the description of objects beyond my comprehension, you will, I hope, allow me to tell you all that I know of those which I have admired in youth, and studied in manhood,—for the acquisition of which I have braved the enervating heats of the south, and the cramping colds of the north, penetrated the tangled cane-swamp, thrid the dubious trail of the silent forest, paddled my canoe in the creeks of the marshy shore, and swept in my gallant bark o'er the swelling waves of the ocean. And now, kind reader, let me resume my descriptions, and proceed towards the completion of a task, which, with reverence would I say it, seems to have been imposed upon me by Him who called me into existence.

" In the United States, the Raven is in some measure a migratory bird, individuals retiring to the extreme south during severe winters, but returning towards the Middle, Western, and Northern Districts, at the first indications of milder weather. A few are known to breed in the mountainous portions of South Carolina, but instances of this kind are rare, and are occasioned merely by the security afforded by inaccessible precipices, in which they may rear their young. Their usual places of resort are the mountains, the abrupt banks of rivers, the rocky shores of lakes, and the cliffs of thinly-peopled or deserted islands. It is in such places that these birds must be watched and examined, before one can judge of their natural habits, as manifested amid their freedom from the dread of their most dangerous enemy, the lord of the creation.

" There, through the clear and rarified atmosphere, the Raven spreads his glossy wings and tail, and, as he onward sails, rises higher and higher each bold sweep that he makes, as if conscious that the nearer he approaches the sun, the more splendent will become the tints of his plumage. Intent on convincing his mate of the fervour and constancy of his love, he now gently glides beneath her, floats in the buoyant air, or sails by her side. Would that I could describe to you, reader, the many musical inflections by means of which they hold converse during these amatory excursions! These sounds doubtless express their pure conjugal feelings, confirmed and rendered more intense by long years of happiness in each other's society. In this manner they may recall the pleasing remembrance of their youthful days, recount the events of their life, express the pleasure they have enjoyed, and perhaps conclude with humble prayer to the Author of their being for a continuation of it.

" Now, their matins are over; the happy pair are seen to glide towards the earth in spiral lines; they alight on the boldest summit of a rock, so high that you can scarcely judge of their actual size; they approach each other, their bills meet, and caresses are exchanged as tender as those of the gentle Turtle Dove. Far beneath, wave after wave dashes in foam against the impregnable sides of the rocky tower, the very aspect of which would be terrific to almost any other creatures than the sable pair, which for years have resorted to it, to rear the dearly-cherished fruits of their connubial love. Midway between them and the boiling waters, some shelving ledge conceals their eyry. To it they now betake themselves, to see what damage it has sustained from the peltings of the winter tempests. Off they fly to the distant woods for fresh materials with which to repair the breach; or on the plain they collect the hair and fur of quadrupeds; or from the sandy beach pick up the weeds that have been washed there. By degrees, the nest is enlarged and trimmed, and when every thing has been rendered clean and comfortable, the female deposits her eggs, and begins to sit upon them, while her brave and affectionate mate protects and feeds her, and at intervals takes her place.

" All around is now silent, save the hoarse murmur of the waves, or the whistling sounds produced by the flight of the waterfowl travelling towards the northern regions. At length the young burst the shell, when the careful parents, after congratulating each other on the happy event, disgorge some half-macerated food, which they deposit in their tender mouths. Should the most daring adventurer of the air approach, he is attacked with fury and repelled. As the young grow up, they are urged to be careful and silent :— a single false movement might precipitate them into the abyss below ; a single cry during the absence of their parents might bring upon them the remorseless claws of the swift Peregrine or Jerfalcon. The old birds themselves seem to improve in care, diligence, and activity, varying their course when returning to their home, and often entering it when unexpected. The young are now seen to stand on the edge of the nest ; they flap their wings, and at length take courage and fly to some more commodious and not distant lodgment. Gradually they become able to follow their parents abroad, and at length search for maintenance in their company, and that of others, until the period of breeding arrives, when they separate in pairs, and disperse.

" Notwithstanding all the care of the Raven, his nest is invaded wherever it is found. His usefulness is forgotten, his faults are remembered and multiplied by imagination ; and whenever he presents himself he is shot at, because from time immemorial ignorance, prejudice, and destructiveness have operated on the mind of man to his detriment. Men will peril their lives to reach his nest, assisted by ropes and poles, alleging merely that he has killed one of their numerous sheep or lambs. Some say they destroy the Raven because he is black ; others, because his croaking is unpleasant and ominous ! Unfortunate truly are the young ones that are carried home to become the wretched pets of some ill-brought-up child ! For my part, I admire the Raven, because I see much in him calculated to excite our wonder. It is true that he may sometimes hasten the death of a half-starved sheep, or destroy a weakly lamb ; he may eat the eggs of other birds, or occasionally steal from the farmer some of those which he calls his own ; young fowls also afford precious morsels to himself and his progeny ;—but how many sheep, lambs, and fowls, are saved through his agency ! The more intelligent of our farmers are well aware that the Raven destroys numberless insects, grubs, and worms ; that he kills mice, moles, and rats, whenever he can find them ; that he will seize the weasel, the young opossum, and the skunk ; that, with the perseverance of a cat, he will watch the burrows of foxes, and pounce on the cubs ; our farmers also are fully aware that he apprises them of the wolf's prowlings around their yard, and that he never intrudes on their corn-fields except to benefit them ; yes, good reader, the farmer knows all this well, but he also knows his power, and, interfere as you may, with tale of pity or of truth, the bird is a Raven, and, as Lafontaine has aptly and most truly said, " La loi du plus fort est toujours la meilleure !"

" The flight of the Raven is powerful, even, and at certain periods greatly protracted. During calm and fair weather it often ascends to an immense height, sailing there for hours at a time ; and although it cannot be called swift, it propels itself with sufficient power to enable it to contend with different species of hawks, and even with eagles when attacked by them. It manages to guide its course through the thickest fogs of the countries of the north, and is able to travel over immense tracts of land or water without rest.

"The Raven is omnivorous, its food consisting of small animals of every kind, eggs, dead fish, carrion, shell-fish, insects, worms, nuts, berries, and other kinds of fruit. I have never seen one attack a large living animal, as the Turkey Buzzard and Carrion Crow are wont to do; but I have known it follow hunters when without dogs, to feed on the offals of the game, and carry off salted fish when placed in a spring to freshen. It often rises in the air with a shell-fish for the purpose of breaking it by letting it fall upon a rock. Its sight is exceedingly acute, but its smell, if it possess the sense, is weak. In this respect, it bears a great resemblance to our vultures.

"The breeding season of this bird varies, according to the latitude, from the beginning of January to that of June. I have found young Ravens on the banks of the Lehigh and the Susquehannah rivers on the 1st of May; about ten days later on those of the majestic Hudson; in the beginning of June on the island of Grand Manan, off the Bay of Fundy; and at Labrador as late as the middle of July. The nest is always placed in the most inaccessible part of rocks that can be found, never, I believe, on trees, at least in America. It is composed of sticks, coarse weeds, wool, and bunches of hair of different animals. The eggs are from four to six, of a rather elongated oval shape, fully two inches in length, having a ground colour of light greenish-blue, sprinkled all over with small irregular blotches of light purple and yellowish-brown, so numerous on the larger end as almost entirely to cover it. The period of incubation extends to nineteen or twenty days. Only one brood is raised in a year, unless the eggs or young be removed or destroyed. The young remain in the nest many weeks before they are able to fly. The old birds return to the same nest for years in succession; and should one of them be destroyed, the other will lead a new partner to the same abode. Even after the young have made their appearance, should one of the parents be killed, the survivor usually manages to find a mate, who undertakes the task of assisting in feeding them.

"The Raven may be said to be of a social disposition, for, after the breeding season, flocks of forty, fifty, or more, may sometimes be seen, as I observed on the coast of Labrador, and on the Missouri. When domesticated, and treated with kindness, it becomes attached to its owner, and will follow him about with all the familiarity of a confiding friend. It is capable of imitating the human voice, so that individuals have sometimes been taught to enunciate a few words with great distinctness.

"On the ground the Raven walks in a stately manner, its motions exhibiting a kind of thoughtful consideration, almost amounting to gravity. While walking it frequently moves up its wings as if to keep their muscles in action. I never knew an instance of their roosting in the woods, although they frequently alight on trees, to which they sometimes resort for the purpose of procuring nuts and other fruits. They usually betake themselves at night to high rocks, in situations protected from the northerly winds. Possessing to all appearance the faculty of judging of the coming weather, they remove from the higher, wild and dreary districts where they breed, into the low lands, at the approach of winter, when they are frequently seen along the shores of the sea, collecting the garbage that has been cast to land, or picking up the shell-fish as the tide retires. They are vigilant, industrious, and when the safety of their young or nest is at stake, courageous, driving away hawks and eagles whenever they happen to come near, although in no case do they venture to attack man. Indeed, it is extremely difficult to get within shot of an old Raven. I have more than once been only a few yards from one while it was sitting on its eggs, having attained this proximity by creeping cautiously to the overhanging edge of a precipice; but the moment the bird perceived me, it would fly off apparently in much confusion. They are so cunning and wary, that they can seldom be caught in a trap; and they will watch one intended for a fox, a wolf, or a bear, until one of these animals comes up, and is taken, when they will go to it and eat the alluring bait.

"While at Little Macatina Harbour, on the coast of Labrador, in July 1833, I saw a Raven's nest placed under the shelvings of the rugged and fearful rocks that form one side of that singular place. The young were nearly fledged, and now and then called loudly to their parents, as if to enquire why our vessel had come there. One of them, in attempting to fly away, fell into the water. It was secured, when I trimmed one of its wings, and turned it loose on the deck along with some other birds. The mother, however, kept sailing high over the schooner, repeating some notes, which it seems the young one understood, for it walked carefully to the end of the bowsprit, opened its wings, and tried to fly, but being unable, fell into the water and was drowned. In a few days the rest of the family left the place, and we saw no more of them. Some of the sailors, who had come to the harbour eight years in succession, assured me that they had always observed the Ravens breeding there. My whole party found it impossible to shoot one of the old ones, who went to the nest and left it with so much caution, that the task of watching them became irksome. One afternoon I concealed myself under a pile of detached rocks for more than two hours. The young frequently croaked as I was waiting there, but no parent came; so I left the place, but the next moment the female was seen from the deck of the Ripley. She alighted in the nest, fed her young, and was off again before I could reach within shooting distance. It was at this place that I observed how singularly well those birds could travel to and from their nest, at a time when I could not, on account of the fog, see them on wing at a greater distance than twenty or thirty yards. On the 29th of the same month, young Ravens were seen in flocks with their parents, but they were already very shy.

"I found a nest of this bird at a narrow part of the Lehigh in Pennsylvania, in a deep fissure of the rocks, not more than twenty feet above the water, the security afforded by which had probably been considered as equivalent to that which might have been gained by a greater height of rock. The nest, in fact, hung over the stream, so that it was impossible to reach it either from above or from below. Many years ago, I saw another placed immediately beneath the arch of the Rock Bridge in Virginia. It was situated on a small projecting stone scarcely a foot square; yet the Raven appeared quite satisfied as to the security of her brood on that narrow bed. This extraordinary production of nature is placed on the ascent of a hill, which appears to have been rent asunder by some convulsion of the earth. The fissure is about 200 feet deep, and above 80 in width under the arch, narrowing to 40 or so at the bottom. The thickness of the arch probably exceeds 30 feet, and increases at either end. At the bottom is seen the water of what is called Cedar Creek, gently meandering in its rocky channel. The place, when I saw it, was graced by handsome trees, and in some positions there was a pleasing view of the 'Blue Ridge' and the 'North Mountain.' Tradition reports that General Washington threw a dollar over the bridge from the creek below. I may mention, that I passed it under peculiar circumstances connected with my ornithological pursuits, as you will find detailed in another page of this volume.

"I have already stated that some Ravens breed as far south as the Carolinas. The place to which they resort for this purpose is called the Table Mountain, which is situated in the district of Pendleton, and of which I extract an account from Drayton's views of South Carolina. 'The Table Mountain is the most distinguished of all the eminences of the State. Its height exceeds 3000 feet, and thirty farms may be discerned at any one view from its top by the unaided eye. Its side is an abrupt precipice of solid rock, 300 feet deep, and nearly perpendicular. The valley underneath appears to be as much below the level as the top of the mountain towers above it. This precipice is called the Lover's Leap. To those who are in the valley, it looks like an immense wall stretching up to heaven, and the awe which it inspires is considerably increased by the quantities of bones which lie whitening at its base,—the remains of various animals which had incautiously approached too near its edge. Its summit is often enveloped in clouds. The gradual ascent of the country from the sea-coast to this western extremity of the State, added to the height of this mountain, must place its top more than 4000 feet above the level of the Atlantic Ocean; an eminence from which vessels crossing the bar of Charleston might be seen with the aid of such improved glasses as are now in use. Large masses of snow tumble from the side of this mountain in the winter season, the fall of which has been heard seven miles. Its summit is the resort of deer and bears. The woods produce mast in abundance; wild pigeons resort to it in such numbers as sometimes to break the limbs of trees on which they alight.'

"A friend of mine, who is an excellent observer of the habits of birds, has told me that he saw a Raven's nest in the high lands of New York placed in a deep fissure of a rock, in the immediate vicinity of that of a Golden Eagle. I chanced one day, while in the Great Pine Forest of Pennsylvania, to stop, for the purpose of resting and refreshing myself, at a camp of the good Jediah Irish, with whom I have already made you acquainted during my former rambles in that remarkable district. We had seen some Ravens that day, and our conversation returning to them, the person employed in preparing the food of the woodcutters told us, that whenever she chanced to place a salt mackerel or other fish in the brook running from the spring near the camp, 'the Raven was sure to carry it away in less than an hour.' She firmly believed that it had the power of smelling the fish as she carried it from the hut to the water. We went to the spot with her, and, leaving a fish there, returned to our homely meal, but on visiting the place several hours after, we found it untouched. 'The Raven perhaps smelt the powder in our guns!' At all events, it did not choose to come that day."

The episodes or tail-pieces with which the work is interspersed, are in general interesting, and several of them are calculated to inform the reader of the nature of the districts in which many of the birds described are most abundantly found. The articles entitled "The Squatters of the Mississippi" and "The Squatters of Labrador," give an idea of the mode of life of the persons who have settled along the unhealthy banks of that great stream, and the sterlile shores of that dreary region. "Spring Garden," "St John's River," "The Live Oakers," and "The Florida Keys," are descriptive of the flat, swampy and "barreny" wilds of Florida, and the numerous islands that skirt its coasts. The "Turtlers" contains some interesting information respecting the habits and parturition of the four species of Turtle that occur on the southern coasts, and the "Merchant of Savannah" is a tribute of gratitude to a generous individual, William Gaston, in Savannah, who exerted himself most effectually in Mr Audubon's behalf. His countrymen, in fact, are now beginning to appreciate his merits, the American names on his subscription list are numerous, and we trust, that they may increase so as to render him a recompense for all the fatigues and privations which he has undergone during his many and long wanderings. But when his country has rendered him due honour, let him not forget that to England alone he owed the commencement of his fame, and that when America refused the unknown wanderer of the woods a seat among her naturalists, Scotland unhesitatingly conferred on him the honours which his zeal, his enthusiasm, and the success of his labours, so well merited, and England followed her example. We speak of Audubon as of one whom we know. We have not only examined his works with attention, but we have seen the original drawings and manuscripts from which they were prepared for the public eye; and whatever others may have said, we know that he is undoubtedly the author of all of which he claims the authorship. Who else, we would ask, could have drawn those birds as they are drawn? Where is the man who can show any to rival them? and if there be those who might produce technical descriptions more accurate, yet there are none who could afford the information given in his biographies: or if there be, let them produce them, and we will read them with not less pleasure. Like all remarkable men, Mr Audubon has had his share of vituperation; but the time will be, although it cannot benefit him, when his works will be referred to as among the most perfect productions of our times. He will then sleep with the illustrious of bygone ages, and the glory of his name will not awaken a thrill of delight in his heart, which will have long ceased to be agitated by the feelings and passions that man must experience in his pilgrimage through life.

Meteorological Observations made at Castle Toward, in Argyllshire.

We are happy to be able to communicate to our readers an interesting series of meteorological tables. Having learned that Kirkman Finlay, Esq. of Castle Toward, in the county of Argyll, has been in the habit, for a series of years, of making regular daily observations on the state of the weather at that place, we expressed to him our regret that such records should be confined to his private circle, convinced that a regular communication of them to the public would be considered a valuable contribution to science. Castle Toward is situated on the western shore of the Frith of Clyde, opposite to Rothsay, in the Island of Bute, a strait of about two miles breadth lying between them, and, from the mildness of the climate, Rothsay has been long recommended by medical men as a safe winter residence for invalids; we doubt not, therefore, that these very accurate tables will be peculiarly acceptable to medical men. Mr Finlay most obligingly acceded to our request, and has given the General Monthly Results for the last five years, together with the Daily Observations for the whole of the year ending the 30th September 1834. In future Mr Finlay is to communicate a quarterly report of the daily observations.

Castle Toward is situated in Long. 4° 58′ W., and in N. Lat. 55° 50′. The situation where the barometer, thermometer, and rain-guage are placed, is about 120 feet above the level of the sea, and at a distance of half a mile to the north, a hill rises to the height of 1100 feet above that level. The term "frosty" is to be understood to mean, a day on which there was any frost: the thermometrical observation of the day shews the degree of it.

General Monthly Results for the Years 1829, 1830, 1831, 1832, and 1833.

	Atmospheric Variations.				State of the Wind, taken at Noon.								Atmospheric Pressure.			External Ther. in the shade.			Fall of Rain.
	Wet and Stormy.	Fair.	Frosty.	Snow and Hail.	East.	South-east.	South.	South-west.	West.	North-west.	North.	North-east.	Lowest.	Highest.	Mean.	Lowest.	Highest.	Mean.	
1829.																			
Jan.	5	22	15	4	18	2	1	...	...	5	1	4	29.05	30.37	29.76	26	43	34½	1.15
Feb.	15	13	6	...	9	3	2	1	7	5	...	1	29.35	30.45	29.90	31	48	39½	2.30
Mar.	6	22	14	3	14	2	4	...	1	4	2	4	29.13	30.45	29.79	34	47	40½	2.10
April	15	15	5	...	13	1	2	3	2	5	1	3	28.70	30.17	29.43	36	49	42½	2.30
May	9	22	1	...	10	2	4	2	4	7	1	1	29.30	30.65	29.97	43	60	51½	3.30
June	15	15	2	...	7	3	5	3	6	5	...	1	29.53	30.40	29.96	50	63	56½	3.70
July	15	16	...	...	7	1	9	4	1	8	...	1	29.10	30.20	29.65	53	62	57½	4.20
Aug.	18	13	...	...	7	2	3	2	2	12	1	2	29.0	30.54	29.77	51	62	56½	6.70
Sept.	15	15	6	...	3	3	3	2	3	14	...	2	29.22	30.17	29.69	45	60	52½	3.60
Oct.	16	15	8	...	4	...	1	11	2	7	3	3	29.38	30.50	29.94	42	55	47½	5.90
Nov.	17	13	5	...	9	3	...	2	3	8	3	2	29.50	30.50	29.55	35	51	43	5.20
Dec.	13	15	9	3	11	4	8	3	...	1	1	3	29.67	30.73	30.20	31	51	41	2.75
	159	196	71	10	122	26	42	23	31	81	13	27							43.55
1830.																			
Jan.	10	14	9	7	7	4	...	3	1	7	4	5	29.28	30.79	30.03	30	45	37½	1.35
Feb.	15	5	10	8	4	2	2	5	2	10	2	1	29.02	30.38	29.70	24	47	35½	4.15
Mar.	19	11	...	1	6	2	3	8	6	4	...	2	29.12	30.60	29.86	34	53	43½	5.80
April	16	13	4	1	7	4	5	6	1	5	1	1	29.02	30.15	29.58	31	60	45½	4.20
May	19	12	1	...	15	...	2	6	4	4	...	...	29.22	30.17	29.69	45	65	55	4.80
June	13	17	3	...	7	1	3	3	4	11	1	...	29.60	30.37	29.98	48	58	53	2.80
July	20	11	...	...	5	3	10	4	1	7	...	1	29.32	30.42	29.87	53	67	60	5.30
Aug.	11	20	1	...	8	2	4	3	3	9	1	1	29.22	30.29	29.75	51	60	55½	4.20
Sept.	16	14	1	...	5	3	7	8	2	5	...	...	29.09	30.27	29.68	49	57	53	9.20
Oct.	13	18	5	...	5	5	1	5	5	7	2	1	29.50	30.57	30.03	43	57	50	2.90
Nov.	20	10	1	...	4	4	7	7	1	4	2	1	28.91	30.42	29.66	38	55	46½	5.20
Dec.	18	12	10	1	9	2	1	3	...	8	3	5	29.03	30.49	29.76	21	47	34	3.95
	190	157	45	18	72	32	45	61	32	81	16	18							53.70

General Monthly Results—*continued.*

	Atmospheric Variations.				State of the Wind, taken at Noon.								Atmospheric Pressure.			External Ther. in the shade.			Fall of Rain.
	Wet and Stormy.	Fair.	Frosty.	Snow and Hail.	East.	South-east.	South.	South-west.	West.	North-west.	North-east.	North.	Lowest.	Highest.	Mean.	Lowest.	Highest.	Mean.	
1831.																			
Jan.	8	21	12	2	12	...	2	1	1	4	6	5	29.50	30.57	30.03	28	46	37	2.
Feb.	15	8	5	5	4	...	7	1	2	7	1	6	29.05	30.37	29.71	28	48	36	5.30
Mar.	17	14	2	...	6	3	5	8	3	4	1	...	29.12	30.67	29.89	37	47	42	7.40
April	12	18	7	...	17	5	...	4	1	3	...	...	29.12	30.74	29.93	39	51	45	2.30
May	9	22	5	...	18	4	4	...	1	3	...	1	29.44	30.40	29.92	38	60	49	2.20
June	11	19	...	...	4	2	10	1	2	6	...	3	29.52	30.29	29.90	55	63	59	2.70
July	13	18	...	...	5	...	6	9	4	4	3	...	29.40	30.40	29.90	52	66	59	3.20
Aug.	13	18	...	...	11	1	6	5	1	3	...	4	29.50	30.40	29.95	54	68	61	5.60
Sept.	17	13	...	...	9	3	6	7	...	3	2	...	29.55	30.30	29.92	53	60	56	4.10
Oct.	20	11	1	...	7	2	7	9	3	2	...	...	29.14	30.40	29.77	46	59	52	8.50
Nov.	17	13	7	3	8	...	6	...	3	8	2	3	29.0	30.60	29.75	31	53	42	6.85
Dec.	16	15	2	...	5	2	7	6	1	3	6	...	28.90	30.60	29.75	31	49	40	5.90
	168	190	41	10	106	22	66	51	22	50	21	22							56.05
1832.																			
Jan.	16	13	...	2	8	2	5	7	2	4	2	1	29.49	30.34	29.91	30	48	39	2.40
Feb.	13	18	7	...	5	4	8	5	1	5	1	...	28.98	30.60	29.79	35	49	42	2.80
Mar.	19	12	8	5	3	...	5	5	2	14	1	...	29.07	30.53	29.80	39	48	43½	5.35
April	13	15	3	...	13	1	3	7	...	3	1	2	29.38	30.54	29.96	44	51	47½	2.70
May	11	18	4	1	10	2	1	3	2	6	4	3	29.30	30.57	29.93	40	57	48½	1.90
June	16	14	...	...	10	3	3	5	2	6	...	1	29.43	30.47	29.95	53	60½	56	2.70
July	11	20	...	...	8	...	3	3	1	15	...	1	29.64	30.42	39.03	53	62	57	2.70
Aug.	13	18	1	..	11	...	5	11	1	1	2	...	29.48	30.19	29.83	51	63	57	3.40
Sept.	16	14	...	...	6	1	2	7	4	7	3	...	29.52	30.60	30.05	51	58	54⅓	3.20
Oct.	17	15	1	...	4	2	7	10	1	6	1	...	29.20	30.50	29.85	45	58	51½	6.30
Nov.	17	13	6	...	3	5	7	3	1	5	2	4	28.98	30.54	29.76	34	50	42	5.0
Dec.	20	11	8	4	2	2	3	10	3	5	3	2	29.15	30.35	29.75	33	50	41½	7.80
	182	191	38	12	83	22	52	76	20	76	20	14							46.25
1833.																			
Jan.	9	20	13	2	15	2	6	3	1	...	2	2	29.49	30.74	30.11	31	42	36⅓	1.20
Feb.	21	6	4	1	7	1	5	5	4	4	2	...	28.68	30.19	29.43	32	47	39½	6.80
Mar.	9	21	11	1	13	4	3	...	...	5	5	1	28.90	30.55	29.72	35	45	40	1.20
April	18	12	2	...	5	1	5	7	2	4	5	1	29.15	30.37	29.76	41	51	46	2.60
May	10	21	1	...	5	4	10	5	...	3	3	1	29.07	30.52	29.79	46	59	52⅓	2.50
June	18	12	...	...	6	3	8	4	2	7	...	...	29.45	30.21	29.83	50	61	55⅓	5.15
July	15	16	...	...	10	2	2	4	3	9	1	...	29.41	30.60	29.55	50	65	57⅓	2.85
Aug.	14	17	...	...		..	3	3	7	12	2	...	29.43	30.54	29.96	50	61	55⅓	2.55
Sept.	17	13	...	...	7	3	7	5	1	2	5	...	29.11	30.45	29.78	48	59	53⅓	5.60
Oct.	20	11	2	...	6	2	6	7	2	5	1	2	28.99	30.33	29.66	44	55	49½	6.15
Nov.	17	13	4	...	4	1	8	2	5	7	2	1	29.02	30.29	29.60	37	55	46	6.80
Dec.	25	6	3	...	1	1	2	10	5	8	2	2	29.0	30.10	29.05	32	48	40	12.0
	193	168	40	4	83	24	65	55	32	56	30	10							55.40

DAILY OBSERVATIONS FROM 1ST JANUARY TO 30TH SEPTEMBER 1834.

Date.	9 o'clock A. M.			6 o'clock P. M.			OBSERVATIONS.
	Bar.	Ther.	Wind.	Bar.	Ther.	Wind.	RAIN FALLEN IN JANUARY, 10 Inches. Do. IN FEBRUARY, 3 do. 50 Hundr.
Jan. 1	29.69	46	NW.	30.	40	N.	Fine day, strong breeze.
2	30.40	37	N.	30.33	38¼	SE.	Fine day, frost A. M., gloomy evening.
3	29.80	47	W.	29.74	47	NW.	Very stormy and showery.
4	30.11	39	E.	30.5	39½	E.	Fine A. M., gloomy and wet P. M.
5	29.90	45¼	E.	29.72	45½	S.	Very misty and wet A. M., fair but cloudy P. M.
6	29.50	47	S.	29.12	47	S.	Showery and stormy.
7	29.39	41	SW.	29.41	38¼	S.	Beautiful day.
8	29. .8	38½	E.	29.50	43	E.	Stormy and wet.
9	29.40	41	E.	29.19	42	SE.	Stormy with a few drops of rain.
10	29.10	41	SE.	29.14	41	E.	Fine, but stormy.
11	29.14	43	SE.	29.18	44	SE.	Very showery.
12	29.	45	S.	29.20	44	S.	Wet day.
13	29.42	42	S.	29.22	43	SE.	Showery and gloomy.
14	29.42	44	SW.	29.50	42	S.	Beautiful day.
15	29.44	42	E.	29.44	44	S.	Beautiful day.
16	29.20	45	SW.	29.10	45	S.	Stormy and cloudy, heavy rain P. M.
17	28.90	43	S.	28.90	46	S.	Very wet A. M., stormy. with thunder, P. M.
18	29.5	45	W.	29.40	44	W.	Very stormy and showery.
19	29.45	41	W.	29.55	40	N.	Stormy, heavy showers all day.
20	29.76	42	W.	29.53	45	S.	Cloudy A. M., very wet P. M.
21	29.45	48	W.	29.55	46	S.	Cloudy, very wet A. M.
22	29.45	45	W.	29.58	43	SW.	Stormy and showery.
23	29.31	46½	W.	29.41	44	W.	Very wet A. M., stormy with showers, P. M.
24	29.57	47	SW.	29.47	42	W.	Stormy A. M., stormy and showery P. M.
25	29.93	44	W.	30.4	40	N.	Stormy and showery A. M., beautiful P. M.
26	29.45	44	NW.	29.59	38¼	NW.	Very stormy, heavy showers of hail and rain.
27	29.69	40½	NW.	29.68	41	W.	Fine day, one shower A. M.
28	29.39	37	NW.	29.59	38¼	NW.	Showery morning, fine day.
29	30.38	36	NE.	30.36	38	S.	Beautiful day, hard frost A. M.
30	30.	43	W.	30.97	43	E.	Wet morning, fine day.
31	29.70	45¼	S.	29.78	42½	S.	Very wet and stormy.
Feb. 1	30.10	41	SW.	30.13	40	E.	Fine day.
2	30.2	35½	E.	29.87	40½	E.	Very gloomy morning, fine day.
3	29.72	44	S.	29.73	44½	S.	Stormy, slight rain A. M.
4	29.70	41	SE.	29.70	41	SW.	Wet and stormy A. M., fine P. M.
5	29.60	41	SE.	29.51	45	S.	Stormy morning, very wet stormy day.
6	29.85	38	S.	29.84	38	S.	Beautiful A. M., stormy, with a hail shower, P. M.
7	30.2	40	SW.	30.9	41½	SW.	Fine day, frost A. M.
8	30.20	39½	N.	30.25	40	SE.	Most beautiful day.
9	30.31	41½	N.	30.37	40	E.	Dull morning, fine day.
10	30.15	44	SW.	30.15	42	SW.	Very wet morning, fine day.
11	29.97	44	SW.	29.78	43½	S.	Stormy and gloomy.
12	29.32	39	NW.	29.49	35	NW.	Stormy, heavy showers of hail and rain.
13	30.2	38½	NW.	30.15	44	SW.	Beautiful, with frost, A. M., wet P. M.
14	30.32	46	NW.	30.38	45½	NW.	Dull morning, beautiful day.
15	30.40	44	NW.	30.43	47	NW.	Most beautiful day, strong breeze.
16	30.45	42½	SW.	30.30	43	SW.	Very misty A. M., misty and showery P. M.
17	30.11	44½	W.	30.	46	W.	Very wet and stormy.
18	29.82	47	W.	29.70	47½	W.	Very stormy A. M., stormy and cloudy P. M.
19	29.50	41	W.NW.	29.69	39	W.NW.	Very stormy, heavy showers of hail and rain.
20	29.89	38	NW.	29.45	39	S.	Stormy and gloomy A. M., very wet P. M.
21	29.90	37½	NW.	30.8	40¼	NW.	Very squally, heavy showers of hail.
22	30.28	39	SE.	30.	44½	S.	Wet A. M., stormy P. M.
23	29.90	44½	SW.	30.	41	SW.	Stormy and showery.
24	29.82	43	SW.	29.78	39	NW.	Stormy, with heavy showers.
25	30.19	40	NW.	30.14	45½	SW.	Stormy and showery.
26	30.12	47	S.	29.91	46½	S.	Fine day, high wind.
27	29.89	41	NW.	29.94	42	NW.	Beautiful A. M., cloudy P. M
28	30.30	37½	NE.	30.32	42	SE.	Beautiful day, frost A. M.

Daily Observations—*continued.*

Date.	9 o'clock A. M. Bar.	Ther.	wind.	6 o'clock P. M. Bar.	Ther.	Wind.	Observations. Rain Fallen in March, 4 Inches 30 Hundredths. Do. in April, 0 do. 40 do.
Mar. 1	30.15	30	NW.	30.20	45	NW.	Fine day, one shower P. M.
2	30.32	44½	NW.	30.32	44	NW.	Showery A. M., beautiful P. M.
3	30.20	45	S.	30.15	46	S.	Showering and blowing A. M., fair P. M.
4	29.80	47	S.	30.50	46	S.	Very wet and rough A. M., showery and rough P. M.
5	29.22	46	SW.	29.30	42	SW.	Tempestuous day with showers.
6	29.49	41½	SW.	29.45	41½	W.	Very stormy and showery.
7	29.83	41½	SW.	29.93	43	W.	Very squally and showery.
8	29.75	44½	W.	30.1	42	W.	Very rough, thunder, lightning, rain, and hail.
9	30.30	46	W.	30.22	49	SW.	Wet day.
10	30.29	47	NW.	30.37	47½	NW.	Very fine day.
11	30.40	47½	SW.	30.42	47	SW.	Fine day.
12	30.32	48	S.	30.50	47½	E.	Gloomy A. M., beautiful P. M.
13	30.42	46½	NW.	30.40	47	NW.	Fine day.
14	30.53	44	N.	30.58	47	N.	Most beautiful day.
15	30.65	46½	N.	30.65	48	N.	Most beautiful day, frost A. M.
16	30.65	40	N.	30.61	48	N.	Most beautiful day, frost A. M.
17	30.61	46½	E.	30.60	46	E.	Very fine, but cloudy.
18	30.63	43	E.	30.63	44	E.	Fine, but cloudy.
19	30.60	42	SE.	30.57	43	S.	Cloudy A. M., beautiful P. M.
20	30.53	39	E.	30.51	41	NE.	Most beautiful day, hard frost A. M.
21	30.47	40½	N.	30.30	44	S.	Misty, with frost, A. M., beautiful P. M.
22	29.88	39	W.	29.90	38½	NW.	Stormy wet morn., stormy day, showers of hail and rain.
23	29.50	47½	W.	29.52	43	W.	Very stormy and wet A. M., stormy and showery P. M.
24	29.80	39	NW.	29.95	39	N.	Very stormy, slight hail shower.
25	30.7	36	N.	30.14	41	N.	Beautiful, hard frost A. M.
26	30.19	39	W.	30.10	45	W.	Cloudy, with hard frost, A. M., wet P. M.
27	29.99	45	S.	29.80	43	W.	Stormy and showery.
28	29.11	46½	W.SW.	29.13	42½	SW.	Very stormy, with heavy showers.
29	29.39	37	SW.	29.50	41½	W.	Very stormy, heavy showers of hail, snow, and rain.
30	29.74	37	W.	29.80	38	W.	Very heavy showers of rain and hail all day.
31	29.85	40	S.	29.85	43	NW.	Very showery, frost A. M.
Apr. 1	30.20	42½	S.	30.12	44½	S.	Very wet day.
2	30.31	48	W.	30.15	48	W.	Very showery.
3	30.33	43	NW.	30.48	45	NW.	Stormy and showery.
4	30.48	47	W.	30.42	47	NW.	Stormy, few drops of rain.
5	30.37	45	NW.	30.37	47	NW.	Fine A. M., stormy P. M.
6	30.41	46¼	NW.	30.38	46	W.	Fine day.
7	30.42	48	SW.	30.40	50	NW.	Cloudy, slight rain A. M., beautiful P. M.
8	30.50	44	E.	30.50	45	E.	Fine but cloudy.
9	30.55	40	SE.	30.55	40½	SE.	Cloudy and windy.
10	30.56	42	E.	30.50	45	E.	Beautiful day.
11	30.53	38	N.	30.40	45	NE.	Beautiful day, hard frost A. M.
12	30.38	43½	NE.	30.48	44	E.	Fine but cloudy.
13	30.41	44	NE.	31.41	46	E.	Cloudy.
14	30.41	44	S.	30.37	46½	S.	Beautiful day, cloudy morning.
15	30.40	46½	S.	30.41	48½	S.	Cloudy, few drops of rain.
16	30.43	48	S.	30.43	51	N.	Very fine day.
17	30.40	48	E.	30.38	52	SE.	Blowy morning, fine day.
18	30.38	47¼	E.	30.38	46	E.	Stormy and gloomy.
19	30.44	47	E.	30.40	51	S.	Most beautiful day.
20	30.40	48	SW.	30.35	53	NW.	Most beautiful day.
21	30.47	48	E.	30.43	53	SW.	Most beautiful day.
22	30.41	48	N.	30.36	55	NW.	Cloudy A. M., beautiful P. M.
23	30.40	47½	E.	30.40	52	N.	Beautiful day.
24	30.40	48	NW.	30.32	51¼	NW.	Beautiful day.
25	30.25	53½	N.	30.32	52½	NW.	Very fine day.
26	30.10	49	S.	29.99	51	S.	Beautiful day.
27	29.65	48½	E.	29.55	51	S.	Very fine day.
28	29.41	40½	E.	29.55	51	E.	Very stormy, shower of sleet A. M.
29	29.65	43	E.	29.65	45½	E.	Very stormy, few drops of rain.
30	29.60	44½	E	29.60	46¼	E.	Stormy, few drops of rain.

DAILY OBSERVATIONS—*continued.*

Date.	9 o'clock A. M.			6 o'clock P. M.			OBSERVATIONS.
	Bar.	Ther.	Wind.	Bar.	Ther.	Wind.	RAIN FALLEN IN MAY, 2 Inches 75 Hundredths. Do. IN JUNE, 4 do. 60 do.
May 1	29.76	46	E.	29.74	49	E.	Blowy and showery.
2	29.80	50	S.	29.78	49½	SE.	Showery day.
3	29.84	50½	S.	29.89	51	S.	Misty A. M., beautiful day.
4	29.80	52	S.	29.71	54¼	S.	Showery.
5	29.78	52½	S.	29.81	52	S.	Cloudy and showery A. M., blowy with sunshine P. M.
6	30.9	52¾	S.	30.9	51½	SE.	Cloudy A. M., very wet P. M.
7	30.22	55	SW.	30.29	57¾	W.	Very fine day.
8	30.19	55	S.	29.89	51¾	SW.	Fine A. M., very wet P. M.
9	29.85	51	NW.	29.82	50	NW.	Fine A. M., blowy, one shower, P. M.
10	29.87	45½	NW.	29.90	50	NW.	Showery and stormy.
11	29.72	50	S.	29.60	48	S.	Blowy and showery.
12	29.55	51	S.	29.62	53	SW.	Blowy and showery.
13	29.70	52	E.	29.51	54	S.	Gloomy morning, most beautiful day.
14	29.61	50	W.	29.74	54	SW.	Showery A. M., beautiful P. M.
15	30.	53	E.	30.10	59½	NW.	Most beautiful day.
16	30.1	52	E.	29.79	51	NW.	Gloomy A. M., bright sunshine till 3 P. M., wet evening.
17	29.51	50	S.	29.36	52	S.	Very fine, but cloudy.
18	29.29	51½	NW.	29.39	52	NW.	Blowy, with slight showers.
19	29.54	49¾	S.	29.74	49	W.	Very wet morning, blowy and showery day.
20	30.10	49	SW.	30.22	52¼	W.	Very showery and blowy.
21	30.57	54	SW.	30.60	55	W.	Most beautiful day.
22	30.60	54	E.	30.50	59	SW.	Most beautiful day.
23	30.50	53	E.	30.47	64	NW.	Most beautiful day.
24	30.60	56	E.	30.62	57½	E.	Beautiful day, but very blowy.
25	30.70	53	E.	30.62	57	E.	Very fine day, but windy.
26	30.61	53½	E.	30.45	60	SE.	Most beautiful day.
27	30.56	56¾	E.	30.45	66½	NW.	Most beautiful day.
28	30.37	60	S.	30.27	65	NW.	Most beautiful day.
29	30.19	59½	E.	30.11	64¼	NW.	Most beautiful day.
30	30.22	54	E.	30.23	61	E.	Most beautiful day.
31	30.30	58	S.	30.30	61	E.	Most beautiful day.
June 1	30.28	57	E.	30.15	58	S.	Blowy and cloudy.
2	30.11	59	S.	29.99	59	S.	Blowy and cloudy, few drops of rain.
3	29.90	55	SW.	29.91	58	S.	Showery and blowy A. M., fine P. M.
4	29.75	54	SW.	29.81	56½	S.	Blowy and showery morning, fine day.
5	29.90	57	NW.	29.99	58	NW.	Fine day, high wind.
6	30.20	58	NW.	30.20	56½	NW.	Very fine day.
7	30.17	57	SW.	30.9	56¾	SW.	Fine day.
8	29.90	57	S.	29.78	55½	S.	Showery day.
9	29.70	57½	SE.	29.60	56	S.	Showery A. M., windy P. M.
10	29.61	56	S.	29.55	56	SW.	Beautiful morning, showery day.
11	29.53	55½	S.	29.59	57	S.	Windy, but fine.
12	29.64	53	S.	29.61	55¼	S.	Showers of rain and hail.
13	29.62	53	W.	29.73	57	W.	Showery A. M., beautiful P. M.
14	29.50	55	E.	29.49	56½	S.	Very rough, with heavy rain.
15	29.78	56	S.	29.70	58	S.	Fine day.
16	29.39	56	S.	29.45	55	N.	Fine A. M., showery P. M.
17	29.59	54	W.	29.79	59	NW.	Showery A. M., blowy P. M.
18	29.89	56	SW.	29.80	56	NW.	Very wet day.
19	29.97	56	SW.	29.75	54½	S.	Fine morning, very wet day.
20	30.4	56	NW.	29.99	56	S.	Fine till 4 o'clock P. M., showery afternoon.
21	29.71	58	S.	29.72	57	S.	Blowy A. M., showery P. M.
22	29.80	54	SW.	29.90	56	NW.	Cloudy A. M., beautiful P. M.
23	30.15	56½	S.	30.10	54	S.	Windy A. M., very showery P. M.
24	30.8	56	S.	30.15	59	NW.	Showery A. M., fine P. M.
25	30.20	57	S.	30.15	59	NW.	Very showery.
26	30.20	56½	NW.	30.	57	SW.	Cloudy, heavy rain in the morning.
27	30.30	56	NW.	30.30	56½	NW.	Beautiful day.
28	30.22	57¼	S.	30.18	56½	E.	Fine A. M., one shower P. M.
29	30.35	57	E.	30.40	62¾	E.	Most beautiful day, wind in the morning.
30	30.50	59	NW.	30.48	60	NW.	Most beautiful day.

Daily Observations—*continued.*

Date.	9 o'clock A. M.			6 o'clock P. M.			Observations.
	Bar.	Ther.	Wind.	Bar.	Ther.	Wind.	Rain fallen in July, 3 Inches 40 Hundredths. Do. in August, 3 do. 50 do.
July 1	30.48	59	E.	30.37	66	W.	Most beautiful day.
2	30.29	62	N.	30.19	64	N.	Most beautiful day.
3	30.20	60	N.	30.20	66¼	NW.	Lovely day.
4	30.30	60	E.	30.27	68	N.	Most beautiful day.
5	30.25	64	E.	30.18	69	SE.	Beautiful day, strong breeze.
6	30.15	62	E.	30.5	65½	E.	Blowy and sultry.
7	29.92	62	E.	29.87	61¼	S.	Showery day.
8	29.88	60	W.	29.95	59¼	NW.	Very wet morning, showery day.
9	30.1	50½	NW.	30.13	62¼	S.	Fine day.
10	29.90	56½	SE.	29.89	61	W.	Very wet day, beautiful evening.
11	29.94	58½	SW.	29.80	58	S.	Fine A. M., showery afternoon.
12	29.62	55½	S.	29.60	57½	S.	Very showery and stormy.
13	29.62	56	SW.	29.71	57	SW.	Stormy wet day.
14	29.95	59	SW.	30.	60½	S.	Cloudy, with slight showers.
15	30.4	56	S.	30.4	58	NW.	Very wet day.
16	30.14	57	SW.	30.4	59	SW.	Very wet day.
17	30.19	58	W.	30.19	60	W.	Very fine day.
18	30.10	59	E.	30.	59½	E.	Blowy and gloomy.
19	29.87	55	E.	29.77	58½	E.	Gloomy, with slight showers A. M., very wet P. M.
20	29.70	62	E.	29.80	63	E.	Fine day, high wind.
21	29.90	60½	E.	29.92	64¼	E.	Beautiful A. M., fine, one slight shower, P. M.
22	30.	62	E.	30.4	66¼	NW.	Most beautiful day.
23	30.13	63	S.	30.18	63½	E.	Beautiful till 4 P. M., very wet afterwards.
24	30.20	61	SE.	30.12	64	SW.	Very cloudy A. M., beautiful P. M.
25	30.9	59	W.	30.1	61	W.	Cloudy, with slight showers.
26	29.81	56	W.	29.79	57	NE.	Cloundy, heavy shower P. M.
27	30.	63	E.	30.10	67	E.	Blowy A. M., beautiful P. M.
28	30.22	61	E.	30.25	65	E.	Beautiful day, strong breeze P. M.
29	30.22	62	E.	30.17	66¼	E.	Beautiful day, very blowy A. M.
30	30.9	67	E.	30.8	73	E.	Beautiful, but very blowy.
31	30.4	69	E.	30.2	75¼	E.	Most beautiful day.
Aug. 1	30.9	69	E.	30.7	69	E.	Most beautiful day.
2	30.10	61½	E.	30.	70	E.	Cloudy morning, beautiful day.
3	29.90	65½	E.	29.85	68	E.	Most beautiful day, thunder in the evening.
4	29.89	63	S.	29.83	65	S.	Dull morning, with a little rain, beautiful day.
5	29.68	60	S.	29.60	60	S.	Wet morning, blowy day.
6	29.67	62	S.	29.62	58½	S.	Stormy A. M., wet and stormy P. M.
7	29.78	60	SW.	29.79	62	SW.	Blowy A. M., fine P. M.
8	29.78	61	W.	29.90	61	NW.	Showery day.
9	30.10	61	NW.	30.17	61	NW.	Fine day, with a breeze.
10	30.16	61	E.	29.98	60	S.	Beautiful day, cloudy evening.
11	29.90	60½	S.	29.95	61½	S.	Very wet day.
12	29.95	61½	S.	29.88	64	S.	Showery morning, fine day.
13	29.83	60	SW.	30.5	59½	NW.	Showery and stormy.
14	30.20	60	S.	30.20	62	SW.	Cloudy morning, beautiful day.
15	30.27	59	SW.	30.28	62½	E.	Most beautiful day.
16	30.20	62	SE.	30.27	65	S.	Lovely day.
17	30.22	63	SE.	30.15	60	S.	Very gloomy, slight showers.
18	30.10	59	N.	30.12	59	N.	Fine A. M., wet P. M.
19	30.14	60	S.	29.97	60	S.	Fine A. M., gloomy P. M.
20	29.70	57	S.	29.68	56½	W.	Very wet A. M., stormy and showery P. M.
21	29.65	56½	SW.	29.67	52	W.	Very showery.
22	29.60	53	SW.	29.57	51½	S.	Showery morning, gloomy forenoon, very wet afternoon.
23	29.78	53½	SW	29.83	55½	SW.	Fine day.
24	29.88	53	E.	29.80	57	E.	Beautiful day, thunder in the evening.
25	29.79	55½	E.	29.85	58¼	N.E.	Very fine day.
26	29.94	53	E.	29.81	54	NW.	Most beautiful day.
27	29.90	55	E.	29.90	54½	E.	Lovely day.
28	29.85	53	W.NW.	29.72	54	NW.	Beautiful day, frost A. M.
29	29.52	51¼	E.	29.39	57½	S.	Very wet day.
30	29.52	57	S.	29.59	56	E.	Beautiful till 4 P. M., wet afterwards.
31	29.58	59	S.	29.67	56¼	SW.	Fine, slight showers A. M.

DAILY OBSERVATIONS—*continued.*

Date.	9 o'clock A. M.			6 o'clock P. M.			OBSERVATIONS.
	Bar.	Ther.	Wind.	Bar.	Ther.	Wind.	RAIN FALLEN IN SEPTEMBER, 3 Inches 30 Hundr.
Sep. 1	29.73	58½	SW.	29.79	58	SW.	Showery day.
2	29.80	56½	SW.	29.81	56	S.	Stormy and showery.
3	29.90	56½	SW.	29.82	56	S.	Fine A. M., showery P. M.
4	29.96	57	S.	29.82	55½	E.	Gloomy A. M., very wet P. M.
5	29.59	59	S.	29.50	57	S.	Stormy and showery A.M., rough with heavy showers P.M.
6	29.60	56	NW.	30.10	54	NW.	Showery morning, beautiful day, strong breeze.
7	30.12	56	S.	30.2	54	S.	Fine A. M., wet P. M.
8	29.80	53	E.	29.62	53	E.	Wet day.
9	29.50	55	NE.	29.60	52½	E.	Very wet day.
10	29.72	51¼	E.	29.69	51	SE.	Fine day.
11	29.72	54	NE.	29.80	54	NE.	Showery day.
12	30.18	52	E.	30.38	51	N.	Most beautiful day, slight frost A. M.
13	30.59	52	N.	30.52	52	S.	Lovely day, frost A. M.
14	30.45	57	W.	30.45	57	E.	Most beautiful day.
15	30.37	57	SE.	30.22	57	S.	Most beautiful day.
16	30.10	55	E.	30.2	55	S.	Most beautiful day.
17	30.2	60	E.	30.	60	SW.	Beautiful A. M., showery P. M.
18	30.15	60	SW.	30.22	60	SW.	Showery morning, fine day.
19	30.21	60	S.	30.27	58½	S.	Showery day.
20	30.44	58¼	NW.	30.44	59	NW.	Very showery day.
21	30.48	58½	E.	30.42	57	NE.	Cloudy A. M., beautiful P. M.
22	30.40	55½	E.	30.31	55	N.	Most beautiful day.
23	30.38	50½	E.	30.32	51	N.	Cloudy and windy A. M., beautiful P. M.
24	30.26	55	NE.	30.24	54	N.	Cloudy A. M., beautiful P. M.
25	30.20	52	E.	30.15	56	N.	Gloomy day.
26	29.98	54	E.	29.85	55	N.	Blowy, with slight rain.
27	29.83	56½	NW.	29.89	58½	NW.	Showery.
28	30.12	58	N.	30.33	54½	E.	Fine day, stormy afternoon.
29	30.32	52½	E.	30.30	53½	SE.	Beautiful day, blowy afternoon.
30	30.29	50½	E.	30.20	53½	E.	Blowy, but fine.

On the Application of Electrico-Magnetic Power to Mechanics. By M. J. D. BOTTO, Turin.

THE singular energy with which magnetic action is developed in soft iron, under the influence of electricity in motion, is well known.

As the possibility of applying this new power to mechanical purposes involves a subject of much interest, I have been induced to make known the results which I have obtained *

* I may here remark, that the expectancy of giving a wider range to my experiments, and also my being under the necessity of leaving town, have produced considerable delay in the publication of these facts. I have now, however, determined to announce them, from having seen in the last number of *Gazette Piemontaise*, that M. Jacobi of Konigsberg has succeeded in obtaining perpetual motion simply by means of electrico-magnetic influence.

The mechanism which I employed consists of a lever put in motion, after the fashion of a metronom, by the alternate action of two fixed electrico-magnetic cylinders, operating upon a third cylinder which is moveable, and attached to the lower arm of the lever, whilst the superior arm maintains a constant swinging movement; which is regulated, in the ordinary method, by a metallic wheel.

The apparatus was so disposed, that the axes of the three cylinders, all perfectly equal, being situated in the same vertical plane, and perpendicular to the axis of motion, the oscillatory cylinder, by one of its extremities, alternatively came in contact with, and in the direction of, the one or the other of the other two cylinders, placed at the extreme limits of its movements; and each time, at this very instant, the direction of the magnetizing current in its spiral was changed, the rest of the circuit maintaining the same direction, so as to produce poles of the same name with those in the fixed cylinders, at the two extremities, situated in relation with the moving cylinder. The change of direction, which we have just been mentioning, is obtained with the help of a piece of mechanism, on the principle of a balance, and known under the name of a *Bascule*, where the very movement of the machine itself inverts the communications.

It is clear that, on account of this arrangement, the middle cylinder must undergo alternating agreeing influences of attraction and repulsion, in virtue of which the mechanism puts itself in motion, to all appearance spontaneously, and so actively maintains it, by the arrangement of the magnetic forces which incite it, and which are sustained by the electrical currents.

I have tried to succeed without the spiral of the middle cylinder, by making the two fixed magnetized cylinders alternately act upon it. An adhesion, however, which continued after the cessation of the magnetic currents, very much diminished the mechanical effect: whilst, on the other hand, in the other arrangement, the adhesion not only ceased, but was converted to a certain extent into repulsion, with a rapidity equal to that of the current itself, which, scarcely for an instant interrupted by the play of the (*bascule*) pendulum, precipitated itself (the communication being inverted) into the spiral of the middle cylinder, in a contrary way to its former direction, at the same time resuming its ordinary course in the other two spirals.

The movement of the lever, and of the regulator, resulting from this arrangement, is perfectly free. Commencing slowly, it speedily and by degrees acquires the maximum of the velocity which the energy of the currents which produce it allows of, a velocity which is then maintained as equally as the intensity of the current itself, and as long as the electrical influence is preserved.*

On the present occasion I shall say nothing concerning some observations I had made upon the employment of various acid and saline solutions, and also of sea-water.

Much interest is excited by the contemplation of these novel effects of a power, which exhibits itself in a manner so different from that seen in most other bodies; and we are almost tempted to anticipate flattering results from those ulterior applications, to which the management of this mysterious agent may lead.†

The dimensions of the apparatus just described are very inconsiderable, and such that the current arising from fifteen plates, 9 inches square, can produce the movement. The electro-dynamic cylinders, which principally determine the limits of the mechanical effect, are 4 inches in length, and about half an inch in diameter; they are surrounded by a spiral thread 130 feet long, of the thickness of about the fiftieth of an inch. The lever is of wood; the superior and inferior arms are respectively of the lengths of 14 and 3 inches; the extent of the oscillations is 15 degrees. In fine, the regulator weighs about 5 pounds, and the entire weight of the whole is about 11 pounds.

Considerations, which readily offer themselves on a comparison of the maximum magneto-mechanic effect of this apparatus,

* There is a great similarity, both as it regards the general arrangement of the apparatus and the nature of the moving principle, between the mechanism of M. Botto and the electrical clock of M. Zamboni. This clock is put in motion by a pendulum, which is alternately attracted and repelled by the poles of two dry galvanic piles, which are known under the name of Zamboni's piles.

† The Chevaliers Avogrado and Bidare, who have both seen the apparatus in movement, have given expression to their surprise, not so much on account of the novelty of the fact, as on account of the speculations it suggested to those able men, respecting the general connection which might subsist between this simple result and the progress of science and mechanism.

and the size of its different parts, have suggested the substitution for the cylinder of the ordinary horse-shoe form of electrico-magnetic bars, and the augmentation, within certain limits, of the number and size of these bars, and also of the length of the spirals.

As I have not finished my experiments on this subject, I shall at present confine myself to the statement of the foregoing facts; which I have thought it expedient to publish, not only on general scientific grounds, but also because the study of the new kind of effects to which it belongs, may be considered as fruitful of important mechanical results.

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*On the Vegetation and Temperature of the Faroe Islands.** By W. C. Trevelyan, M. W. S. Communicated by the Author†.

The Faroe Islands, situated between 61°.26 and 62°.25 N. latitude, and 6°.17 and 7°.43 longitude west from Greenwich, are twenty-two in number, of which seventeen are inhabited.

Most of them may be compared to the summits of mountain ridges, rising out of the ocean, and generally running in a direction from north-west to south-east, attaining an elevation of nearly 3000 feet, and usually with deep water close to the land, which often rises in perpendicular cliffs to a height of 1200 and 1500, in one instance to above 2000 feet. For an interesting description of this last mentioned cliff, as seen under circumstances of peculiar interest, I would refer to Scoresby's Journal of a Voyage to the Northern Whale Fishery, p. 368.

The soil is principally composed of vegetable earth, mixed with the decomposed matter and debris of the different varieties of trap-rocks of which (excepting Suderoe, Myggenes, and Tindholm, where there occur beds of coal and clay) these islands consist.

Some of the mountains are covered with verdure, but most of them towards their summits produce only mosses and lichens,

* Read (in part) in the Natural History Section of the British Association at Edinburgh, September 11. 1834.

† Mr Trevelyan resided for some time in the Faroe Islands.—Edit.

particularly *Trichostomum lanuginosum* and *canescens*, which attain above one foot in length.*

The climate is generally mild; but damp, frequently visited by fogs and stormy winds, though not so subject to rain† as might have been expected. The extremes of heat or cold are seldom felt in these islands, as is well shewn by the annexed thermometrical tables, which I have drawn up from observations made at Thorshavn, in Faroe, during the years 1781, 1782, 1798, and 1799, from which it appears that the mean annual temperature of that place is 45.399.

It is interesting to observe, that the observations which I made in the islands during part of the year 1821, afford nearly the same results, though they were made in various parts of the islands,‡ not at very regular hours, and at elevations varying from the level of the sea to 70 feet above it.

With so low a temperature in summer, it cannot be expected that many exotic species of corn or fruit can flourish; in fact, the only corn which is generally cultivated is a hardy variety of barley (the Scotch Big), and that does not always ripen.§

* The following is a note of the elevation at which some plants occur on the south-east side of the mountain Mallingsfiall, in the island of Videroe, as observed by Dr Forchhammer and myself, on July 18. 1821:—

Feet 1088	Salix herbacea (first plant).
1098	Prunella vulgaris (last plant).
1382	Dryas octopetala (one plant only); Botrychium lunaria, Thalictrum alpinum, Azalea procumbens, Veronica alpina.
1530	Dryas octopetala (frequent), Papaver nudicaule (one plant), Salix arctica.
1950	Papaver nudicaule (frequent), Arabis petræa.
2000	Sibbaldia procumbens, Azalea procumbens.
2300 to the summit 2366	Salix herbacea and arctica, Empetrum nigrum, Rhodiola rosea, Silene acaulis, Cerastium alpinum, Vaccinium myrtillus, Polygonum viviparum, Oxyria reniformis, Saxifraga oppositifolia and palmata, Armeria vulgaris, Sibbaldia procumbens, Alchemilla alpina, β. argentea and vulgaris, β pubescens.

† I am not aware of any observations having been made regarding the *quantity* of rain which falls in these islands. I hope at a future time to draw up a table of the number of days on which rain or snow fell during several years, for which I have transcribed observations kept in Thorshavn.

‡ Excepting those during the months of September and October, which were principally made in Thorshavn, and corresponds, as might have been expected, most nearly with the old observations.

§ In 1821, the corn harvest commenced on September 10. According to Dr Forchhammer's observations, cultivation of corn extends in a southern exposure

Oats and rye have been tried, but seldom with success. Turnips and potatoes thrive well.

Frosts, which are not frequent, and seldom severe, are occasionally of long duration. About the middle of December 1815, one commenced, which lasted till April 1816, and having come when the ground was covered with snow some inches deep, the surface of which had thawed, the freezing of this prevented the sheep, one of the most important productions of the islands, from obtaining their food, so that a very large number of them perished, as many, it is said, as 30,000. In the island of Stromoe, out of 16,517, there were lost 7870, or nearly one-half.*

In the coal and fossil wood occurring in it, and in the clay which accompanies it, there is evidence, but probably in a very different state of things, of the former existence of timber here; although it may, indeed, have been floated into this locality, and subsequently elevated into its present situation, as appears to have been the case in other parts of the globe.†

In the peat-bogs occur the remains of birch trees, which do not now grow in these islands, having probably been extirpated by being used as fuel.

The Flora of these islands contains (as far as hitherto ascertained) 584 plants, viz.

ACOTYLEDONES.		
Fungi,	7	
Lichenes,	50	
Algæ,	127	
Characeæ,	1	
Hepaticæ,	22	
Musci,	85	
Filices,	21	
		313
MONOCOTYLEDONES,	83	
DICOTYLEDONES,	187	
		270
		583

to a height of 200 feet, and in a northern, to 100 feet above the sea. See "For. Historie og Statistik," 1822, p. 170.

* Lyngbye, in a periodical entitled, "For Historie og Statistik," 1822, vol. i. p. 133.

† This fossil wood appears to belong to the *Coniferæ*, as will be more particularly explained in a future communication.

The numbers and proportions of the principal families of the phenogamous plants are as follow:

Number of Species.		Proportion to whole Phenogamous Vegetation.	Number of Species.		Proportion to whole Phenogamous Vegetation.
24	Cyperaceæ, . .	11	20	Compositæ, . .	13
27	Gramineæ, . .	9	3	Umbelliferæ, .	90
14	Junceæ, . . .	19	9	Saxifrageæ, . .	30
6	Orchideæ, . .	45	11	Rosaceæ, . . .	24
6	Amentaceæ, . .	45	4	Leguminosæ, .	67
10	Polygoneæ, . .	27	17	Caryophyllaceæ,	15
6	Plantagineæ, .	45	16	Cruciferæ, . .	15
6	Labiatæ, . . .	45	10	Ranunculaceæ, .	27
11	Scrophularineæ,	24			

MONOCOTYLEDONES.

Pistiaceæ.
Lemna polyrhiza

Typhaceæ.
Sparganium natans

Alismaceæ.
Potamogeton pusillus
perfoliatus
lucens
natans
Zostera marina

Cyperaceæ.
Eriophorum vaginatum
angustifolium
polystachyon
Scirpus maritimus.
Eleocharis palustris
cæspitosus
Bæothryon
acicularis
fluitans
Carex dioica
pulicaris
incurva
arenaria
stellulata
pallescens
flava
panicea
recurva
cæspitosa
rigida
stricta
acuta
riparia
Elyna scirpina

Gramineæ.
Anthoxanthum odoratum
Nardus stricta
Alopecurus pratensis
geniculatus
Phalaris arundinacea
Phleum pratense
Agrostis canina

Gramineæ.
Agrostis vulgaris
alba
Aira cæspitosa
alpina
flexuosa
Melica cœrulea
Holcus lanatus
mollis
Poa fluitans
alpina
β. vivipara
trivialis
annua
cæsia of Eng. Bot. t. 1719.
Dactylis glomerata
Festuca ovina
β. vivipara
rubra
pratensis
Bromus arvensis
Elymus arenarius
Triticum repens

Junceæ.
Juncus effusus
conglomeratus
uliginosus
trifidus
bufonius
squarrosus
triglumis
biglumis
Luzula sylvatica
pilosa
β. maxima
campestris
arcuata
spicata
Narthecium ossifragum *

Juncagineæ.
Triglochin maritimum
palustre

Liliaceæ.
Scilla verna †

Irideæ.
Iris pseudacorus

* Generally in flower about the last week in July 1821.
† About three miles north of Waii, on the west coast of Suderoe, at an elevation of about 300 feet.

ORCHIDEÆ.
Orchis morio
mascula
latifolia
maculata
Habenaria viridis
albida

DICOTYLEDONES.

CONIFERÆ.
Juniperus communis

AMENTACEÆ.
Salix capræa
phylicifolia
hastata *
lanata
arctica †
herbacea ‡

URTICEÆ.
Urtica dioica

EMPETREÆ.
Empetrum nigrum §

POLYGONEÆ.
Rumex crispus
acutus
acetosa
acetosella
Oxyria reniformis ||
Polygonum viviparum
hydropiper
persicaria
aviculare
Kænigia Islandica ¶

CHENOPODEÆ.
Atriplex laciniata
hastata, Fl. Dan. 1286.
patula
Chenopodium viride

PLANTAGINEÆ.
Plantago major
media
lanceolata
maritima
β. alpina
coronopus
Littorella lacustris

PLUMBAGINEÆ.
Armeria vulgaris

PRIMULACEÆ.
Anagallis tenella
Primula vulgaris

LENTIBULARIÆ.
Pinguicula vulgaris

LABIATÆ.
Mentha arvensis
Lamium purpureum
Galeopsis ladanum
tetrahit
Thymus serpyllum
Prunella vulgaris

SCROPHULARINEÆ.
Veronica serpyllifolia
β. alpina, reptans
alpina
saxatilis
anagallis
beccabunga
officinalis
Limosella aquatica
Euphrasia officinalis
Bartsia alpina
Rhinanthus crista-galli
Pedicularis palustris

BORAGINEÆ.
Myosotis arvensis
collina
palustris
Pulmonaria maritima

GENTIANEÆ.
Menyanthes trifoliata
Gentiana campestris

ERICINEÆ.
Vaccinium vitis-Idæa } **
uliginosum }
myrtillus
Azalea procumbens
Erica cinerea } ††
Calluna vulgaris }

MONOTROPEÆ.
Pyrola minor
rotundifolia

CAMPANULACEÆ.
Campanula rotundifolia
var. uniflora

COMPOSITÆ.
Leontodon palustre
taraxacum
Apargia autumnalis
Taraxaci
Hieracium alpinum
pilosella
Lawsoni
murorum

---

* On the level of the sea.
† On Mallingsfiall, Videroe at 2300–2366 feet.
‡ Generally growing at an elevation of above 1000 feet; one plant only found at about 50 feet, of which the leaves were much larger than in more elevated situations. In all the specimens which I have, the footstalks, midribs, and edges of the leaves, are very hairy.
§ In fruit in the island of Waagoe on 4th of August 1821.
|| Occurs at all elevations.
¶ Occurs at all elevations, but is most abundant at the highest.
** In fruit on Waagoe, August 4. 1821.
†† In flower, August 4. 1821, on Waagoe.

COMPOSITÆ.
Carduus acanthoides
Cnicus lanceolatus
palustris
Tanacetum vulgare
Gnaphalium supinum var. nan. uniflor.
Tussilago farfara
Senecio vulgaris
Bellis perennis
Pyrethrum maritimum
inodorum
Achillea ptarmica
millefolium

DIPSACEÆ.
Scabiosa succisa

RUBIACEÆ.
Galium boreale
saxatile
uliginosum

CAPRIFOLIACEÆ.
Cornus suecica *

UMBELLIFERÆ.
Ligusticum Scoticum
Angelica archangelica
sylvestris

HALORAGEÆ.
Callitriche verna
autumnalis
Myriophyllum verticillatum

CERATOPHYLLEÆ
Ceratophyllum demersum

ONAGRARIÆ.
Epilobium angustifolium
montanum
tetragonum
roseum
palustre
alsinifolium
alpinum
β. nutans, Fl. Dan. 1387.

SAXIFRAGEÆ.
Saxifraga stellaris
nivalis
oppositifolia
rivularis
cæspitosa, var. grœnlandica

SAXIFRAGEÆ.
Saxifraga palmata
hirta
hypnoides
tricuspidata

CRASSULACEÆ.
Sedum villosum
Rhodiola rosea †

PORTULACEÆ.
Montia fontana

ROSACEÆ.
Spiræa ulmaria
Dryas octopetala ‡
Geum rivale
Rubus saxatilis
Comarum palustre
Potentilla anserina
Tormentilla erecta
Sibbaldia procumbens
Alchemilla vulgaris
β. pubescens
alpina §
var. agentea ||
Rosa ¶

LEGUMINOSÆ.
Lathyrus pratensis
Vicia cracca
Trifolium repens
Lotus corniculatus

HYPERICINEÆ.
Hypericum perforatum
dubium
pulchrum

GERANIACEÆ.
Geranium sylvaticum

OXALIDEÆ.
Oxalis acetosella

LINEÆ.
Linum catharticum

CARYOPHYLLACEÆ.
Silene acaulis **
Stellaria uliginosa
graminea
cerastoides ††
Arenaria peploides
Lychnis dioica
flos-cuculi

---

* Most abundant about 200 feet above the sea.

† At all elevations, but largest in clefts of the rocks near the sea; on summits of mountains very dwarf, plants in flower sometimes not more than one inch in height.

‡ Gathered in flower on 18th July, in seed in August 22. 1821.

§ At all elevations.

|| In this variety, which in some places occurs in abundance where none of the true *alpina* is found, the leaflets are not divided to the base as in that, but only about half way, they are also serrated lower down, and are not so silky. I have seen it, I think, sometimes in gardens, under the name of *A. argentea;* can it be *A. sericea* of Hort. Berol. 2. t. 79?

¶ A rose is mentioned by Landt as growing in Faroe, but I had not an opportunity of visiting its locality. I am, however, in hopes of obtaining a specimen of it from a friend there.

** At all heights. In flower, August 4. 1821, on the summit of Reinsatind, in Waagoe; at lower elevations in seed.

†† July 25. 1821. On Kœungafiall, at 1850 feet, among Bartramia fontana, in springs of the temperature of 36° F.

CARYOPHYLLACEÆ.
Sagina procumbens
Alsine media
Cerastium alpinum
β. glabratum, Fl. Dan. 979.
latifolium
vulgatum
viscosum
semidecandrum
Spergula saginoides
arvensis
nodosa

VIOLACEÆ.
Viola canina
palustris
tricolor

POLYGALEÆ.
Polygala vulgaris

CRUCIFERÆ.
Draba incana
rupestris
verna
lapponica, De Candolle.
Thlaspi bursa
Cochlearia anglica
danica *
officinalis
Cardamine amara
pratensis
hirsuta
Arabis petræa †
alpina. Fl. Dan. 62.‡
Sisymbrium nasturtium
Brassica campestris
Bunias cakile

PAPAVERACEÆ.
Papaver nudicaule §

RANUNCULACEÆ.
Thalictrum alpinum
Ranunculus glacialis ||
acris glacialis ¶
β. minor
flammula, var. repens
auricomus
hirsutus
repens
nivalis
Ficaria ranunculoides
Caltha palustris

ACOTYLEDONES.

EQUISETACEÆ.
Equisetum arvense
fluviatile
hyemale
palustre
sylvaticum

MARSILIACEÆ.
Isoetes lacustris

LYCOPODINEÆ.
Lycopodium clavatum
alpinum
selago
selaginoides

FILICES.
Botrychium lunaria
Blechnum boreale
Polypodium vulgare
phegopteris
Aspidium lonchitis
filix-mas.
Cistopteris fragilis
Asplenium trichomanes
filix fœmina
Hymenophyllum Wilsoni

CHARACEÆ.
Chara vulgaris

HEPATICÆ.
Marchantia polymorpha

JUNGERMANNICÆ.
Jungermannia tamarisci
barbata
furcata
scalaris
emarginata
ventricosa
nivalis
bidentata
minuta
undulata
complanata
serpyllifolia
concinnata
cordifolia
epiphylla
violacea
asplenioides
tridentata
ciliaris
resupinata
dilatata

MUSCI.
Andræa alpina
rupestris
Sphagnum obtusifolium

---

* Generally at the summits of mountains.

† Common among the fine debris on the sides of mountains.

‡ On Kunoe, at 2100 feet.

§ From the elevation at which this plant occurs in Faroe (nearly 2000 feet), it would appear that Professor Giesecké was in error, in thinking that he had discovered it at Achil-head, in the north-west of Ireland, in a considerably lower elevation, (see Eng. Bot. Suppl. pl. 2681,) where he probably mistook for it stunted plants of ***P. cambricum***, which is, I believe, abundant in that locality. ***P. nudicaule***, if growing in Ireland, we should expect to find at a higher altitude than in Faroe. The specimen sent to Dr Hooker, and figured in E. B., is certainly ***P. nudicaule***, but probably from Greenland.

|| On the summits and sides of most mountains, above 1500 feet.

¶ At all heights, at the greatest elevations assuming the form of ***R. pygmæa***.

Musci.
Sphagnum acutifolium
  squarrosum
Gymnostomum ovatum
  truncatulum
Splachnum mnioides
  ampullaceum
Phascum subulatum
Conostomum boreale
Polytrichum piliferum
  juniperinum
  aloides
    β Dicksoni
  alpinum
  septentrionale
  urnigerum
  nanum
  cummune, α yuccæfolium
Tortula subulata
  rigida
  tortuosa
Encalypta ciliata
Grimmia maritima
  ovata
  apocarpa
  pulvinata
Weissia crispola
  acuta
Dicranum taxifolium
  bryoides
  longifolium
  flexuosum
  falcatum
  scoparium
  Starkii
  pellucidum
  heteromallum
Trichostomum lanuginosum
  heterostichum
  aciculare
  fasciculare
  ellipticum
  canescens
    β ericoides
Didymodon purpureum
Orthotrichum Hutchinsii
  anomalum
Fontinalis antipyretica
  squamosa
Bartramia fontana
  gracilis
  pomiformis
  ithyphylla
Hypnum dendroides
  loreum
  crista castrensis
  purum
  uncinatum
  cuspidatum
  velutinum
  denticulatum
  aduncum
  splendens
  lutescens
  undulatum
  cupressiforme
  prælongum
  filicinum
  squarrosum
  scorpioides
  revolutum
  proliferum
  Schreberi
  sericeum

Musci.
Hookeria lucens
Bryum cæspiticium
  ventricosum
  nutans
  argenteum
  roseum
  hornum
  lingulatum

Algæ
Being published in number 127, of Lyngbye's valuable work "Tentamen Hydrophytologiæ Danicæ," 1819, need not be repeated here.

Lichenes.
Lecidea confluens
  geographica
  viridescens
  fuscolutea
Gyrophora cylindrica
  proboscidea
Endocarpon miniatum
Urceolaria calcarea
Lecanora muscorum
  tartarea
  gelida
  parella
  atra
Parmelia aquila
  parietina
  omphalodes
  olivacea
  saxatilis
  stellaris
  physodes
  encausta
Borrera ciliaris
  furfuracea
Cetraria Islandica
Solorina crocea
Peltidea polydactyla
  venosa
  canina
  aphthosa
Cenomyce pyxidata
  coccifera
  uncialis
  gracilis
  rangiferina
  cornuta
  vermicularis
Stereocaulon paschale
Sphærophoron fragile
  coralloides
Alectoria jubata, β chalybeformis
Usnea hirta
Ramalina scopulorum
  farinacea
  fastigiata, β calicaris
Cornicularia aculeata
  lanata
Collema lacerum
  spongiosa
  flaccidum
Lepraria flava

Fungi.
Agaricus infundibuliformis
  campestris
  muscarius
  fimetarius
Æcidium thalictri
Uredo saxifragarum
Tremella nostoc.

Tabular Arrangement of Thermometrical Observations in Faroe.

Date.	Morning.	Noon.	Evening.	Mean of Three daily Observations.	Mean of Morning and Evening Obs.	Highest.	Lowest.
1782,	31°.80	34°.09	32°.74	32.°87	32°.270	45°.50	18.°50
1799,	43.55		42.14	43.37	45.845	39.87	29.90
January,	37.675		37.44	38.12	37.557		
1782,	35.39	36.77	34.52	35.55	34.955	44.37	18.50
1799,	39.02		38.68	39.36	38.850	50.00	30.87
February,	37.205		36.60	37.455	36.902		
1782,	31.64	36.14	31.94	33.23	31.790	45.50	20.75
1799,	43.46		43.04	44.64	43.250	48.31	30.87
March, .	37.55		37.49	38.93	37.520		
1782,	38.63	43.49	38.81	40.31	38.720	50.00	25.25
1799,	44.93		44.86	45.28	44.895	54.50	37.62
April, .	41.78		41.835	42.775	41.807		
1782,	40.73	44.55	41.49	42.26	41.110	54.50	33.12
1799,	50.18		49.09	50.92	41.635	55.06	43.25
May, .	45.455		45.29	46.59	45.372		
1781,	55.31	57.01	54.11	55.49	54.710	72.50	43.25
1782,	50.54	53.46	50.60	51.53	50.570	58.00	36.50
1798,	53.84	55.89	55.19	54.97	54.515	63.50	48.87
1799,	54.85		53.09	54.73	53.970	59.00	50.00
June, .	53.635	55.45	53.247	54.18	53.441		
1781,	60.50	61.09	59.00	60·19	59.750	68.00	52.25
1782,	51.98	56.63	52.85	53.82	52.415	63,50	45.50
1798,	56.00	60.46	55.28	57.24	55.640	67.12	51.12
1799,	56.31		55.03	56.81	55.670	61.25	42.12
July, .	56.197	59.39	55.54	57.015	55.868		
1781,	57.31	58.19	55.22	56.90	56.265	70.25	45.50
1782,	51.91	53.87	52.31	52.69	52.110	61.25	39.87
1798,	55.06	58.88	55.13	56.35	55.095	65.75	48.87
1799,	54.97		54.51	55.56	54.740	59.00	45.62
August,	54.812	56.98	54.292	55.375	54.552		
1781,	50.90	51.64	49.77	50.76	50.335	65.75	38.75
1798,	52.45	55.02	52.88	53.45	52.665	62.37	46.62
September,	51.675	53.22	51.325	52.105	51.500		
1781,	43.97	44.73	42.50	43.72	43.235	54.50	26.37
1798,	49.30	50.72	48.04	49.36	48.670	54.50	39.87
October,	46.635	47.72	45.27	46.54	45.952		
1781,	38.54	39.67	37.62	38.61	38.080	48.87	25.25
1798,	45.87		44.71	45.82	45.290	53.25	34.25
November,	42.205		41.165	42.215	41.685		
1781,	42.37	42.82	40.93	42.04	41.650	47.50	33.12
1798,	44.51		42.72	44.15	43.615	52.81	33.12
December,	43.44		41.825	43.095	42.632		
Ann. Mean,	45.6886	45.850	45.1099	46.201	45.399		

Tabular Arrangement of Thermometrical Observations at Faroe.

Date.	Morning.	Evening.	Mean.	Date.	Morning.	Evening.	Mean.
1821, June .	51°.354	48°.939	50°.146	1821, September,	50°.836	51°.391	51°.113
July, . .	54.683	50.508	52.595	October, .	47.029	48.359	47.694
August, .	52.730	51.700	52.215				

Mean Temperature of . . .	mild years,	49.203
	cool ditto,	42.265
		45.734
Mean Temperature of Year, and of June, July, August, of . . .	1781–98, .	45.742
	1782–99, .	45.055
		45.399
Mean Temperature of May and October in	mild seasons,	49.152
	cool ditto,	42.172
		45.662
Mean Temperature of February and July, the coolest and warmest months in	1782, .	43.685
	1799, .	47.260
		45.472
Mean Temperature of June, July, August in	mild seasons,	56.908
	cool ditto, .	51.698
		54.253
Mean Temperature of Four Years, ...		54.620
Mean Temperature in 1821, ...		51.652
Mean Temperature of January, February, and March, in	mild seasons,	41.648
	cool ditto, .	33.005
		37.326
Highest, ...		72.50
Lowest, ...		18.50
	Mean,	45.50

NOTES.

The sources from which I have compiled the foregoing Tables, were, 1st, A collection of observations made during part of the years 1781–82, which I transcribed from the MS. of Svabo's Account of Faroe, vol. iii. in the Royal Library, Copenhagen in 1822 : 2d, A collection of observations made at Thorshavn during the years 1795–6–7–8–9, chiefly by Captain Kuhn, Commandant in Faroe, which I copied from the originals there preserved in 1821. Thermometrical observations were only made during that period, of which I have here given the results : the remaining observations on the barometer and weather I hope to be able to make use of at a future time. The house in which the lattter observations were made, is about 30 feet above the level of the sea, and they were taken at 8 A. M., noon, and 8 P. M. The particulars of those of 1781–82 are not given, but they were probably made in a similar situation.

My own observations in 1821 were made in various parts of the islands, and at elevations varying from 0 to 70 feet above the sea. The morning observations were principally made at 8 A. M.; the evening at various hours, between 9 and 12, but chiefly between 9 and 10 P. M.

Added to the mean of the morning and evening observations, to obtain the mean of the day for the months of

January, February 1799, November and December 1798,	0.53
March, April, May, 1799,	1.39
June 1799,	0.76
July 1799,	1.14
August 1799,	0.82

Analysis of Coprolites. By Dr William Gregory and Mr R. Walker.* (Communicated by the Authors).

1. *Analysis of a Coprolite from Burdiehouse.*

This coprolite was enclosed in a rolled mass of clay ironstone, and the interior of the coprolite, when broken up, seemed to have been converted into the same substance as that by which it was surrounded. A good deal of pyrites (iron) was also disseminated in the mineral. Owing to the small size of this coprolite, and its mixture with foreign matter, its analysis was rendered unusually difficult, and the proportion of phosphate of lime was less than usual from the same cause. It would be very desirable to have an opportunity of repeating the analysis, on a larger portion of coprolite from the same locality.

The result of our analysis is as follows:—

Organic matter, Sulphuret of iron, Siliceous matter,	4.134
Carbonate of lime,	61.000
Carbonate of magnesia,	13.568
Oxide of iron with a little alumina,	6.400
Phosphate of lime,	9.576
Fluoride of calcium, Oxide of manganese,	A trace.
Water and loss,	5.332
	100.000

* Read before the Wernerian Natural History Society, 29th November and 13th December 1834.

In a coprolite from Burdiehouse, analyzed by Mr Connell, that accurate chemist could not detect the presence of fluorine. In the coprolite analyzed by us, however, we had no difficulty in detecting that substance, by the ordinary process.

This interesting substance, when exposed to a high temperature, gives off water highly charged with bituminous matter, and a small portion of ammonia; this circumstance, taken in combination with the occurrence of the phosphate of lime, proves beyond the possibility of a doubt its animal origin.*

2. *Analysis of a Coprolite from Fifeshire.*

This coprolite differs considerably from the one which we last examined, inasmuch as it contains a much greater proportion of phosphate of lime, with a smaller quantity of carbonate. The oxide of iron in this is a mere trace, whereas the Wardie coprolite contained a considerable portion. In this as well as in the Wardie coprolite, we found very distinct traces of the presence of the fluoric acid, as the accompanying glass shews.† The organic matter which we obtained from this coprolite exhibited, in a more unequivocal manner, its animal origin, than that got from the other, for, when exposed to heat in a tube, it not only gave off a water highly ammoniacal, but exhaled the peculiar smell of decomposing animal matter at a high temperature. In this as well as the other we found an appreciable quantity of carbonate of magnesia, and we detected besides a small portion of phosphate of magnesia.

The following is its composition :—

Matter insoluble in muriatic acid, and chiefly organic,	3.380
Carbonate of lime,	24.255
Carbonate of magnesia,	2.888
Phosphate of lime,	63.596
Water,	3.328
Phosphate of magnesia, Oxide of iron, Oxide of manganese, Fluoric acid,	Trace.
	97.447

* Mr Connell informs me he has, since the publication of his analysis of coprolite, found, as Dr Gregory and Mr Walker had previously done, fluoride of calcium in the coprolite of Burdiehouse, and also in the fish scales, bones, and bony rays from the same quarry.

† On the specimens of glass exhibited to the Society, letters and figures were beautifully etched by the fluoric acid from the coprolite.

Answer to Professor T. S. Davies's Complaint respecting his Paper on the Hour-lines of the Antique Sun-Dials. By William Cadell, Esq. F. R. S. L. & E., M. W. S. &c.

TO THE EDITOR OF THE EDINBURGH PHILOSOPHICAL JOURNAL.

Sir,

May I beg the favour of your inserting the annexed statement.—I am, Sir, very truly yours, W. A. Cadell.

The following statement is for the purpose of shewing the erroneous nature of a publication in which my name is brought forward, and which, as I suppose, appeared in one of the scientific journals in 1831. As the existence of that publication did not come to my knowledge till lately, it is only now for the first time that I have an opportunity of contradicting it, and justifying myself against any imputations it may contain.

The passage by which I was first informed of the existence of the publication, is from a letter which formed part of a correspondence I had in 1834, with Professor T. S. Davies of the Royal Military Academy, Woolwich. He writes, " I own to you that I did insert a communication, either written, or through some authenticated friend, respecting the part which you took in the business (that is to say the business respecting Mr Davies's paper), of which I complained." From this passage I infer the existence of the publication; and although I have not seen the publication itself, I will nevertheless proceed to shew that Mr Davies's complaints, in whatever terms they may be expressed, are groundless, and that I took no " part in the business," except giving a favourable opinion of Mr Davies's paper when it was submitted to me.

Several years after the publication of my first paper on the ancient hour lines, I wrote a second paper on the same subject, which was deposited by me in the hands of Dr Roget, Secretary of the Royal Society, in the month of June, being about five months before I knew that any one was employed in researches on the same subject, and the paper remained unaltered in the hands of Dr Roget, till it was read at a meeting of the Society. Mr Davies's paper in manuscript, entitled, " An Inquiry into the Geometrical Character of the Hour-lines upon the antique Sun Dials," was put into my hands in November of the same year. Thus, as I sent my paper to the Royal Society in June, and did not know of the existence of Mr Davies's manuscript till I saw it in November, it is impossible that my paper can contain any thing taken from his.

Mr Davies's manuscript was put into my hands by Professor Wallace of Edinburgh, that I might give him my opinion of it. The author was unknown to me. I kept the paper some days, and after having read it, I returned it to Mr Wallace with a note, in which I gave a favourable opinion of the paper as far as I could judge of it. This is the only point of connection that I ever had with Mr Davies's paper. This is all I did. I took no other step whatever, and I was ignorant of what took place respecting the paper afterwards, having been absent from Edinburgh during the winter, spring, and summer, in some part of which period Mr Davies's paper was read before the Royal Society of Edinburgh.

I have thus shewn that there was no interference on my part with Mr Davies's paper, and in consequence of the correspondence I have had with Mr Davies, I have received from him a letter, in which he acknowledges his conviction, that his complaints and "suspicions" regarding such supposed interference were groundless.

Second Essay, preliminary to the Series of Reports on the Progress of the Useful Arts, ordered by the Society of Arts for Scotland. Read 27th October 1834.

In the paper which was read at the last meeting of the Society, I endeavoured to point out the connection which exists between the practice of the arts, and the advancement of civilization; and indicated, I hope with sufficient clearness, that though poignant evils at times result from rapid improvement, these are extremely limited both in their extent and duration, and are soon reabsorbed into the mass of good. At the same time, I took occasion to remark, that the natural antidote for such evils is to be found in the cultivation of more than one craft by the artisan. That course was necessary, in order to defend the objects of such a Society as ours from the charge of being inimical to the welfare of the producer. I shall now proceed to consider of the classification of the arts, or rather, I should say, of the total want of classification among them.

The first business, in attempting the classification of any set of phenomena, is to look out for some prominent characters which may serve to separate them into large groups; and again, in each of these groups, for other minor marks of distinction. Such a classification, be it remembered, is one of the utmost importance, as well for the purpose of treating of the arts, as for that of attaching the features of them to the memory.

When we seek to classify those objects which NATURE presents to us, we experience no difficulty in detecting marks of distinction, but are rather at a loss to which class of distinctions to attach the greatest importance. The objects which surround us are at once classified under two heads, the Inorganic and the Organic, giving rise to the sciences of Physics and Zoology. The inorganic bodies again readily separate into three classes, the Solids, the Fluids, the Gases; while the organic bodies range themselves in two kingdoms, the Vegetable and the Animal. Such distinctions, ramified in every direction, enable the student of Nature, with a given exertion, to compass an immense field of knowledge; put him in possession of a memory that seldom deceives; and extend, as it were, the duration of his vigour. Similar advantages would accrue to the polytechnist from the extension of this method to the arts. The processes of the arts, however, are continually changing; nor do they exhibit that infinite WISDOM which is conspicuous, at every turn, in the natural phenomena of the universe: they are the products of the finite and irregular wisdom of man, and far from offering facilities to, rather oppose the introduction of, arrangement.

Many lines of distinction, indeed, can be drawn between the different arts; and each one can be sufficiently separated from its neighbours; but then the principle of this separation varies with each art, and with each boundary, so to speak, of that art. When we attempt to apply any principle, we find that in some cases it answers to admiration, while in others it leads to inextricable confusion. The simplest, indeed the only sure method, for arriving at a classification, is to analyze each art, to examine minutely its various auxiliary processes, and to seek for some appearance of distinction. Far, however, from simplifying, this method rather tends to complicate the subject: yet it opens such a splendid view of the true nature of human society, and awakens such a thrill of wide spreading philanthropy, that to follow it out one would even dare the dangers of the Cretan Labyrinth.

A few years ago, the uneven thread now and then exposed, to the admiring student of nature's loveliest work, the flash of transitory discontent; and awakened in the peaceful and happy home soft but frequent murmurs. A felicitous idea transferred from our floating ramparts to the needle of the sempstress the diminutive cable, and the mile-end cotton has spread its soothing influence over the united empire; and, though as yet no pavilion has been reared over its meritorious inventor, we shall delight to honour him by installing the 300 *yards warranted* as the representation of Ariadne's clue.

Let us trace this beautiful fabric to its source; not, however, by a minute analysis of the machinery, but rather by a rapid view of the principal steps which lead to its formation.

The manufacture of the cable twist, like that of every other commodity, must be studied under two heads; the obtaining of the raw material, and the conversion of it into the marketable article. I am too little acquainted with the details of cotton culture, to venture into a critical examination; yet there are features in it too striking to escape the notice of a very casual observer. The raw material of the British manufacturer is in truth a manufactured commodity, and no small degree of skill is required to bring it to that state which fits it for the commencement of his labours.

Tracing it back from the British storehouse, we find that it has been brought from the other shore of the Atlantic; and the process of transportation is thus that which demands our first attention. This very first step in the analysis of the cotton manufacture leads us to an eminence from which, though we can descry only a portion of the surrounding country, we are yet able to form some idea of the immense extent of the entire view. To how many different processes does the ship owe its existence!

And to what an intense development of the energy of the human mind, does it owe its safe conduct!

The art of ship-building is one that requires the previous exercise of many subsidiary processes. The wood must be hewn and transported to the shore: The saw and axe makers must have been at work, and the cartwright must have laboured ere the shipwright could obtain the material to work upon; and even when he has obtained that, he cannot proceed a single step ere he have applied to the tool-maker for his implements. The hulk, we shall suppose, is finished; the rope-maker, the manufacturer of our identical cable-twist on the large scale, the sailmaker, must both be set to work; and even ere that, some previously finished vessel must have crossed the German Ocean to bring our supply of hemp, of tar, and tallow.

The mere formation of the vessel thus leads us to contemplate many separate arts, each perhaps more important than that which we are analyzing. Let us now pass to the safe-conduct of the vessel, and let us attend, not to the mere bodily labour, but to that succession of mental efforts which has enabled man to trace his path across the ocean. The discovery of the directive power of the magnet, and its application to the compass, carry our thoughts back for several centuries, and transport us from the sea-enthroned island to those countries whose timid sons yet creep along the coasts. We thank the fanaticism of the impious crusaders, and place the preachings of Peter the Hermit in the list of steps by which mankind have reached their present state. The compass, however, has been gradually improved, and it would scarcely be fair to place all the merit among the arcana of antiquity. When we reflect on the immense extent of ocean that is spread over the surface of the earth; when we bring before us the never ending variety of man's appetites, and his singular power of accommodating himself to every species of climate, we perceive, in the directive power of the needle, a provision for the safe exercise of his spirit of adventure, and begin to trace a perfect unity between the design of the phenomena of the material universe, and the subtile properties of mind. But the needle and the log would, in the course of a long voyage, give very erroneous results, and would leave the mariner ignorant of the effects of those currents that exist in every part of the sea. Though the needle had been perfect in its direction, and though the log were improved to the utmost, there would still exist the necessity for some other guide, whence the effect of currents might be eliminated. The mariner sees nothing around him but the monotonous wave, and, conscious that the ocean on which his log swims may itself be moving onward, looks anxiously for some object uninfluenced by the stream. The stars alone can supply, in every situation, an unchanging guide, and a knowledge of their movements becomes essential to the seaman. But the science of astronomy is one founded on a long series of observations, and which has only reached a sufficient exactitude with the assistance of many collateral aids.

The observations of the ancient astronomers, made by means of the rude gnomon and clypsedra, derive value from their mere antiquity; the errors incident to them being rendered insensible by subdivision among so many epochs. But such observations would never have enabled us to attain to that degree of precision which the mariner demands; and the true nautical astronomy was only founded when Galileo turned his telescope to the stars. The labours of Tycho, of Kepler, of Guericke, the deep studies of the Bernoullis, of Euler, of Newton, of Maclaurin, of Lagrange, and of Laplace, were all steps essential to the perfection of the nautical art; the multiplicity of these steps prevent their detail, but there is one among them whose importance stands so pre-eminent, that it would be unfair to Scotland and to its author to pass it over in silence. The illustrious Kepler had been toiling through endless calculations to demonstrate the true figures of the planetary orbit; and the fearful truth was just breaking upon his mind that human life is too short, and that human endurance is too limited for the necessary labour, when our own Napier presented to the scientific world the Logarithmic Canon. There is not a ship-boy who is unacquainted with the power of the logarithmic calculus, or who has not reason to turn his face every day towards the tower of Merchiston, and thank that giant mind which first opened the spring whence such wide-spreading benefits have flowed. Even with all the assistance which the logarithms have given, the labour is still regarded by many as excessive; and when newly out of sight of the West India Islands, all hands have been called on deck for the *taking of a lunar*, while the conclusion of the calculation brought the vessel within sight of Cape Clear.

There is more necessary, however, than the nightly toil of the astronomer. Hadley must contrive his quadrant, and Troughton must improve it—Newton must detect the chromatic observation of light, and Dollond correct it; Huygens must investigate the phenomena of vibration and contrive the chronometer; and the endless series of improvements must be made on that instrument ere the ship can boldly leave the land astern, and trust herself to the interminable ocean.

I have now rudely analyzed the process of transportation, and have traced the cotton wool to its native shore. But much yet has to be done ere I have completed the first part of my investigation. The toil of the cotton planter, the instruments which he employs, and a long train of improvements, have all to be considered. We must examine the machinery which clears the cotton of its seeds, and must return to our own country to view the slow lathe cutting out the ponderous cylinder. Ignorance of the subject, however, compels me to leave that part untouched, and I shall now proceed to analyze, in the same hasty manner, the process of converting the raw cotton wool into the cable twist.

The detail of the various movements,—the description of the multitudes of ingenious contrivances,—the history of their introduction, would swell this merely speculative essay into a formidable quarto; and I must content myself with a glance at the general aspect of the machinery.

The toothed wheel, the steel arbour, and the all-uniting screw, are the more prominent parts; and the formation of these essentials offers thus the most important features in the manufacture of machinery. When we walk through the various works we observe one mandril used in the formation of another; one divided plate producing thousands of others; one planing engine occupied in the construction of slide rests, which are only planing engines in another form; and one screw reproducing new screws of every variety of pitch and thread. And when we inquire whence came these parent plates, lathes, planing engines, and screws, we are answered that these were themselves deduced from others of acknowledged excellence. A first glance at this reproduction of one machine by another, would lead us to believe that handicraft is but little concerned in the formation of accurate instruments; and that the operations of machinery possess an exactitude far higher than can be obtained from the workman's skill. A deeper reflection will, however, conduct us to very different results. The method of making a flat surface by hand-work is incomparably superior to any other, so that the planing engine must be considered as originally deduced from hand-labour. The divisions of the teeth of wheels were also originally hand-work, and even yet the more precise astronomical instruments are divided by hand. Linear divisions also are better done originally than copied by any machine; and thus the formation of an accurate screw, which requires the combination of equable linear and angular motions, comes likewise to be considered as the product of human skill. Good angular and linear divisions, an accurate planing machine, and an equable screw being once obtained, it is indeed easy to form others of nearly equal value; but it must be noticed, that all the imperfections of the originals are transferred to their copies, and that nothing but a sagacious arrangement of the work, and a skilful variation of the parts, can prevent these instruments from degenerating. In this way we may regard all the finer machinery of our country as having originated from the careful workmanship of some few primary instruments; which, deteriorating by use, have been preserved of a proper degree of precision by the continued exercise of patience and of skill.

But the formation of the machinery is not all—the providing of the materials is a point of as great importance: and here again we are led into the same round of processes, and find that each art, as at present practised, depends on the practice of the same art in a ruder state. Thus the iron mine is wrought by means of iron tools, these were obtained from other mines by the help of other tools, and we trace up the parentage of each pick-axe and shovel to the rude stone chisel, itself constructed by means of some other, until we reach the first finder of a sharp-edged stone; and while we boast of the power and precision that have now been attained, we must own our obligations to the rude processes of uncivilized man. No set of processes run so far back as those connected with the manufacture of iron, and none have contributed so much to the increase of civilization: Iron seems to attach itself most pertinaciously to our species, and not a seaman is cast away but a saw, a knife, or an axe must *providentially* follow him. The truth being that it is almost beyond the power of the novelist to supply, by any other scheme, their place. For the production, then, of one of the most ordinary articles of commerce, the exertions of almost, I may say, the whole human race have been combined; and the midnight toil of the man of science mingles itself with the roar of the blast furnace and the clatter of the forge; the sage of antiquity and the ancient craftsman have both lent an assistance which could not have been awanting without a postponement of the period at which the human race has reached to its present state. It is, as I have already said, not an individual, but the whole race that progresses to maturity; and not merely every statement, but every useful piece of labour, goes to swell the capital of mankind.

In spite of the fanaticism which has sent the Turk to exterminate the Brahmin, the Christian to eradicate the Turk,—in spite of the craft that sets nation to war against nation, and declares France to be the natural enemy of Britain,—the arts and the sciences have made of us one family, not a single branch of which can enjoy an advantage that will not speedily diffuse itself through the whole.

Such being, then, the anastomosing nature of the arts, it becomes almost impossible to treat of them systematically, and there is left little else to guide us in arrangement than the peculiarity of taste. Some of the arts are, indeed, more elementary than others, yet this consideration affords us but little assistance. I have therefore determined to follow, in the arrangement of the series of reports, whatever circumstances may appear to combine interest with utility, and I propose for my first subject, the recent improvements that have been made in damask, shawl, and carpet weaving; improvements in which, I am happy to say, our own country, nay even our own Society, has had no trifling share.

Edw. Sang.

On a New Classification of Fishes, and on the Geological Distribution of Fossil Fishes. By Professor AGASSIZ of Neufchatel.

IN a memoir lately read before the Geological Society of London, the author begins by stating that the science of Ichthyology had obliged him to undertake an examination of recent fish, for the sake of comparing them with the fossil species, and, in doing so, he had arrived at a classification of fish, in general differing considerably from the various arrangements previously adopted by naturalists. One of the essential characters of fish is, to have their skin covered with scales of a peculiar form and structure. This covering, which protects the animal without, is in direct relation with its internal organization; and Mr Agassiz has found, that, by attentive examination of the scales, fishes may be divided into more natural orders than had hitherto been established. In this manner, he has established four orders, which bear some relation to the divisions of Artedi and Cuvier, but one of which, hitherto completely misunderstood, is almost exclusively composed of genera whose species are only found in the older strata of the crust of our globe. These four orders are the *Placoidians*, which comprehend the cartilaginous fish of Cuvier, with the exception of the sturgeon: the *Ganoidians*, which comprehend above fifty extinct genera, and to which we must refer the Plectoganathes, Syngnathus, and Acipenser; thirdly, the *Ctenoidians*, which are the Acanthopterygians of Cuvier and Artedi, with the exception, however, of those which have smooth scales, and with the addition of the Pleuronectes; lastly, the *Cycloidians*, which are principally Malacopterygians, but which comprehend besides all those families excluded from the Acathopterygians of Cuvier, and from which we must take the Pleuronectes, already placed in the preceding order.

If we estimate the number of fish, now known to amount to about 8000, we may state that more than three-fourths of this number belong to two only of the above mentioned orders; namely, the Cycloidians and Ctenoidians, whose presence has not been discovered in the formations below the chalk. The other fourth part of living species is referable to the orders Placoidians and Ganoidians, which are now far from numerous, but which existed during the whole period which elapsed since the earth began to be inhabited, to the time when the animals of the greensand lived. These remarkable conclusions, to which M. Agassiz had come from the study of more than 600 fossils on the Continent, have been corroborated by the inspection of more than 250 new species, found in British collections.

The author next observes, that, in the class of fish, more considerable differences may be remarked within narrow geological limits, than among inferior animals. We do not see in the class of fishes the same genera, not even the same families, pervading the whole series of formations, as takes place among zoophytes and testacea. On the contrary, from one formation to another, this class is represented by very different genera, referable to families which soon become extinct, as if the complicated structure of a superior organization could not be long perpetuated without important modifications; or rather, as if animal life tended to a more rapid diversification in the superior orders of the animal kingdom, during equal periods of time, than in its lower grades. With respect to this, it is with fish nearly as with mammifers and reptiles, whose species, for the most part but little extended, belong, at a short distance in the vertical series, to different strata, without passing insensibly from one formation to another, as is generally admitted to be the case with certain shells. One of the most interesting facts which Mr Agassiz has observed is, that he does not know a single species of fossil fish, which is found successively in two formations; whilst he is acquainted with a great number which have a very considerable horizontal extent. But the class of fish presents besides to zoological geology, the immense advantage of traversing all formations. Thus they afford us the only example of a great division of vertebrated animals, in which we may follow all the changes experienced in their organization, during the greatest lapse of time of which we possess any relative measure.

The fish of the tertiary formations approach nearest to recent fish, yet hitherto the author has not found a single species which he considers perfectly identical with those of our seas, except the little fish which is found in Greenland in geodes of clay, and whose geological age is unknown to him.

The species of the crag of Norfolk, the superior sub-apennine formation, and the molasse, are related for the most part to genera now common in tropical seas; such are the platax, the large carcharias, the myliobates, with large palatal plates, and others. In the inferior tertiary formations, the London clay, the Calcaire grossier of Paris and Monte Bolca, a third at least of the species belong to *genera* which exist no longer. The chalk has more than two-thirds of its species referable to genera which have now entirely disappeared. In it we already even see some of those singular forms which prevail in the Jurassic series. But, as a whole, the fish of the chalk recall more forcibly the general character of the tertiary fish, than that of the species of the Jurassic series.

If we paid attention only to fossil fish in the grouping of geological formations on a large scale, the author thinks it would be more natural to associate the cretaceous with the tertiary strata, than to place the former among the secondary groups. Below the chalk there is not a single genus which contains recent species, and even those of the chalk which have them, contain a much greater proportion of species which are only fossil. The oolitic series, to the lias inclusive, forms a very natural and well defined group, in which also must be included the Wealden, in which Mr Agassiz states he has not found a single species referable even to the genera of the chalk. Henceforth, the two orders which prevail in the present creation are found no more; whilst those which are in a small minority in our days, appear suddenly in great numbers. Of the Ganoidians, those genera which have a symmetrical caudal fin are found here; and among the Placoidians, those above all predominate which have their teeth furrowed on both the external and internal surface, and have large thorny rays. For it is now certain that those great rays which have been called Ichthyodorulites, belong neither to Silures nor Balistæ, but are the rays of the dorsal fin of the great squaloids, whose teeth are found in the same strata.

On leaving the lias to come to the inferior formations, we observe a great difference in the form of the posterior extremity of the body in the Ganoidians. All have their vertebral column prolonged at its extremity into a single lobe, which reaches to the end of the caudal fin; and this similarity extends even to the most ancient fish. Another observation worthy of attention is, that we do not find fish decidedly carnivorous before the carboniferous series; that is to say, fish provided with large conical and pointed teeth. The other fish of the secondary series before the chalk appear to have been omnivorous, their teeth being either rounded, or in obtuse cones, or like a brush.

The discovery of coprolites containing very perfect scales of fish which had been eaten, permit us to recognise the organized beings which formed the food of many ancient fish; even the intestines, and in some fossil fish of the chalk, the whole stomach is preserved, with its different membranes. In a great number of fish from Sheppey, the chalk and the oolite series, the capsule of the bulb of the eye is still uninjured; and in many species from Monte Bolca, Solenhofen, and the lias, we see distinctly all the little blades which form the branchiæ.

It is in the series of deposits below the lias, that we begin to find the largest of those enormous sauroid fish whose osteology recalls, in many respects, the skeletons of saurians, both by the closer sutures of the bones of the skull, their large conical teeth, striated longitudinally, and the manner in which the spinous processes are articulated with the body of the vertebræ, and the ribs at the extremity of the spinous processes.

The small number of fish yet known in the transition formations, does not as yet permit the author to assign to them a peculiar character, nor has he discovered in the fossil fish of strata below the greensand, any differences corresponding with those now observed between marine and fresh water fish, so that he cannot, on ichthyological data, decide on the fresh water or marine origin of the ancient groups.

Prodromus Floræ Peninsulæ Indiæ Orientalis. By ROBERT WIGHT, M. D., F. L. S., &c. and G. A. WALKER-ARNOTT, A. M., F. L. S., &c. &c. Vol. I.

MUCH as has been done of late years to elucidate the botany of our Indian possessions, far more remains behind to reward the researches of such men as Wallich, Wight, and Royle. It is gratifying to see them returning to Europe for a season, and devoting their leisure to the publication of their observations, and, with a due liberality, communicating a share of their collections to their European fellow labourers in science. Nor is it less gratifying (speaking merely as a philosophical looker-on), to see them exploring with undiminished energy the wilds of that vast continent. To dwell on the munificent patronage which the Directors of the Honourable East India Company have extended to the cause of Indian Botany, would be to speak of what is known to every one who takes any interest in natural science. We are however convinced that, apart from the liberal and enlightened feelings which might prompt such a body as the East India Company to encourage the progress of scientific discovery, they cannot act more wisely, in a commercial and economical point of view, than by promoting a complete investigation of the natural history of their vast territory. To a great extent they are at present unknown, and it is impossible to say what might not result to the prosperity of India herself, from a more perfect knowledge of its animals, plants, and minerals.

We have great pleasure in bringing the present work under public notice. Dr Wight is a surgeon on the Company's Madras Establishment, and during his residence in India availed himself of every opportunity of examining the botany of the Indian peninsula. He made very extensive collections, and, at his own expense, procured drawings to be made by native artists of a great number of curious plants, some of which have been already published in Professor Hooker's Botanical Miscellany. On his recent visit to Europe, he associated himself with an eminent botanical friend, Mr Walker-Arnott, and proceeded to arrange the work, of which the first volume is before us. It cannot be expected that we should here enter into any minute details; but we have examined the volume with some attention, and feel bound to say, that it bears the evident traces of extreme care and unsparing labour; and is in our opinion one of the most important works that have been published on Indian botany. It does credit to both the learned authors, and between whom, the labour of the present volume is exclusively divided; and more than that, it is honourable to the East India Company, that such a work should have originated under their auspices; and we recommend it to them as a useful measure, to place some funds at the disposal of Dr Wight, in order to enable him to extend and complete his important researches.

We are informed in the preface that the second volume will be enriched by some valuable contributions. Professor De Candolle has named the greater part of the *Compositæ*, and communicated notes on the new species. Professor Nees von Esenbeck affords his assistance in the *Acanthaceæ*, *Laurineæ*, *Solaneæ*, *Cyperaceæ*, and *Gramineæ*. Mr Bentham describes the *Labiatæ* and *Scrophularinæ*; Dr Lindley the *Orchideæ*; Dr Hooker the *Filices*, and De Greville the *Algæ*.

New Genera of Indian Grasses. By Prof. Ch. G. Nees ab Esenbeck. (Communicated by G. A. Walker-Arnott, Esq.)

I. THYSANOLÆNA. *N. ab E.*

Trib. Tristegineæ.

Spiculæ hemiologamæ, heterogamæ, racemosæ, geminæ, vel solitariæ. Glumæ duæ, flosculis minores, muticæ; inferior brevior. Flosculus inferior neuter, univalvis; valvula herbacea, glabra, integra, mutica; superior hermaphroditus, bivalvis: valvula inferior herbaceo-membranacea, mutica, trinervis, longe ciliata; superior minor et angustior, lineari-lanceolata, membranacea. Lodiculæ exiguæ, rotundatæ, integerrimæ. Stamina duo, antheris linearibus latiusculis luteis. Stigmata purpurea, penicillata; styli basi conjuncti.

Inflorescentia: racemus *amplus, supra decompositus, ramis multis elongatis filiformibus basi callosis sparsis approximatis, ramulis brevibus oligostachyis.* Planta *alta.* Folia *lata, rigida, glabra.* Spiculæ *valde parvæ.*

1. Th. *agrostis* (N. ab E.)—Agrostis maxima, *Roxb. fl. Ind.* 1. *p.* 317 (*ed. Wall.*) 1. *p.* 319; *in cat. merc. angl. Ind. or. mus. tab.* 823 (fide *Arnott*); *Kunth. en.* 1. *p.* 227.

Hab. in montibus Circarensibus; *Roxburgh.* In Benghala boreali, *Royle*, n. 284.

II. BATRATHERUM. *N. ab E.*

Trib. Sacchantineæ. § Andropogoneæ.

Spicula in rachi articulata geminatæ, heterogamæ, altera sessili hemigama, altera pedicellata neutra. Glumæ spiculæ perfectæ duæ, subæquales, herbaceo-chartaceæ, acutæ apiceve acute bidentatæ, in aliis superior apice setacea, inferior plana bi-sex-nervis, superior carinata, complicata, uni-trinervis, a dorso implicata canalem struens, in quo seta flosculi continetur, margine tenui simpliciter connivente. Flosculi membranacei, glumis breviores, nunquam saltem longiores; inferior neuter, univalvis, muticus; superior bivalvis, valvula inferiori acuminata apice minute, bidentata prope a basi emittente setam in medio geniculatam tortam; superior exigua, lineari-subulata, bidentata, quandoque nulla. Lodiculæ latæ, membranaceæ, truncatæ, dentatæ, plicatæ in semicirculo singulæ singulum floris latus ambientes. Stamina tria. Stigmata villosa; styli discreti. Spicula pedicellata angustior, subuniglumis, gluma plana, acuta, nervosa, margine subtilius serrulata, superior gluma et flosculi rudimentum minuta, rotundata, squamiformia.

Inflorescentia: spica *parce dichotoma, ad genicula magis minusve barbata.* Pedicelli *spicularum sterilium ciliati.*—Gramina *repentia, ramosa,* foliis *brevibus amplexicaulibus.* Spiculæ *membranaceæ, exsertæ.*

Structura floris *Pleuropliti*, Trin., quodammodo et *Arthraxo*, P. de B., accedit, sed differunt hæc genera spiculis non geminatis heterogamis; posterius hoc autem et inflorescentia paniculata.

[*Arthraxon*, P. de B., ipsissimum genus videtur ac *Pleuroplitis*, Trin., et *Lucæa*, Kunth. A. *Pleur. plumbea*, N. ab E. in Wight. cat. n. 1783, *Arthraxon ciliare*, P. de. B., tantummodo differt culmi nodis et racheos articulis geniculisque glabris: planta utraque colore plumbeo gaudet.—*G. A. W.-A.*]

1. B. *echinatum* (N. ab E.:) gluma inferiori lanceolata grosse pectinato-serrata, articulorum racheos barba brevi, foliis pubescentibus.

α; gluma inferiori etiam dorso muricata, vaginis inferioribus tuberculatis hirsutisque.—*Wight. cat. n.* 1684.

β; gluma inferiori dorso inermi, vaginis glabris circa basin simpliciter tuberculatis.

Hab.—Peninsula Ind. or.; *Wight.* In Benghala boreali; *Royle*, n. 387.

Repens, longisque radicibus sarmentosum. Folia pollicem 1 longa, ad basin 2–¾ lineas lata, e cordata amplectente basi acutata, plana, ciliata, pubescentia. Vagina superior ventricosa, aphylla, vel foliolo parvo lineari spicas attingente. Spica pollicaris, rigida, semiteres, glabra, arcuatim flexuosa, a basi dichotoma ramis fastigiatis conformibus simplicibus. Nodi pauci, barbati. Pedicellorum cilia subtilia. Spiculæ glabræ; sessiles 2 lin. longæ, lanceolatæ, acuminatæ, gluma inferiori toto margine serraturis callosis conicis asperis pectinata; in var. *α* in tribus nervorum basin versus simili ratione muricata; in var. *β* autem inermi; arista juxta basin valvulæ inferioris flosculi fertilis orta, spicula duplo longior, gracilis, glabra, inferne purpurascens.

[Multum mihi in mentem venit *Thelopogon elegantem*, Rothii, ab hac specie non esse diversam: prætermitto characteres spicularum solitariarum aliosque, forsitan pessime exstructos, glumæ structuram solummodo perpendens.—*G. A. W.-A.*]

2. B. *lanceolatum* (N. ab E.:) gluma inferiori lineari subtiliter cartilagineo-serrata seriebus duplicatis, dorso lævi, articulorum racheos barba longa, vaginis lævibus, inferioribus quandoque tuberculato-hirsutis, foliis glabris basi ciliatis.—*Wight. cat. n.* 1685.—Andropogon lanceolatus, *Roxb. fl. Ind.* 1. *p.* 257 (; *ed. Wall.*) 1. *p.* 262; *Kunth. en.* 1. *p.* 498.

Differt a *B. echinato*: foliis ratione longitudinis angustioribus strictioribus glabris, basin versus e tuberculis ciliatis; maxime autem gluma inferiori duplo angustiori lineari dorso lævi nervis quatuor tenuibus valde approximatis notati, et ad margines multo argutius subtiliusque serrata, seriebus subduplicibus, altera ipsius marginis, altera paullo superiori. Valvulæ alterius flosculi hermaphroditi in hac nulla vestigia inveni, sed paucas tantum vidi spiculas et non nisi unam dissecui.

3. B. *molle* (N. ab E.:) glumis lineari-lanceolatis attenuatis apice scabris

inferiori sexnervi bidentata, superiorí setaceo-caudata, rachi pedicellisque spicularum sterilium plumulosis, vaginis vel totis glabris, vel margine foliisque oblongis, basi cordata amplectentibus, pubescentibus molliterque ciliatis flaccidis, spicis subquaternis.

α, *majus;* spicis vagina inclusis, vaginisque glabris, foliis majoribus mollissimis.—*Wight. cat. n.* 1686.—Andropogon lanceolatus, *Heyne.*—A. lancifolius, *Trin. in act. Petrop.* 7. *p.* 271.

β, *tenue;* spicis longe exsertis, culmo violaceo filiformi, foliis parvis, angustioribus aut latiusculis rigidulis, spicis pallido et violaceo-variis.

γ, *parvulum;* spicis ut in β, violaceis, foliis mollissime pubescentibus, vaginis margine villosulis.—Andropogon microphyllus, *Trin. l. c. p.* 275.

Hab.—α, in Peninsula Ind. Or.; *Heyne, Wight.*—β (n. 221, 222, 228) et γ (n. 220) in Benghala boreali; *Royle.*

Differt a binis præcedentibus culmo graciliori, foliis mollioribus, magis oblongis, e linearum trium quidem ad $1\frac{3}{4}$ poll. longitudinem variis, sed ubicunque paulo perfectiora sunt, distincte oblongis in medio vel paulo ultra latioribus, hinc basin versus mediocriter attenuatis (majoribus 5–6 lineas latis), spicis ut in reliquis bifidis minoribus (in var. α omnino intra vaginam supremam aphyllam acuminatam pallentem reconditis et e latere ejus prorumpentibus, post anthesin delabentibus jam spiculis in pedunculo gracili emergentibus; in var. β et γ cum culmi apice filiformi villosa exsertis), spiculis minoribus vix linea longioribus, glumis fere membranaceis nec pectinatim serratis, sed ad nervos scabris, superiori præsertim setigera. Glumæ in α pallidæ sunt, in β et γ magis minusve violaceæ, inferior fere linearis, sexnervis, nervis duobus penultimis in dentes apicis acutos excurrentibus; superior gluma nervi utrinque lateralis guadet vestigio. Flosculi glumis duplo breviores, basi stipite communi brevi conjuncti, glabri, tenerrimi; inferioris valvula oblongo-lanceolata, acutiuscula subenervis, flosculi fertilis valvulam superiorem mentiens, sed vere *exterior* illiusque inferiorem valvulam basi *amplectens*; superioris valvula isti similis, paulo major obtusiuscula, binervis, dorso obtuse canaliculata, ubi arista, a basi valvulæ adscendens, tenuissima, glumis duplo, valvula sua quadruplo longior incumbit (ceu nervus medius solutus et liber emergens), quæ in var. α ad $\frac{2}{3}$ in β ad $\frac{1}{3}$ in γ ad medium lævis amœne rubra, hinc nodulo exiguo articulata scabra et pallida aut violacea pergit, siccitate autem in parte lævi leniter torquetur; valvula superior lineari-subulata, angustissima, inferiori quadruplo brevior. Lodiculæ lineari-oblongæ, obtusæ. Stamina duo *; antheræ oblongæ, violaceæ. Ovarium oblongum luteum; styli mucrone ovarii basi conjuncti; stigmata lutea. Pedicellus spiculæ neutrius longitudine demidiæ spiculæ fertilis, pulchre, nec admodum late, ciliatus. Spicula hæc oblongo-lanceolata, fertili minor eidemque tam arcte appressa, ut oculos facile effugiat; glumæ ut in fertili, sed minus acutatæ; valvularum rudimenta exigua, squamiformia. Culmi longitudo in var. α 1–$1\frac{1}{2}$ ped, in var, β vix pedem æquans, in γ $\frac{1}{2}$–$2\frac{1}{2}$ pollicum.

4. B. *micans* (N. ab E.:) glumis oblongo-lanceolatis attenuatis micanti scabriusculis, inferiori sex-nervi nervis serrulato-scabris apice subulato integro superiori breviseto, rachi pedicellisque spicularum sterilium plumulosis, vaginis glabris margine ciliatis, foliis oblongis basi cordata amplectentibus pilosis inferiusque rigide ciliatis, spicis geminis ternisve.

* Videas Generis Characterem ubi Stamina *tria.*—G. A. W.-A.

α; spiculis pallidis, basi a vagina suprema inclusis.

α*; spiculis pallidis, nudis.

β; spiculis violaceis, culmi apice gracillimo longe exserto.

Hab. In Benghala boreali; *Royle.*

Præter notas, in charactere exhibitas, a *B. molli* differt: spiculis duplo fere majoribus, $1\frac{1}{2}$–$1\frac{3}{4}$ lineas longis, seta flosculi breviori, spicula sua ad summum duplo longiore, i. e. parte exserta 2-lineari, inferne haud rubra, sed primum lutescente, demum fuscescente totaque sæpe concolore, spiculis neutris subulatis. Glumæ muriculis exiguis micant, prætereaque inferior ad nervos distincte prominulos, superior ad carinam scabræ sunt. Gluma inferior, in hac specie dorso rigidior, margine membranacea a parte dorsali elastice convolvitur setamque quasi canali exceptam arcte retinet, quod quidem et in aliis hujus generis speciebus obtinet, in hac autem luculentissime cernitur.

III. LIPEOCERIS. *Trin.*

(Charactere reformato.)

Trib. Saccharineæ. § Andropogoneæ.

Spiculæ in rachi angusta barbulata geminatæ ideoque quadrifariæ, heterogamæ, conformes; seriebus duabus contiguis sessilibus hemiologamis setigeris, aliisque duabus hemigamis masculis neutrisve muticis. Glumæ duæ, inferior utriusque generis herbacea, multinervis, lata, plana vel laxe convoluta, apice tridentata vel integra; superior spiculæ sessilis chartacea, carinata, trinervis; masculæ submembranacea, plana trinervis, lateribus inflexa. Flosculus uterque univalvis; inferior neuter, valvula membranacea acutiuscula ciliata; superior in spicula sessili hermaphroditus, lineari-angustissimus, abiens in setam flexuosam basi tortam. Lodiculæ magnæ, coloratæ, crassiusculæ, obconicæ, introrsum (versus genitalia) convexæ, extrorsum leniter canaliculatæ, emarginatæ, angulis acutis subbicornibus. Stamina tria, antheris olivaceis. Styli basi contigui; stigmata aspergilliformia. Caryopsis basi angustior, obtusa cum mucronulo duplici a stylorum residua. Spiculæ masculæ flosculi inferioris valvula membranacea, lanceolata, sursum nonnihil dilatata, apice tridentata, ciliata. Stamina ut in hermaphrodito.

Inflorescentia: spica *imbricata, tetrasticha, subsecunda, solitaria, et tum* Heteroponis *inflorescentiæ omnino simillima, aut fasciculatim divisa; plerumque leniter torta, subspiralis.*—Gramina *basi repentia, panicula, adscendentia, ramosa.* Nodi *barbati.* Folia, *linearia, acuta, circa basin barbata.* Ligula *brevissima.* Spica *terminalis in longe exserto culmi apice, quandoque geminæ ejusmodi aut plures. Secundum Roxburghium etiam spicæ in eodem pedunculo geminæ ternæve obveniunt.*

Genus, uti patet, Heteropogone in primis diversum forma glumarum et sexus diversa distributione, quæ notæ habitu proprio bene confirmantur; ab *Andropogone* subgenere *Trachypogone* caute, nec tuto omnino, distinguendum glumis utriusque spiculæ conformibus herbaceis mollibus. Cl. Trinius, nescio quomodo evenerit, in exponendis partibus spicularum lapsus est, glumam unam ponens, alteram autem glumam valvulam flosculi inferioris singulam esse statuens; quod si ita esset, valvula aristata non *inferior*, sed *superior* dicenda fuisset, si ponas, valvulam neutram, pro more glumæ inferiori proximam, illum alteram declarasse flosculi hermaphrodi valvulam; semper etenim valvula inferior flosculi superioris glumæ superiori respondet; *superio-*

rem autem esse glumam illam unam, quam statuit Trinius necesse sit conjici, quod eidem flosculus sic dictus neuter chartaceo-coriaceus, qui absque dubio eadem pars, quam glumam superiorem in antecedentibus dixi, oppositus sit. Unicum errorem, plures secuti sunt, probabiliter propter valvulam superiorem superioris flosculi, in hoc gramine revera deficientem, a cl. auctore infauste surrogatam gluma superiori in flosculorum numerum recepta. Iconum interpretatio in tab. xviii. Fund. Agrost. *vera* hac est: fig. 2, gluma inferior spic. masc.; 3, eadem spicula a latere glumæ superioris; 4, gluma superior. (Trinio flosc. neuter); 5, valvula flosculi neut. (valvula flosc. masc. inf. Trinio); 6, valvula flosculi masculi (valvula flosc. masc. sup. Trinio). Cl. Trinio argumento fuisse videtur incisura apicis hujus valvulæ, quæ sane superioris magis quam inferioris indicium; accuratius autem rem examinando plerumque apiculi intermedii vestigii invenimus, et si istius vestigia nulla adessent, non obliviscendum tamen, in Saccharinearum tribu ubicunque setæ sive arista valvulam terminat, hanc e sinu apicis bifidi ortum ducere, nec nisi laciniis deletis, quod quidem in hujus generis flosculo hermaphrodito accidit, videri pure terminalem. Tum vero in spiculæ mascula valvula inferior flosculi masculi vel omnino absorpta deesse videtur, vel ubi magis evoluta superstes est, *apice* ad typum primitivum *bifido*, sinu vel nudo vel setulæ vestigio prædito, venit in conspectum. 11, Codiculæ (figura mala); 7, spicula hemiologoma a latere glumæ superioris; 8, eadem, a latere; 9, gluma superior (valvula neutra Trinio); 10, flosculus uterque, neuter ad dextram, hermaphroditus setiger ad sinistram (flosc. hermaphroditi valvulæ inferior ad sinistram, superior ad dextram, ex Trinio). *Lipiocercidis* nomen, si defectum glumæ superioris significet, utpote ex errore natum, mutandum fuisset: de vera interpretatione autem vocis λειποκερκις ex sententia auctoris cum plurima ad hucdum dubia restent, rem intactam relinqui.

1. L. *serrata* (Trin.:) glumis apice tridentatis, spicis solitariis geminisve.—*Tr. Agrostogr. p.* 203. *t.* 18; *Wight. cat. n.* 1687.—Andropogon caricosum, *Linn. sp. pl. p.* 1480; *Thunb. Jap. p.* 39; *Kunth. en.* 1. *p.* 507; *Roxb. in cæt. merc. Ind. or. mus. tab.* 873.——A. serratus, *Retz. obs.* 3. *p.* 21; *Willd. sp. pl.* 4. *p.* 903; *Kunth. en.* 1. *p.* 490; *Roxb. fl. Ind.* 1. *p.* 253 (ubi errore calami vel typographico verba "involucre smooth, glossy, keeled, pointed," pro "interior (i. e. gluma interior) smooth, &c."); (*ed. Wall.*) 1. *p.* 257.

Hab.—In Peninsula Ind. or. et in Benghala; *Roxburgh*, *Wight*, aliique.

Synonymon Rumphii hujus certe graminis non est. Malus haud raro quidem exhibuit Rumphius figuras præsertim graminum, sed adeo pessimas dare, nostrum si pingere voluisset, certo nunquam potuisset.

2. L. *digitata* (N. ab E.:) glumis apice integris, spicis fasciculatim divisis rariusve solitariis.—Andropogon mollicomus, *Trin. in Act. Petrop.* 7. *p.* 276 (excl. syn. *Kunth.* et *Sieb.*).—A incurvatus, *Koen. in herb. Banks.* (non *Retz.*)

β; spicis solitariis.

Hab.—In Benghala boreali; *Royle.* In Peninsula?; *Koenig.*

Distincta a L. serrata foliis vaginisque omnino glabris, illis margine angusto cartilagineo pallido scabriusculo cinctis, spiculisque minoribus. Folia 2–2¼ pollices longa, vix lineam lata. Spiculæ sessiles lineam longæ, sordide virides; glumæ herbaceæ, 6–8-nervosæ, apice obtusæ, integræ; spiculæ masculæ aut neutræ similes; si neutræ, minores. Spiculæ sessiles flosculus superior semper hermaphroditus.

3. L. *mollicoma* (N. ab. E.)—Andropogon, *Sieb. maur.* 1. *m.* 48.—A. mollicomus, *Kunth. rev. gram.* 1. *p.* 365. *t.* 96; *en.* 1. *p.* 497.

Hab.—In insula Mauritii; *Sieber.*

IV. HOLOGAMIUM. *N. ab E.*

Trib. Sacchårineæ. § Andropogoneæ.

Spiculæ in rachi angusta geminatæ, quadrifariæ, heterogamæ, polygamæ, subconformes, altera sessili monoica setigera; altera pedicellata, mascula, subsetigera. Glumæ duæ, nervosæ, inferior herbacea, plana, attenuata, apice bifida, spiculæ sessilis parinervis (8-nervis) canaliculata angustior, spiculæ masculæ imparinervis (5–7-nerv.) nervis valde prominulis, latior; superior gluma carinata, chartaceo-membranacea, spiculæ sessilis apice setigera, spiculæ pedicellatæ mutica. Flosculi duo, bivalves, valvulis membranceis subæqualibus ciliatis; inferior spiculæ sessilis masculus, muticus; superior femineus, valvula inferiori ex apice bifido setam validam lævem inferius canaliculatam emittente, superiori flosculi masculi valvulæ superiori simili. Lodiculæ crassæ, trigonæ, obconicæ, truncatæ, coloratæ, glabræ, in utroque flosculo similes. Stamina flosculi masculi tria, antheris luteis. Styli flosculi feminei duo, graciles, basi conjuncti, stigmata laxe penicilliformia, pallida. Caryopsis libera. Flosculi spiculæ pedicellatæ duo masculi, uterque bivalvis, valvulis subæqualibus omnibus muticis.

Inflorescentia: spica *solitaria.* Heteropogonis, *laxiuscula, spiculis sat speciosis, masculis præsertim valide regulariterque nervosis, ciliatis.* Racheos *articuli et pedicelli compressi, plumuloso-ciliati.*—Gramen *perenne.* Culmi *duri, graciles.* Vaginæ *arctæ, internodiis breviores, striatæ, superne tuberculatæ et hispidæ.* Ligula *ciliata.* Folia *angusta, acuminata, plana, rigidula, striata, scabra, ad basin contractam utrinque plica callosa prædita, glaucescentia.* Spiculæ *lanceolatæ, sessiles,* 3 *lin.,—pedicellatæ,* $3\frac{1}{2}$ *lin. longæ.* Spica *exserta,* 3–4 *pollices longa, subundata.* Seta (*dempta valvula* $1\frac{1}{2}$–2 *lin. longa*) *pollice longior, lævis, flexuosa, inferne purpurea et canaliculata.*

1. H. *nervosum* (N. ab E.)—*Wight. cat. n.* 1689.—Andropogon nervosus, *Rottl.; Willd. in act. am. nat. cur. Ber.* 4. *p.* 218; *Roem. et Schult. syst. veg.* 2. *p.* 812.—*Kunth. en.* 1. *p.* 507.—A. striatus, *Willd. sp. pl.* 4. *p.* 903; *Kunth. l. c. p.* 487.—Pollinia striata, *Spr. pug.* 2. *p.* 12; *syst. veg.* 1. *p.* 288 (*excl. syn. Ait. et Brown*).

Hab.—In Ind. or.; *Rottler, Wight.*

Ad *Schizachyrium* perperam duxi hanc speciem in Agrost. Bras. p. 332.

(To be continued.)

Description of several New or Rare Plants which have lately Flowered in the neighbourhood of Edinburgh, chiefly in the Royal Botanic Garden. By Dr Graham, Prof. of Botany.

Gerardia aphylla. *10th December* 1834.

G. *aphylla*; caule erecto, virgato, 4-gono, base simplice subpiloso, sursum glabro parce ramoso, subaphyllo, squamis ovatis minutis decussatis, floribus suboppositis, pedicello longioribus *(floribus rubris).*

Gerardia aphylla, *Nuttall,* Genera, 2. 47.—*Elliot,* Bot. of S. Carolina and Georgia, 2. 114.—*Sprengel,* Syst. Veget. 2. 807.

Description.—*Root* annual. *Stem* erect (in native specimens 3 feet high), 4-sided, somewhat hairy towards its base, in the specimen described simple, native specimens sparingly branched towards the top. Minute leaves said to be occasionally observed, the only substitutes which I have seen are small scales, green, somewhat fleshy, ovate, below reflected and hairy, higher up subappressed and smooth, opposite and decussating. *Flowers* in terminal spicate racemes on the stem and branches, subopposite and decussating like the scales, from the axils of which (now reduced to extremely minute subulate bracteæ) they spring. *Pedicels* erect or slightly arched outwards, glabrous, enlarging a little towards the campanulate, glabrous, 5-toothed, persisting *Calyx. Corolla* (half an inch long, half an inch across) rose-coloured, except in its short narrow tube, which is nearly colourless; above this campanulate, gibbous, and longest on its lower side, and there slightly spotted within; limb 5-lobed, lobes rounded, entire, veined, ciliated, the lowest the narrowest, two upper ones woolly within at the faux. *Stamens* included, inserted into the tube of the corolla, filaments very unequal in length, spreading in the middle, converging at the apex, where the two longest meet. *Anthers* yellow, greenish along the edges, oblong, lobes pointed at both extremities, slightly divaricated at the lower, connective slightly pointed at the apex between the lobes; pollen granules pale yellow, very minute, oblong. *Pistil* included; stigma blunt, lobes cohering, the lowest the longest; style passing through the woolly lining of the upper part of the corolla, and stretching a little beyond the stamens, slightly hairy, flattened towards the stigma; germen globular, green, shining, placed upon a small disk of darker green, bilocular; ovules very numerous, placed upon the central placentæ.

This very pretty plant came up in soil in which Mr Cunningham had imported from North America plants of *Dionæa muscipula*, and flowered in the stove at Comely Bank in November, the first time, I believe, in Britain. The geographical distribution of the species is said by Nuttall to be from North Carolina to Florida. I have excellent specimens from Alabama, communicated by my kind friend Dr Torrey of New York.

Indigofera violacea.

I. *violacea;* fruticosa; foliolis 6-jugis, oblongis; racemis axillaribus folio demidio brevioribus; leguminibus strictis, subcylindraceis, glabris, 6–10-spermis.—*Roxb.*

Indigofera violacea, *Roxb.* Fl. Indica, 3. 380.—Bot. Mag. 3348.

Description.—*Shrub* (with us 5 feet high) erect, branches suberect, round, pubescent when young, bark brown, with straight, slightly prominent continuous longitudinal lines, slightly warted on the older branches. *Leaves* ($2\frac{1}{2}$ inches long) pinnated, leaflets in five pairs, obovato-elliptical, flat, slightly pubescent on both sides, the hairs, as most commonly in the genus, fixed by the middle and adpressed, rufous upon the young leaves and on the extremities of the twigs. *Stipules* and *stipellules* bristle-like, hairy, marcescent, the former spreading, the latter erect. *Racemes* axillary, longer than the leaves; flowers 12–20, continued nearly to the bottom of the pubescent peduncle; pedicels nearly twice as long as the concave-subulate deciduous bracteæ, from the axils of which they spring. *Calyx* rather shorter than the pedicel, pubescent, rotate, 5-toothed, the lowest tooth the longest, the two upper distant. *Corolla* large and handsome, nectariferous at the base; vexillum erect, elliptical, concave, with a white slightly striated spot on the inside near its base, above which it is reddish-purple, passing into lilac, and becoming gradually paler upwards, nearly sessile, and somewhat callous at its insertion into the calyx; alæ scarcely shorter than the vexillum, of a bright deep rose colour, spread out horizontally in the centre of the flower, the upper (inner) edges being straight and in contact, the lower (outer) edges hatchet-shaped, attenuated downwards, swollen at the base, and there slightly hairy and gibbous on the outer and upper sides, its short tooth-like claw being projected from the lower edge; keel rather longer than the alæ, rose-coloured in its edges, everywhere else pale lilac, its petals united except at the claws, which are callous, at first straight, and afterwards bent down elastically, separating very widely the keel and alæ from the vexillum, somewhat hairy towards its edge and back, toothed on the upper edge of its claws, and having a distinct papilla on each side. *Stamens* diadelphous, included within the keel; filaments purple, glabrous, a very short ascending portion only being free; anthers green, mucronate, pollen-granules extremely minute. *Pistil* little longer than the stamens; stigma minute; style pubescent; germen linear, glabrous; ovules about 10.

This very handsome shrub has stood for several years in the open air in the Botanic Garden, Edinburgh, and flowered for the first time in July 1834. We received it from Mr Thomas Hogg, Clapton, in 1820, marked with a query as a species of *Indigofera*. It differs from Roxburgh's description of *I. violacea* in having the raceme rather longer than the leaf. I should have considered it his *I. arborea*, had it not been that the branches are erect, not "spreading in every direction," and had it not been reasonable to expect that *I. arborea* would have attained a larger size in a shorter time. There is a very near affinity between *I. cassioides*, Rottl., *I. violacea*, Roxb., *I. arborea*, Roxb., *I. Jirahulia*, Hamilton, and the specimens which I named *I. verrucosa* in Wallich's List of Plants in the East India Company's Museum. If they shall prove to be specifically the same, the name of *I. cassioides* should be adopted, as published by De Candolle in his Prodromus in 1825. I have no specimen of *I. violacea* from the Botanic Garden, Calcutta, with which to compare our plant, and the specimens of *I. arborea* from thence have the branches much diffused.

Phaca canescens.

P. *canescens;* tota canescens; caule subrobusto, subramoso; foliolis 8–12-jugis, oblongo-linearibus, obtusis, submuticis, stipulis ovato-acuminatis; racemo axillari, multifloro, laxo, pedunculato; pedunculo fructifero, folium superante; leguminibus pubescentibus, ovatis, apice attenuatis.

Phaca canescens, *Hook. & Arnott*, Bot. Miscel. vol. 3. p. 185,—*Cuming's* Herb. No. 735.

Description.—*Stem* elongated, slightly branched, hoary-pubescent, somewhat flexuose, nearly round. *Leaves* (3 inches long) divaricated; leafets (9 lines long, $2\frac{1}{2}$ broad) in 10–12 pairs, oblongo-linear, hoary-pubescent on both sides, concave above, nearly pointless. *Stipules* acuminato-subulate, adhering for a little way round the stem at the base. *Racemes* axillary, on peduncles, gradually elongating, and when in fruit as long as the leaves. *Flowers* scattered loosely upon a rachis as long as the peduncles, spreading upon very short pedicels. *Calyx*, like the peduncle, pedicel, and every part of the plant, except the corolla, stamens, and style, hoary, the lower teeth the longest. *Corolla* pale rose-coloured; vexillum, which is the darkest petal, and slightly striated, elliptical, erect, reflexed in the sides, and keeled, slightly notched; alæ rather shorter than the vexillum, hatchet-shaped toothed at the base, claw linear, thrice as long as the tooth; keel half as long as the alæ, blunt, flattened on its lower side, tipped with greenish-yellow, its petals free only for a little way above the insertion of its linear claws, its teeth short and blunt. *Stamens* diadelphous, filaments glabrous, anthers orange-coloured, pollen-granules small, round, glistening. *Germen* covered with white silky hairs. *Legume* (unripe) turgid, ovate, somewhat compressed, pubescent, about 5-seeded.

This plant, found by Mr Cuming at Valparaiso, we received in the Botanic Garden, Edinburgh, from that of Birmingham in spring 1834. It flowered in the greenhouse in June and July.

Rhodochiton volubile.

Generic Character.—Calyx membranaceus, coloratus, campanulatus, 5-fidus. Corolla; tubus anguloso-clavatus, interne pilis simplicibus reflexis, basi ubique, faucem versus 5-fariam, vestitus; limbus 5-partitus, segmenta subæqualia erecta. Stamina didynamia, rudimento quinti, erecta, apicibus simplicibus. Stylus sub stigmate rectus.

Rhodochiton volubile, *Zuccharini.*—Bot. Mag. 3367

Lophospermum Rhodochiton, *Don*, in Sweet's British Fl. Garden, 250.

Description.—*Stems* filiform, branched, twining, subcylindrical, firm, purple, sparingly covered with minute, glandular hairs. *Leaves* (fully 3 inches long, nearly as much broad) alternate, petioled, rounded and cordate at the base, acuminate, lobed, dentate, strongly nerved, when young of dark greenish-purple, when older bright green above, below pale, and at length with a purple tinge, sparingly covered with short glandular pubescence on both surfaces, nerves prominent below, channelled above; petioles about as long as the leaf beyond the sinus, volubile, channelled above. *Peduncles* axillary, solitary, pendulous, filiform, purple, longer than the leaves, flexuose and spirally twisted, when young glanduloso-pubescent, afterwards nearly glabrous, shining. *Flower-buds* ovate. *Flowers* pendulous. *Calyx* (nearly 1 inch long, rather more across) campanulate, spreading from the base, 5-cleft, shining, deep purple, reticulate, externally slightly glanduloso-pubescent afterwards nearly glabrous, on the inner surface pretty copiously covered with rather long glandular pubescence; lobes ovate, acute, in the bud closely imbricated, after expansion slightly connivent, and later somewhat spreading at the apices. *Corolla* twice as long as the calyx, of much deeper purple than it, covered externally with glandular pubescence; tube clavato-cylindrical, unequally 5-sided, dilated at its base where it incloses the germen, internally towards its base uniformly and rather densely covered with blunt white inverted simple pubescence, which, higher in the tube, is nearly confined to the longitudinal angles corresponding to the external depressions; and is nearly awanting on the uppermost of these; limb glabrous within, and externally less pubescent than the tube, of five elliptical, blunt erect lobes, of which the two upper are rather the shortest and broadest, the lowest the narrowest and rather the longest. *Stamens* subequal, rather longer than the tube; filaments straight, purple, glabrous, shining and filiform above, near their base, dilated, somewhat flattened, paler and covered with inverted hairs similar to those on the inside of the tube, to which they adhere (at the same time becoming smooth) as it passes round the germen; anthers smooth, dark violet-coloured, lobes elliptical divaricated, bursting along their outer edges; pollen white, granules minute, oblong. There is a minute abortive stamen between the bases of the two upper perfect ones. *Stigma* of two minute, erect white lobes. *Style* filiform, scarcely deflected, rather longer than the stamens, glabrous, or with a very few scattered hairs towards the base. *Germen* green, ovate, compressed, glanduloso-pubescent, placed obliquely upon a smooth fleshy disk. *Ovules* very numerous, globular, on podosperms as long as themselves.

This plant, native of Mexico, was received at the Botanic Garden, Edinburgh, from Mr Low of Clapton, who had it from Berlin, and has flowered with us very freely in the open border during September and October. It seems perfectly hardy, and is highly ornamental.

I regret that I have not seen the original observations on the genus by Professor Zuccarini, but I cannot agree with Mr Don in uniting it with *Lophospermum*, though undoubtedly these genera are very nearly allied. The following contrast shows the ground of this opinion:

Rhodochiton.—*Calyx* membranous, 5-cleft, campanulate, segments connivent in the bud, and long after. *Corolla*, tube clavato-cylindrical, with distinct angles, hairs on inside reflected, and occupying the five angles; limb erect. *Stamens* subexserted, filaments nearly glabrous, erect, simple at the apex. *Style* scarcely deflected, straight below the stigma.

Lophospermum.—*Calyx* herbaceous, 5-parted, segments prominent at the edges, and spreading at the apices even in the youngest state of the bud. *Corolla*, tube campanulate, turgid below, hairs on inside erect, and occupying two dense lines; limb spreading. *Stamens* included, filaments deflected, glandular towards the anthers, with a tubercle or short blunt branch at the apex. *Style* deflected, bent to a right angle immediately below the stigma.

Proceedings of the Royal Society of Edinburgh.

1834, *Jan.* 20.—Sir THOMAS MAKDOUGALL BRISBANE, K.C.B President, in the Chair. At this meeting the following communication was read :—

On the Principle of Vital Attraction and Repulsion, with some applications to Physiology and Pathology. By Dr Alison.

THE object of this paper was, to state and estimate the scientific value of a variety of facts, which have been recorded by various physiologists ; and many of which have been verified by personal observation, in proof of the proposition,—That the fluids of living bodies, or in immediate contact with them, are in many instances liable to movements,—dependent on the vitality of those bodies, but independent of any vital contractions of their solids,—and which can hardly be conceived to be effected otherwise than by certain *attractions* and *repulsions,* peculiar to the living state.

Five classes of observations, perfectly distinct from one another, were stated in proof of this general proposition.

I. The first are those made on the regular progressive movements of juices (made visible by whitish globules) in many kinds of vegetables, to which the name of *Rotation* has been given in the case of the cellular plants, such as the Chara and Caulinia, and that of *Cyclose* in the case of cellular plants with emitting juices, such as the different species of Ficus,—movements which go on nearly uniformly, under considerable variations of temperature, and of other external circumstances, while life continues ; and which are not only unattended with any visible contractions of the parietes of the cells or vessels containing the fluid, but are of such a nature, as no contractions of these parietes appear capable of producing, as appears particularly from the elaborate inquiries of Schultze, Amici, Nisbet, and Cassini. This conclusion is the more important, as it is probably applicable to nearly all the movements, peculiar to life, in the fluids of vegetables, although the observations on which it rests can be satisfactorily made on those only which contain opaque globules.

II. The second set of facts are those connected with the *visible currents,* which take place in water, in contact with many living bodies ; as ascertained, *first,* By the observations of Dutrochet and of Dr Grant on living sponges ; *secondly,* By those of Dr Sharpey, M. Quillot, and M. Raspail, on many aquatic animals, chiefly mollusca and the larvæ of reptiles ; and, *lastly,* By those of M. Raspail, and of many others, on certain animalcules, chiefly of the genus Vorticella. In all these instances, facts seem to be established, which are altogether inconsistent with the supposition of the movements depending merely on contractions or vibrations of any living solid textures.

III. The third class of facts adduced on this subject consists of those which show, that, in the fœtal state of animals, different parts are successively developed from the semi-fluid matter of the ovum; and the particles of that matter must therefore have been much and variously moved before the heart acts, or any contractile vessels have been formed; and farther, that the human ovum itself, during the time when it is surrounded on all sides by the shaggy chorion, must draw its nourishment from the semi-fluid matter contained in the uterus, through the filaments of the chorion, without the aid of any contracting vessels in these filaments. These points appear established by the observations of Prevost and Dumas, Breschet, Velpaeu, Raspail, and others.

IV. The author considers the existence of attractions and repulsions, peculiar to the living state, among certain of the particles of the blood of animals, to be established by due consideration of the following facts:

1. By the phenomena of the coagulation of healthy blood, and the utter absence of any contemporaneous mechanical or chemical change, adequate to explain the change of aggregation of the particles of the fibrin, on which that process depends.

2. By the great retardation of that process, when blood (although its circulation is arrested) is confined within a healthy living texture.

3. By the great acceleration of that process, when the living texture, in which blood is contained, is severely injured.

4. By the total suspension of that process, when death is produced by a sudden and violent cause, especially by a cause which at the same time destroys the power of contraction after death in muscular fibres.

5. By the different modifications of that process, which are observed in inflammation.

6. By the phenomena which are observed in those portions of blood, which are extravasated in inflamed parts.

In proof of these points, the author refers partly to personal observation, and partly to the works of Hunter, Hewson, Thackrah, Scudamore, Prater, Schræder van der Kolk, Velpeau, Gendrin, Royer-Collard, and Kaltenbrunner.

V. The last set of observations, adduced in support of the general principle, are those which, in reference to more complex questions in physiology, are the most important, viz. those which indicate that the blood circulating in the capillary vessels of living animals, and examined by the microscope, exhibit a variety of movements, and changes of movement, which no visible or conceivable vital contractions of the heart and arteries are adequate to explain.

Most of these facts, as to the capillary circulation, were accurately described, and the conclusion, which appears inevitable from them, as to the existence, in the living state, of a peculiar cause of movement inherent in the blood itself, or at least independent of any impulse from contracting solids, was stated and carefully limited by Haller. In regard to the rest, the author refers, not only to personal observations, but chiefly to the authority of Dollinger, Wedemeyer, and Kaltenbrunner in Germany, and of Quillot and Leuret in France.

The analogies which may be traced, between the principle which seems thus established, and other ascertained laws both of living beings and of inorganic matter; and the applications which may be made of it, to the explanation of the more complex phenomena of the living body in health and disease, were reserved for a future communication.

Feb. 3.—Sir THOMAS MAKDOUGALL BRISBANE, K. C. B. President, in the Chair. The following communications were read :—

1. Notice of some recent discoveries in Organic Chemistry. By William Grego y, M.D.

The author in this paper communicated to the Society an account of Creazote, a new organic principle lately discovered by M. Reichenbach, which possesses remarkable antiseptic properties, and is the source of the antiseptic power of wood-smoke, empyreumatic pyroligneous vinegar, and other empyreumatized substances; also of a very volatile fluid, lately put into his hands by Mr Enderby of London, which is obtained by the destructive distillation of caoutchouc, and possesses in a higher degree than any other menstruum the property of dissolving that substance ; and lastly, of three new crystalline bodies which have lately been discovered by M. Robiquet, and other French chemists, in opium, and which are named Narceïne, Meconine, and Codeïne. Specimens of the several substances were exhibited.

The author stated, more particularly in regard to the last of these principles, that although in common with the two other newly discovered principles of opium, it constitutes an extremely small proportion of that drug, it may be obtained in a tolerably large quantity from the muriate of morphia of commerce, which appears to contain about a thirtieth of codeine.

From experiments made on various healthy individuals with codeine, obtained in this manner, he is led to infer, that in the doze of three, four, or five grains, it is distinctly stimulant in its action, and to suspect that it may be in part the cause of the disagreeable exciting effects produced by opium in some particular constitutions.

Feb. 17.—JAMES RUSSELL, Esq. V. P. in the Chair. The following communications were read :—

1. Analysis of Coprolites from the Limestone of Burdiehouse. By A. Connell, Esq.

These coprolites, as well as the limestone where they are found, contain a trace of animal matter, as ammonia is disengaged at a red heat.

Muriatic acid dissolves the greater part with slight effervescence. Ammonia throws down from the solution a copious gelatinous precipitate of phosphate of lime ; and in the remaining fluid, oxalate of ammonia throws down oxalate of lime. The matter left undissolved by the muriatic acid is inflammable, leaving a small siliceous residue, and appears to be bituminous matter derived from the matrix. There is no magnesia, sulphur, nor fluorine.

The analysis of two coprolites, measuring from two inches to two inches and a half in length, and containing each a few fish scales, gave the following numerical results.

Phosphate of lime with a little oxide of iron.	85.08	83.31
Carbonate of lime,	10.78	15.11
Silica,	0.34	0.29
Bituminous matter,	3.95	1.47
	100.2	100.00

The proportion of phosphate of lime, appears thus to be pretty uniformly 5-6ths of the whole. The variation in the proportion of carbonate of lime may probably be influenced by the matrix, from which also the bituminous matter is derived. The limestone, when dissolved in muriatic acid, leaves a dark bituminous matter, in the proportion of 2.5 per cent.

2. Notice relative to the Polyzonal Lenses belonging to the Commissioners of the Northern Light-houses. By Alan Stevenson, Esq.

These lenses, which were exhibited to the Society by Mr Stevenson, are three in number. One, a plano-convex lens, two feet six inches square, was made by M. Soleil at Paris, under the superintendence of the late M. Fresnel. Another is a double convex circular lens of flint-glass, three feet in diameter, which was constructed by the Messrs Gilbert of London, at the suggestion of Sir David Brewster. The third is a circular plano-convex lens, two feet six inches in diameter, cast in one piece as originally proposed by Buffon. This lens has been executed for the first time by the Messrs Cookson, plate-glass-makers, Newcastle.

The author, with the assistance of Mr John Adie jun., made a numerous set of observations, to determine the relative value of these lenses, and for this purpose ascertained, *first*, the mean focal distance of the central lens, and the several concentric rings of each, comparing the results with the focal distance of its aggregate surface; and *secondly*, the mean diameter of the spectra produced in the focus, by the central lens and several zones separately, comparing this result also with the spectrum formed by the whole compound lens. The general results are as follows:—

	Focal Dist. Feet.	Focal Dist. In.	Diam. of Spec. In.
FRENCH.			
Mean for central lens and 5 rings severally,	2	11.65	0.66
Aggregate surface of whole lens,	3	0.25	0.70
Difference,	0	0.60	0.04
NEWCASTLE.			
Mean for central lens and 5 rings severally,	2	11.97	0.57
Aggregate surface of whole lens,	3	0.75	0.75
Difference,	0	0.78	0.18
LONDON.			
Mean for central lens and 4 rings severally,	3	1.90	0.84
Aggregate surface of whole lens,	3	3.00	1.25
Difference,	0	1.10	0.41

The conclusion at which he arrives is, that the Newcastle lens is scarcely inferior to the lens made in Paris; and that the Messrs Cookson are undoubtedly entitled to the merit of having successfully combated the difficulties which attend the making of polyzonal lenses in one piece,—difficulties previously considered insurmountable, but which they have overcome at the first attempt. The author expects that some of the particulars of the method by which they effected their purpose will be communicated to the British Association at their meeting at Edinburgh in September next.

March 3.—Sir THOMAS MAKDOUGALL K. C. B. President, in the Chair. The following communications were read :—

1. On a New Register Anemoscope. By Dr Traill.

The author's object was to obtain an instrument which might register the changes of the wind in the absence of the observer. For this purpose he connected a vane with a vertical axis, at the lower end of which the horizontal revolution was changed to a vertical revolution by bevelled wheels; and the axis of the vertical wheel carried an index and pencil; which described on a vertical dial of slate, or of polished porcelain, all the changes experienced by the vane above. In this manner, however, the instrument registered the changes occurring during only one revolution of the vane. In order to obtain the registration of a greater variety of changes,—when the wind has blown all round the compass more than once, the following addition was made. "Each bevelled wheel containing 42 teeth, a pinion of 21 leaves was fitted to the axis of the vertical wheel, which pinion plays in the teeth of a smaller wheel with 42 teeth also provided with a pinion of 21 leaves. This last moves a second small wheel of 42 teeth, which again turns round the axis of the primary vertical wheel. The last small wheel moves a second index which turns round the dial-plate once, while the vane and primary index make four complete revolutions. The second index carries a stud, which moves in either direction a pair of hands concentric with the indices, but not attached to their axis. This stud, then, will carry one of the hands through 90 degrees, while the vane has made one complete revolution; or the hands are capable of indicating four entire revolutions of the vane. The face of the instrument has three concentric graduations. The interior is the rhumbs of the mariner's compass; the second has the degrees of a circle; and the outer scale has four series of 360 degrees."

2. On the force of the Latin Prefix *ve* or *vae*. By the Rev. John Williams.

March 17.—JAMES RUSSELL, Esq. Vice-President, in the Chair. The following communications were read :—

1. Notice of Experiments on the Diminution of Intensity sustained by the Sun's rays in passing through the Atmosphere. By Professor Forbes.

This subject, though in itself deeply interesting, and leading to conclusions of much importance for elucidating many obscure questions connected with the constitution of the Universe, has hitherto received but little attention. *Bouguer* attempted to fix the actual amount of diminution approximatively, by comparing the moon's light with that of wax candles at different ascertained elevations; and in this way obtained data, from which he inferred, that about a fifth part of the entire rays of the sun is absorbed in traversing the atmosphere vertically. *Lambert* concluded, that the loss sustained is much greater. By observing at two altitudes of the sun, the difference of temperature indicated by a thermometer in the shade and exposed to the suns rays, and, determining by theory the proportion of air traversed at these altitudes, he inferred the loss at a vertical incidence to be $\frac{6}{10}$ths of the whole. On these slender foundations some philosophers have ventured to found most important conclusions on various subjects of transcendental speculation;—such as the temperature of the sun's surface, and the temperature of planetary space.

Facts, however, of much greater value may be looked for, since the invention of Sir John Herschel's actinometer. Proceeding like Lambert on the principle, that the heating and illuminating powers of the sun's rays are proportional, this instrument measures the light by measuring the heat they produce. But, avoiding the great defect of Lambert's method, viz. the assumption, that the stationary condition of the thermometer is proportioned to the heating cause, a law which would only hold, if the cooling influence on the thermometer were invariable; Herschel proposes to ascertain, by an extremely delicate thermometer, *first*, the velocity of heating in the sun's rays, or the number of degrees passed through in a given short space of time, and then, *secondly*, the rate of cooling in the shade. The algebraic difference of these expresses the excess of one effect over the other. These data will obviously supply the means of measuring the true intensity of the sun's rays; since the velocity of changing temperature is known by Newton's law to be the measure of the producing cause.

Having made these preliminary explanations, the author proceeded to observe, that, at the request of Sir John Herschel, he had made some observations with two instruments entrusted to him by that gentleman during his visit to the Continent in 1832. Twenty series of observations were made on six different days in Swizerland at various altitudes, the comparative observations being made by Professor Kamtz of Halle in the overland of Berne. The columns of air varied from 5000 to 7000 feet. On one day, observations were made every hour from sun-rise to sun-set. Every observation indicated increased radiation at the higher station, and the general diminution appeared to be not less than $\frac{1}{5}$th for the thickness just mentioned, which is a far greater proportion than was assigned even by Lambert.

The author found, by an extensive series of experiments made at the Observatory of Paris, that, in favourable circumstances, the numerical estimate of radiation by Herschel's instrument may be relied on to $\frac{1}{100}$th of its amount.

3. On a Register Barometer for indicating Maxima and Minima. By Dr Traill.

April 7.—Sir Thomas Makdougall Brisbane, K. C. B. President, in the Chair. The following communications were read :—

1. Remarks on the Remains of an Oak dug from a Peat-moss near Lanfyne, Ayrshire. By Thomas Brown, Esq.

[This memoir published in Vol. xvii. of this Journal.]

2. Analysis of Levyine. By Arthur Connell, Esq.

A few years ago, this mineral was described as a new species by Sir David Brewster, on account of peculiar optical properties ascertained by himself, and its crystallographic characters, as determined by Mr Haidinger. Berzelius, however, inferred from the analysis of a specimen sent to him by Sir David Brewster, that it is merely a variety of chabazite, its chemical constitution appearing to be, Silica 48, Alumina 20, Lime 8.35, Magnesia 0.4, Potash 0.41, Soda 2.75, Water 19.30. But, from a subsequent explanation, it seemed probable that Berzelius had analyzed not the true levyine, but a mixture of this and chabazite, constituting the specimen which was sent. The author therefore considered it desirable to execute a new analysis of the mineral in question, which he has found to yield the following results :—

Silica, . . .	46.33
Alumina, . .	22.47
Lime, . . .	9.72
Soda, . . .	1.55
Potash, . . .	1.26
Oxide of Iron, .	0.77
Oxide of Manganese,	0.19
Water, . . .	19.51
	101.77

The specific gravity is 2.198, the fundamental crystalline form a rhomb 79° 29′, as stated by Mr Haidinger, while that of Chabazite is 94° 46′. Sir David Brewster found the crystals to possess one axis of double refraction, like other rhombohedral crystals, while the optical properties of chabazite are very anomalous. It is impossible, therefore, to consider the two minerals to be the same, without disregarding several marked differences.

April 21.—Sir Thomas Makdougall Brisbane, K. C. B. President, in the Chair. The following communications were read :—

1. Summary of the Discoveries hitherto made in the Ossiferous Beds of the Basins of the Forth and Clyde. By Dr Hibbert.

The author gave a summary of the discoveries which had taken place during the course of the session relative to the ossiferous beds of the basins of the Forth and Clyde. The additional information contained in his paper comprised, in the first place, an account of the older class of strata upon which the carboniferous group of rocks (in which saurian remains had been found) were supposed, in an unconformable position, to rest. Some of these were referred to a system of beds, which geologists consider as of a newer transition class, intermediate to grauwacke schist and coal strata. Thus, it was found that a peculiar hard and gray sandstone, containing mica, and occasionally alternated with siliceous schist,—which in Shetland succeeds to clay-slate; which, near Loch Ness, succeeds to a transition granite; and, on the north of the Tay, to grauwacke schist,—was thrown up on the south of the Forth, near North Berwick, in the form of immense severed beds or fragments, shewing that this transition-rock (an important one in the series of Scottish strata) is to be regarded as in some places fundamental to the coal measures of the district. This older grey sandstone is also alternated, either with aluminous strata of the same general character, or with a hard sandstone of a reddish colour.

The carboniferous deposits inclosing saurian and other remains which rest in an unconformable position upon these strata, were formerly shewn to contain inferior beds of sandstone, shale, and fresh-water limestone, together with very thin seams of coal and ironstone; and to be succeeded, first, by a limestone containing marine shells, encrinites, corallines, &c., and afterwards by extensive coal measures which formed the upper beds of the series. This is shewn in the following general section of the strata connected with the limestone of Burdiehouse.

In arguing from these appearances, the author considered that, at the commencement of the Carboniferous epoch, the coal beds of the Forth and Clyde did not, agreeably to received theories, indicate an Archipelago of islets, like those of the Pacific, little elevated above the level of the sea, but, on the contrary, an unbroken expanse, bounded on the north by the elevated ranges of the Grampians, and on the south by the high ridge of grauwacke schist which runs from St Abb's Head to the Mull of Galloway; and that while the higher lands might have encouraged the growth of coniferæ, the ferns, equiseta, and other monocotyledonous plants of our coal-fields, flourished amidst marshes, or on the borders of fresh-water lakes, tenanted by entomostraca, conchifera, and fish, and to which resorted various saurian animals. This land, as had been previously remarked, appears to have undergone a depression, probably of a gradual nature, by which it became liable to the inroads of the sea. Eventually, however, (as the extensive coal strata lying above the marine limestone sufficiently indicate), the land became once more elevated above the ocean, and again afforded a soil to the Flora of tropical climates.

The author next remarked, that he had found a fresh-water deposit, like that of Burdiehouse and Calder, to extend to Fifeshire, where it existed as a thinner bed; and that, in addition to the coprolites and fish discovered more than a year ago by Lord Greenock and Mr Trevelyan in the iron-stone nodules of Wardie, Mr Robison, General Secretary of the Royal Society, had procured saurian remains from the coal-field of Greenside near Glasgow, and had discovered large coprolites in the shale which is associated with the sandstone of Craigleith quarry.

Some remarks were made upon the remains of saurian animals, which had been more recently obtained for the Royal Society's Museum from the quarry of Burdiehouse, chiefly through the exertions of Mr Robison, and to which new acquisitions are daily adding. Among these, three distinct kinds seem to have been ascertained. The larger animal, the author thinks, rather approaches in character to the Steneosaurus of M. St Hilaire; but he suspects, at the same time, that such marks of difference exist, as must eventually authorize the assignment of the Edinburgh σαυρος to an entirely new genus. The other remains were supposed to resemble most those of the two kinds of Pterodactyli described by Cuvier. Bones also which appear to have belonged to a Trionyx have been discovered.

Lastly, the author adverted to prior notices of the actual discovery of saurian remains in the carboniferous group of rocks. Whitehurst, who wrote in the year 1778, and Pilkington, in his history of Derbyshire 1789, have each spoken of the remains of crocodiles and alligators which had been discovered in the limestone of Ashford in Derbyshire, from which locality the author has in his possession a specimen of fresh-water limestone, like that of Burdiehouse, containing plants. Four years afterwards, namely, in the year 1793, saurian remains like those of Burdiehouse, found in a bed above a seam of coal, were actually figured by the Rev. Mr Ure in his History of Rutherglen near Glasgow, though he was not aware of their real character. And very lately the discovery of a saurian vertebra in the mountain-limestone of Northumberland, by the Rev. Charles Vernon Harcourt, has been recorded by Mr Lyell in his Principles of Geology.

The author, in concluding, expressed his reluctance to allude to other occasional notices which had been published, regarding the discovery of similar remains, on account of their having been mistaken for those of fish. But, if found necessary, he will complete the history *.

2. Account of the Dissection of a Young Rorqual, or short Whalebone Whale, (the Balæna Rostrata of Fabricius); with a few Observations on the Anatomy of the Fœtal Mysticetus. By Dr Knox.

In February 1834, a young Whalebone Whale was taken near the Queensferry, in the Frith of Forth. After being exhibited for a short time by the proprietors, it was dissected by the author as carefully as time and circumstances would permit. The term Rorqual is employed throughout this memoir in the sense employed by M. Cuvier, as designating "Whalebone Whales, with longitudinal folds

* Professor Jameson's opinion in regard to these fossils, as defended before the Wernerian Society, viz. that they are remains of *true fishes, not of saurians*, has now been adopted by Dr Hibbert and Messrs Agassiz, Buckland, Robison, &c.

under the throat and chest." He thinks the present specimen quite distinct, specifically from the "Great Rorqual," (the Balæna boops, jubarte, musculus, &c.), and not as M. Cuvier seems to think it, a mere variety. Among other distinctions, the Great Rorqual has 13 dorsal, and 43 lumbar, sacral, and caudal vertebræ; while the individual now under consideration has only 11 of the former, and 36 of the latter. There are, therefore, at least two species of Rorquals inhabiting the North Seas, viz. the Great Rorqual, and the one now under consideration, a specimen of which was described by Fabricius (Balæna rostrata); another dissected by Hunter, and a third casually observed by James Watson, Esq., who sent a drawing of the same to Dr Traill, by whom it was communicated to Mr Scoresby.

The author had not leisure to examine the osteology with sufficient care; the following results have, in the mean time, been attained.

Internal and External Character.—Eight distinct bristles, arranged in perpendicular rows, were found in the extremity of the snout, in both jaws. The lower part of the mouth is a huge pouch, which, in the Great Rorqual, must at times contain a vast volume of water. The tongue was free towards the apex; and the inside of the mouth of a pale rose or vermilion colour.

The whalebone was about 2½ inches in length, varied from a pale rose colour to a dull white, and 614 large external plates were counted. No vestiges of teeth were found in either jaw; but it is not improbable that they exist in the fœtus of this species, as well as in that of the Mysticetus, in the lower jaw of which, lying imbedded below the gum, a series of teeth was discovered by M. Geoffroy St Hilaire several years ago; and in which the author of this paper has since observed them in the *upper jaw.*

Brain and Nervous System.—The cranium, besides containing the brain and its membranes, incloses a very large mass of a vascular substance, closely resembling an "erectile tissue." This forms an exception to the hitherto uniformly observed law of coincidence, at least in the Mammalia, between the configuration of the inner table of the skull and the contained brain. The erectile tissue filled a large proportion of the interior of the cranium, also three-fourths of the spinal canal, where it surrounded the spinal marrow and nerves; being in some places nearly two inches in thickness. The whole cerebral mass, comprising two inches of the spinal chord, weighed 3½ pounds; while the cerebellum, pons, and two inches of the chord, weighed only three-fourths of a pound.

Respiratory Organs.—The mode of breathing, and the structure of the nostrils, was precisely as in the Great Rorqual. Two bolster-like substances filled the nostrils, which are withdrawn from them at the moment of breathing by muscles provided for that purpose. There are turbinated bones in the nose and olfactory nerves, as large at least as the human. The author thinks it impossible for water to be habitually spouted through the nostrils. The Whalebone Whales have complex nostrils, and smell and breathe precisely as the higher orders of the Mammalia.

The *Stomach,* composed of four compartments, contained no food. The middle tunic of the *ureter* was composed of distinct longitudinal muscular fasciculi.

The author then proceeded to consider, at some length, a question which has lately arisen relative to the structure and functions of the abdominal glands of the Cetaceæ, and which has been six or seven times before the French Institute in the course of the late and present session,—viz. Whether these glands are mammiferous? M. St Hilaire conceives that they are not mammæ, and do not secrete milk, but that they are probably similar to those of the *Ornithorynchus paradoxus*, which he thinks are sexual, specific, and odoriferous, but not mammiferous.

The author first observed, that the question ought, in strictness, to be limited to the Whalebone Whales among the Cetacea; because the great group of the *Delphinus* was proved to be mammiferous long ago by Mr Watson, an extract of whose observations is given in "Scoresby's Greenland." He next stated, that his own observations left, in his opinion, no doubt whatsoever, that the similarly situated glands in the *Balæna rostrata* are also true mammæ. An elaborate anatomical examination shewed that they resembled the lactiferous glands of other mammalia in their structure. A cursory examination of the fœtal *Mysticetus*, led to the same conclusion in regard to that genus; and the author was farther informed by a former pupil, Mr Auld, that in the young Mysticetus harpooned, he had seen a fluid of a cream colour and consistence, and oleaginous taste and smell, issue abundantly from the mouth; and, in the full-grown females, he had forced out several pounds of a similar fluid from the orifices of the glands by pressure of the foot on the abdomen.

The specimen of Balæna rostrata examined by the author was 9 feet 11 inches in length, 3 feet from snout to ear, and 4 feet 8 inches in girth at the termination of the plicæ and folds.

Proceedings of the Wernerian Natural History Society.

1834, *Jan.* 18.—Professor Robert Graham, formerly V. P. in the chair.—Dr Traill read the description of a specimen of *Squalus cornubicus*, captured near Kirkwall, and also an account of the different species of Shark which occur in the Orkney seas. He at the same time exhibited to the meeting a specimen of the angel-fish (*Squalus Squatina*), which he had procured during a visit to the Orkneys.

The Secretary read a notice regarding the growth of a large herbaceous plant, apparently *Senecio jacobæa*, through a very small orifice in a leaden water-pipe, which had become completely choked up with the fibrous roots; communicated in a letter from J. W. Riddoch, Esq. Falkirk.

Professor Jameson then laid before the meeting an analysis, by Mr Walker, of the substance of the fossil tree found in the strata of Craigleith Quarry; shewing, that besides lime and alumina, and a comparatively small amount of silica, it contains a considerable proportion of carbonate of magnesia, the last being an ingredient not detected in the fossil trunks previously discovered in the same quarry.

1834, *Feb.* 1.—Professor Jameson, P. in the chair.—Dr Traill read a memoir of the Reverend George Low, the naturalist of Orkney, and laid before the meeting some of his unpublished sketches or drawings, and also specimens of his original notes.

At this meeting Dr Allen Thomson, at the request of the President, exhibited to the Society, and made remarks on some rare specimens in his possession, illustrating the subject of fœtal development in its early stages. 1. Five ova and fœtuses of the common cat, which were taken from the mother between the thirteenth and fifteenth day after impregnation. The entire ova are about $\frac{3}{8}$ths of an inch in diameter, the fœtus is about $\frac{3}{16}$ths. The vascular area on the yolk sac is completely formed; the intestine still quite open in the abdomen, and the amnios still open over a large part of the back. 2. Two specimens of the fœtus of the common fowl, at nearly a corresponding stage of advancement, on the second day of incubation, were shewn to illustrate those of the cat. 3. The fœtus from a swan's egg, incubated in an apparatus for between nine and ten days, and corresponding in its advancement to the chick in ovo at the end of the fourth day. This specimen, from its comparatively large size, serves very well to shew the branchial slits in the neck, the incomplete state of separation of the ventricles of the heart, and several other peculiarities of structure belonging to this transitory period of fœtal life. The vesicular allantoid membrane attached to the fœtus is also very well displayed. 4. A preparation described by Dr Thomson as very rare (there being only two other cases on record), of a double monstrous fœtus obtained from a goose's egg, hatched artificially for about five days, and corresponding in its state of advancement with the chick in ovo towards the end of the second day. This is an instance of a double monster produced from a double germ; for both fœtuses, the heads of which lie across one another, are placed in the centre of a single transparent and vascular area; the transparent area being of a cruciform shape, as described by Baer, in a similar example above referred to, and the tails of the fœtuses diverging from one another to each side. The head and spinal column are formed, but the intestine seems to be as yet quite open, and the amniotic folds scarcely begun. There appears to be a single heart common to the two fœtuses, situated between them in the angle formed by the neck's crossing.

At the same meeting was read a notice by Mr Stark, regarding the *Mytilus polymorphus* of Pallas, a colony of which was lately detected in the Union Canal, not far from Edinburgh.

1834, *Feb.* 15.—Professor JAMESON, P. in the chair.—Dr T. J. Aitken submitted to the consideration of the Society, a view of the brain and cerebral nerves of the cod in general, and of the olfactory nerve in particular, being part of the results of his late physiological and anatomical investigations into the nervous system of this animal. He shewed that the olfactory cavities are comparatively small, though beautifully and elaborately constructed; these cavities communicate externally by means of two orifices, each furnished with a valve-like apparatus. The surface is covered by a mucous membrane, elegantly plaited, and defended by an abundant quantity of thick viscid mucus. Pursuing the usual mode of tracing nerves from the brain, he pointed out the olfactory connected with the inferior surface of the anterior tubercles, from which they arise by two or three capillary roots; the two nerves soon unite and run together as one nerve, along a canal leading from the skull forwards; they next enter a large oblong cavity, filled with a similar fluid to that which occupies so considerable a part of the skull. Here the nerve again divides into two, which diverge to their respective olfactory organs, on the central, internal, or convex surface of which they are swollen into a ganglion, affording one of the few examples of this modification of nervous structure in the organization of fishes. From the ganglion numerous threads are seen passing to the membranes which penetrate it, and are dispersed freely upon it to receive the impressions of odorous emanations. He observed, that though cod, when urged by the cravings of hunger, swallow their food, apparently regardless of its odour, and indeed occasionally voraciously devouring almost every thing which comes in their way; yet, on the other hand, when surrounded by an abundance of their favourite subsistence, as the herring, become extremely nice, and may be seen to submit the bait to the sense of smell, and according to the satisfaction afforded by the test, either take it or turn away with indifference or apparent contempt. After pointing out several peculiarities in regard to the other nerves, Dr A. stated it as his intention to submit to the Society further views in the same department on a future occasion.

Dr John Coldstream then read a paper on the structure and habits of the *Limnoria terebrans*, the small crustaceous animal which has proved so destructive to the wooden erections on our shores. (This interesting memoir will be found in No. 32. of this Journal, p. 316. *et seq.*)

1834, *Mar.* 15.—Dr R. K. GREVILLE, V. P. in the chair.—Professor Jameson read a communication from Dr Meredith Gairdner, dated Fort Vancouver, 31st August 1833, containing the details of the observations made by him during the voyag from this country to Columbia River, on the N. W. coast of America.

1834, *Mar.* 15.—Dr Charles Anderson, V. P. in the chair. —The Secretary read Mr William Nicol's additional observations on the structure of recent fossil coniferæ; and Mr Nicol being present, exhibited both drawings and specimens of the sections made by him. Professor Jameson then described and exhibited drawings of a stickle-back having four dorsal spines, and apparently hitherto undescribed, detected by Mr Stark in the ditches of Hope Park.

1834, *Mar.* 29.—David Falconer, Esq formerly V. P. in the chair.—The Secretary read Mr Mark Watt's observations on the attractive and repulsive powers of light, as exhibited upon metals when in a state of galvanic action; and Mr Watt exhibited his apparatus, and described its mode of action. The Secretary then read an account of the strata found in excavating Hartlepool Docks, communicated by Mr James Milne, the resident engineer.

1834, *April* 12.—Professor Jameson, P. in the chair.—A communication from Mr J. F. Swan of Douglas, Isle of Man, was read, giving a geological account of the spot where the fossil elk now in the University Museum was found. Dr Greville then read a short notice, illustrated by a characteristic drawing by M. Price, of a remarkable appearance in the Claydock Coalmines, Breconshire, which the Doctor regarded as the remains of the lower extremity of a gigantic monocotyledonous vegetable.

The Wernerian Natural History Society commenced its twenty-eighth session on the 29th November, when the following gentlemen were elected office-bearers for the year 1835:—

President.

Robert Jameson, Esq. Prof. Nat. Hist. Univ. of Edinburgh.

Vice-Presidents.

W. C. Trevelyan, Esq. Sir P. Walker.
Dr R. K. Greville, Esq. Bindon Blood, Esq.

Secretary—Pat. Neill, Esq. *Assistant-Secretary*—T. J. Torrie, Esq.

Treasurer—A. G. Ellis, Esq. *Librarian*—James Wilson, Esq.

Painter—P. Syme, Esq. W. H. Townsend, Esq. *Assistant.*

Council.

Principal Baird, David Falconar, Esq.
H. T. Maire Witham, Esq. Thomas Sivwright, Esq.
Dr T. S. Traill. James Young, Esq.
Dr John Coldstream. William Copland, Esq.

The Society met on 13th December, Professor Jameson, President, in the chair. Mr Neill, Secretary, read the Rev. Mr Hodgson's account of the remains of a species of deer, found, in 1833, in diluvium, below the foundation of the great Roman Wall, near Walton in Cumberland; and Mr Torrie, Assistant-secretary, read Dr Barry's Narrative of his Ascent to the Summit of Mont Blanc in September last. There were also communicated to the meeting, analyses, by Dr Gregory and Mr Walker, of coprolites from Wardie and from Fife, in which these chemists detected flouric acid; on which occasion, Professor Jameson made remarks illustrative of his early discovery of fossil fishes in the secondary strata of the middle district of Scotland.

Proceedings of the Society of Arts for Scotland.

The Society for the Encouragement of the Useful Arts commenced its sittings for session 1834–35, in the Royal Institution, on Wednesday, the 12th November 1834, at eight o'clock P. M. The following communications were read and exhibited during the month of November.

Nov. 12.—1. Second Essay on the Useful Arts, preliminary to the Series of Annual Reports regarding new Inventions and Improvements in the Arts throughout Europe: ordered by the Society. By Edward Sang, Esq. Teacher of Mathematics, and Lecturer on Natural Philosophy, Edinburgh, Member of Society of Arts.

2. Additional Observations on the Construction of Public Buildings, in relation to the Theory of Sound. By Dr D. B. Reid, Lecturer on Chemistry, and Member of the Society of Arts.

3. Specimens of Ivory Turning, and notice of a Fruit Gatherer, or Fruit Shears. By Mr Alexander Robertson, Peterhead.

4. There was exhibited a Drawing for an Engraved Map of the Levels of Edinburgh, and its Environs, shewing the relative Altitudes of the principal Public and other Edifices, &c. &c. in and around Edinburgh and Leith, above the level of the high-water mark of the sea, carefully constructed from actual survey, and intended to be engraved and published by subscription. By Mr William Moffat, surveyor, 8. Middle Row, Knightsbridge, London, presently residing at 3. Chapel Street, Edinburgh.

Nov. 26.—1. Model, Description, and Drawings of some alterations on his plan of 1830, relating to Steam Navigation on Canals, by means of a Chain, &c. By Mr James Clark, 35. Hutchinson Street, Glasgow.

2. Description and Drawings of a Double Screw-Press, for packing goods, &c. By Mr Dixon Vallance, Liberton, Lanarkshire.

3. Specimens were exhibited of Paper made in France from various Materials not generally used in this Manufacture. With a Catalogue. Communicated by John Robison, Esq. Sec. R. S. E. and Vice-Preses Soc. of Arts.

4. An Improved Mortice Lock. By John Robison, Esq. Sec. R. S. E. and Vice-Preses Soc. Arts.

Dec. 10.—1. On Rotary Steam-Engines. By the Rev. James Brodie, A. M. Monymail, Fife, Assoc. Soc. Arts.

2. Method of preventing the Escape of Steam in Rotary Engines, by the application of a property in Aëriform Fluids, hitherto neglected. By the same.

3. Application of the Expansive Property of Steam to Engines of all the different Constructions. By the same.

4. Analytical Table of Mechanical Movements; with a Key. Published at Manchester, 1834.

5. A Latch Lock, on a new construction. By Mr David Kemp, smith, Leith.

6. A Chest or Desk Lock, on a new Construction. By the same.

7. The following Gentlemen were admitted Ordinary Members, viz.—

1. The Very Rev. Archdeacon Williams, 13 Saxe Cobourg Place.
2. William A. Lawrie, Esq. W. S. 11 George Square.

8. The Society elected Office-bearers for the ensuing year, viz.

President, ...	His Grace the Duke of Buccleuch and Queensberry.
Vice-President, . . .	Professor Forbes, F. R. SS. L. & E.
Secretary, ...	James Tod, Esq. W. S. 21 Dublin Street.
Foreign Secretary, . .	Wm. Cawfurd, Esq. of Cartsburn, 5 Bellevue Cresent.
Treasurer, ...	Robert Horsburgh, Esq. Accountant, 15. London Street.
Curator, ...	Mr John Dunn, 50 Hanover Street.

Ordinary Councillors,

Robert Stevenson, Esq.	John Robison, Esq.
Robert Stein, Esq.	Sir David Milne.
Rev. Edward Craig, A. M.	Dr D. B. Reid.
Sir Thomas Dick Lauder, Bart.	Edward Sang, Esq.
James Jardine, Esq.	Dav. Geo. Sandeman, Esq.
Geo. Buchanan, Esq.	Mungo Ponton, Esq.

NOTICE TO THE READERS OF THE EDINBURGH NEW PHILOSOPHICAL JOURNAL.

The division of the Journal containing Scientific and Literary Intelligence, will in future appear on a more extended scale. Authors will require to transmit their works a month at least previous to the publication of the Journal, in January, April, July, and October.

THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

On Springs, Artesian Wells, and Spouting Fountains.* By M. Arago.

It may not be out of place to preface the following observations with the remark, that the ancients were not ignorant of these various kinds of wells, and it would moreover seem that they were acquainted with their construction. Thus, Olympiodorus narrates, that when wells are sunk in the Oasis of the desert, to the depth of two, three, and sometimes five hundred ells, water springs from the orifices, so as to form rivers, of which the farmers avail themselves for the irrigation of their fields†. Again, there seems just ground to suppose, that, in certain parts of Italy, artesian wells were used at a very remote period ; for Bernardini-Romazzini informs us, that in excavating the rubbish of the very ancient town of Modena, leaden pipes are sometimes found, which apparently communicate with old wells ; for what could be the use of these pipes, at the depth of seventy or eighty feet under the surface, if it were not to convey far beneath the unwholesome surface water, those limpid and pure streams which now supply all the fountains of the modern city ?

We have no means of ascertaining if artesian wells were known at so remote a period in France. The most ancient is said to be that of the Convent of the Chartreux at Lillers, in Artois ; reported to have been constructed in 1126. I am also

* Named Artesian Wells, from the French province of *Artois*, where extensive researches were carried on for the discovery of subterranean water.

† This statement is borrowed from Niebuhr. Olympiodorus flourished at Alexandria about the middle of the sixth century.

credibly informed, that there are very ancient artesian wells at Stuttgard, but their exact date cannot accurately be ascertained.

The inhabitants of the desert of Sahara have, for a long period, been acquainted with these wells, as we learn from the following passage taken from *Shaw's Voyages*. "The *Wad-reag* is a group of villages lying in the depth of the Sahara. These villages have neither springs nor fountains, and the inhabitants procure water by a singular method. They sink wells an hundred, and sometimes two hundred fathoms, and thus always succeed in finding water in abundance. During the process they meet with various beds of sand and gravel, and at length reach a rock which very much resembles slate-clay, and which they know immediately overlies what they call the *Bahar tâht el Erd*, in other words, the *sea underneath the earth*, and which is also their name for the abyss. They pierce this stone without difficulty, and instantly the water gushes up in such abundance, that those who are immediately engaged in the operation are sometimes surprised and drowned, though they endeavour to ascend with the greatest possible speed *."

Previous to his arrival in France, about the middle of the seventeenth century, Dominico Cassini sank a well, at Fort Urbino, in the ecclesiastical dominions, the waters of which pro-

* It has been said that the Chinese have been acquainted with these wells for some thousands of years. The evidence for this, however, does not appear very satisfactory. M. Dupresse, bishop of *Tabraca* (See *Nouvelles Lettres édifiantes*, tom iv.) speaks of artesian wells, of small diameter, sunk many hundreds of feet, which lie in the province of *Kia-ting-fou*, and which furnish subterranean salt water. The letter of this missionary is dated 11th October 1804, and in it he says nothing of the antiquity of the date of the construction of these Chinese wells. M. Imbert, another French missionary, who is still resident in that country, has also given a description of these wells, from which we may conclude that the waters are not projected above the level of the neighbouring earth. "In drawing the salt water," he remarks, "the hollow tube of a bamboo, twenty-four feet in length, is lowered into the well. At the lower extremity of this machine there is a valve, and when it has reached the bottom, a strong man seats himself on a cord, and works the pump; every stroke opens the valve, and the water rises." It cannot be denied that it is very possible, that a people who set about finding salt springs at the depth of fifteen or eighteen hundred feet, may sometimes do so in localities, where the geological structure would give rise to the appearance of spouting fountains: But this is nothing more than conjecture; and it is sufficiently apparent, that at least the springs of Kia-ting-fou cannot be regarded as such, although they have been ranked in this class.

jected fifteen feet above the surface, and when confined in pipes, rose to the tops of the highest houses.

These historical details, will, we must, be sufficient to propitiate that class of individuals who cannot succeed in interesting themselves about any thing which has not antiquarian alliances, and will induce them favourably to regard this important subject.

WHENCE IS THE WATER OF THESE WELLS DERIVED?

It appears natural to suppose, that the water of common and artesian wells, and spouting fountains, is no other than the rain-water, which has found its way through the pores or the fissures of the soil, until it encounters some bed of rock which it cannot penetrate. This opinion, however, has not always been admitted so soon as it was stated. Theories of a more learned character have taken the precedence of it, and these theories, though now abandoned, appear nevertheless to merit a few minutes' consideration; and the more so, as the recollection of them may be traced, in many of the publications which owe their existence to the recent success of those inquirers who have been labouring in this department of science.

It was for a long time believed that the water of the sea must of necessity extend itself, by means of infiltration, into the very interior even of continents, and that at length it there formed a liquid expanse, which, despite the influence of capillary attraction, was to be found in the extension of the general level of the ocean. It was also admitted, that in its progress across the tortuous circuits of earths and rocks, the water entirely lost its saltness, so that in whatever quarter of the globe wells were sunk, fresh water would be met with, so soon as the wells were sunk to a depth equal to the elevation of the land above the level of the sea.

For the overturning of this hypothesis, we are not now reduced to the necessity of adducing the fact, that there are some isolated dry wells, the depth of which is far below the level of the pretended continental subterranean waters; for we can point to a whole district, viz. that portion of Russia which the Wolga, through the greater extent of its course, traverses: there an immense extent of territory, which is situated much *beneath the* *level* of the Black Sea, is nevertheless not inundated; nor is it even a marsh, as it ought to be, if the sea, by a continued infiltration, penetrated indefinitely towards the bowels of the earth.

To this theory, whose frail foundation we have been exhibiting, another element has been conjoined, viz. a central heat, which is brought to bear not so much on deep wells, as on those fountains which occur at more or less considerable elevations above the level of the sea. With its help, it was the interior vapours, which, either alone or mixed with air, by constant condensation towards the surface, produced there an increasing humidity. Such were, in reality, the opinions held by Aristotle, Seneca and Cardan; we may also add, by Descartes, as expressed in his own words, which we quote: "Water penetrates by many subterranean conduits beneath the mountains, whence the internal heat elevates it, in vapour, towards their summits, and there supplies the springs of fountains and of rivers." This conception, in which the globe becomes a kind of alembic, and its exterior crust a sponge, and which has so often been put forward since the time of Descartes, of course to the exclusion of the very simple idea which would lead us to attribute the origin of springs to rain-water, is so complicated, as to lead to the inference, that it owes its existence to the necessity experienced in the explanation of some inaccurate ill-understood observation. And such, in fact, was its origin; or, at all events, it was this circumstance that led it to be regarded with the consideration it has received.

Seneca mentions, in his Questions on natural history, that rain, however abundant it may be, never penetrates into the soil above ten feet: he states that he is certain of this, from having made many careful experiments with this object in view. It becomes a question whether we must not have recourse to internal vapours, in explaining the existence of fountains which are situated far above the level of the sea, whilst their source is also deep under a vast extent of soil. According to the experiments of the greater number of naturalists, who have recently engaged in these researches, the permeability of the earth would be decidedly inferior to the limit assigned by Seneca. Thus Mariotte maintains, that, *in cultivated lands*, the heaviest rains of summer do not penetrate above six inches. Lahire also has observed, that, in soils covered with vegetation, they, on no occasion, penetrate more than two feet; and he has likewise stated, concerning a bed of naked earth eight feet thick, that not a drop of water had penetrated to the leaden plate which supported it, during the fifteen years it had been freely exposed to every atmospheric vicissitude. Buffon has supplied the results of a similar experiment; for he mentions having examined, in a garden, a bed of earth more than nine feet high, which had been undisturbed for many years, and he noticed that the rain had never penetrated above four feet deep.

These several observations would be of the deepest import in the question concerning the origin of fountains, if the surface of the globe were universally covered by a layer of *vegetable earth* of the thickness of two or three yards. But the very reverse of this is the fact; and every one knows that, in many places, the superior layer is sand, and that sand allows water to percolate, as if it were a sieve; whilst in other places the naked rocks appear, and through their fissures and gaps the water runs most freely. In proof of this last assertion, we may state the constant observations of miners, and more especially of those of Cornwall, that in those mines that are situated in limestone, the water increases in the deepest galleries *a few hours* after it has begun to rain above ground. We may also add, that the springs which issue at various elevations from the cliffs of chalk on our coasts, are much increased immediately after rain.

The consideration upon which those who imagine they must look to evaporation and precipitation of subterranean waters, especially on their approximation to the colder strata near the surface, principally take their stand, is one well worthy of examination; it is the allegation of the existence of copious springs at the very summit of certain mountains. Montmartre, in the neighbourhood of Paris, has borne a part in this controversy; for on it there was, and perhaps there still is, a spring which was not above fifty feet below the highest part of the hill. It was maintained that the supply which constantly fed a spring so situated, could only come from beneath in the state of vapour. Upon minute examination, however, it was found that that part of the hill which was on a higher level than the spring, and which consequently might transmit its waters in the way of simple percolation, was nearly 600 yards long by about 200 broad, which, according to the mean quantity falling at Paris, would supply a volume of water a great deal larger than the quantity which annually issues from the spring under consideration. The difficulty, therefore, was to be sought for in some other locality. And it was supposed to be discovered in the neighbourhood of Dijon; but there also, despite of appearances, it was found that the quantity of rain which fell on the hill above the spring, was more than sufficient for its supply. The *Font Feyole*, on the celebrated Mont Ventoux, departement de Vaucluse, at an elevation of 1754 yards, has also been adduced: but the summit of the mountain is 200 yards above it; and as there has been no accurate comparison between the quantity of rain, dew, and snow, which falls on this portion of Mont Ventoux, and the quantity of water which really issues from Font Feyole, the objection, in its present form, is of no value. But a single remark is sufficient to overthrow all these theoretical speculations, which we have been examining in detail. It is this, that, in the time of severe droughts, nearly every spring becomes less abundant, and a vast number dry up altogether, although such causes can have no influence upon the supposed elevation of central vapours, and their subsequent condensation.

An accurate observation, therefore, concerning the permeability of certain parts of the crust of the globe, most injudiciously generalized, has been the sole cause of the long prevalence of the theory of Aristotle, Seneca, and Descartes, on the origin of springs in elevated localities. But other ideas, which are altogether absurd *, about the annual amount of certain running

* This word will not appear too strong, when I remark, that in a book of which Newton was the editor, viz. Bernard-Varenius' Geography, and which was the text-book of the students at Cambridge at the close of the 17th century, these words occur: "Rivers of the largest size contain such a vast quantity of water, that the volume which one of them conveys to the sea in a year exceeds that of the whole earth!!! such is the mass which the Wolga empties into the Caspian; and it is thus absolutely necessary that the water should be incessantly passing from the sea into the earth, &c.!!!"

streams, and great ignorance concerning the quantities of rain, dew, and snow, in different climates, have given a wide scope to the part played by these internal vapours in the formation of streams and rivers. Thus, for example, it was thought that the basin of the Seine, by which I understand all that portion of territory which drains its water into this river, did not receive a quantity of water equal to that which the Seine delivers to the sea in the same space of time. Perrault and Mariotte were the first experimentally to study the subject, and they found, as is very often the case in such circumstances, that the vague ideas of their predecessors were the very reverse of the truth. According to Mariotte, the Seine every year carries to the sea only a *sixth* part of the water that falls into its basin, in the shape of rain, dew, and snow. The other five-sixths, then, must either be evaporated so as to form clouds, or be imbibed by the soil for the nourishment of the vegetation, or lastly, must penetrate through the fissures of the rocks into the interior reservoirs whence the springs issue.* The calculations of

* A word upon the meteorological facts on which these calculations rest. The quantity of rain which falls at every height, and in every place, can be easily and very accurately ascertained by direct measurement. By melting snow in the rain-gauge before it has had time to evaporate, we may also accurately determine what quantity of fluid it represents. It is also true that old experiments which have been often repeated, permit us to come to a safe conclusion from the decision of the eye. When the snow has fallen in large flakes, if we measure its depth before any drifting has taken place, we may reckon, when thawed, that the height of the liquid which would result, if the soil were impermeable and horizontal, would not be above a *tenth* part of the original depth of the snow. Snow falling in small particles is much more dense, and, in melting, a *fifth* part must be allowed for it. Finally, when the snow in falling has been much drifted, the reduction on thawing may be regarded as *two-thirds.*

The water resulting from hail might be usually neglected; but since it rarely hails without at the same time raining, the rain-gauge will accurately supply the joint amount of both.

As regards dew, Dalton calculates that a depth of water equal to about three inches over the whole surface of the globe, would be a fair annual allowance for it. This result is deduced from an experiment of Hales, which might be legitimately generalized so long as it was supposed that dew *descended* in the same manner that rain does. But since the researches of Dr Wells,—since it has been generally known that dew does not descend at all, but that the air deposits it upon such surfaces as have been previously refrigerated by the radiation of their caloric into the celestial regions,—and that

Mariotte have been recently repeated from more accurate data, especially in what relates to the gauging of the Seine. And we shall now present the conclusions, as they are arranged in an excellent work of M. Dausse, the engineer, which has not yet issued from the press.

The basin of the Seine (and we shall here limit and terminate it northwards at Paris, since we can so easily measure the quan-

the nature of the bodies themselves, their exposure, and the clearness of the atmosphere, exercise the greatest influence over the phenomenon, it may be clearly understood, that, even an approximation to the definite quantity of dew which is deposited in each country, would be one of the most complicated problems in physics.

Dr Dalton has found that the mould of a garden saturated with moisture contains in bulk not less than seven-twelfths of water. The quarter, and even the half, of this water may disappear, without materially affecting vegetation.

It would appear that, in all countries, the layer of water which evaporation removes from any sheet of water, in the course of a year, is just about as thick as that which the rain deposits in its place. The experiment, however, would need to be repeated with vessels of a much larger size than those which have been hitherto employed by meteorologists. The observations made now nearly a century ago by Bazin, give a larger quantity from the evaporation of earth saturated with moisture, than that supplied by pure water itself. This result seems not at all likely ; but, in all such subjects, it is only experiment that can authoritatively determine.

I shall conclude this note by a remark of the late Professor Leslie, who, without adding any thing to our knowledge, as yet so imperfect, on the cause of evaporation, has notwithstanding pointed out, in this phenomenon, a development of mechanical power most striking to the mind, especially when we reflect on the silent manner in which it is accomplished by Nature.

Let it be conceded that the water which is annually elevated from the globe by means of evaporation, is equal, in all climates, to the quantity of water which falls in each of them. This evaporated water is disseminated throughout the atmosphere at *all heights.* We may, however, procure a kind of mean between these extremes of the ascending movements, by conceiving that the evaporated water is *all* raised to a certain mean height, and no farther. The annual evaporation, so far as regards *its mechanical effects,* would be thus represented by a known mass of water being elevated vertically to the extent of a number of yards, which is also known. But the work of this sort *which a man* could effect during a year has been determined ; and the comparison of the two results demonstrates, that evaporation represents the labour of (80,000,000,000,000) eighty billions of men. If we suppose, then, that (800,000,000) eight hundred millions is the population of the globe, and that one-half of them could work, then the power employed *by nature* in the formation of clouds, would equal what could be rendered by two hundred thousand times the constant labour of the whole human race.

tity of water that passes under any of the bridges of this capital), has about 10,307,000 acres of superficies. The water which descends into this basin, if it did not evaporate, nor penetrate into the soil, and if it were quite horizontal, would supply it at the end of the year with a covering of water about twenty inches deep. It is easy to discover that this mass would consist in round numbers of about 677,000,000,000 (six hundred and seventy-seven thousand millions) cubic feet of water. Now, the average discharge of the Seine at the Bridge *de la Revolution* is 7,537 cubic feet per second.

652,740,000 .... day.

234,585,140,000 .... annum.*

Which last number is to the 677,000,000,000 which annually fell into the basin of the river nearly as one to three. Thus the volume of water which annually passes under the bridges of Paris is not much above a third of that which descends in rain into the basin of the Seine. Two-thirds then of this rain either reascends into the atmosphere in the way of evaporation, or supports vegetation and the life of animals, or finds its way into the sea by subterranean communications.†

	Cubic Feet per Second.
* The smallest quantity ever known to pass (in 1767 & 1803) was	2,187
The average quantity when the river is low,	3,237
The average quantity when the river is in its ordinary condition,	7,171
The quantity during the flood of January 1802 was	23,282
The greatest quantity ever recorded (1615),	40,838

Thus, during the great flood of 1615, the Seine sent down a volume of water nearly twenty times greater than when in its lowest state during the droughts of 1767 and 1803.

† On the road to Fontainebleau, at a place called *Rungis*, there is an abundant spring, the waters of which, after uniting in a subterranean canal which is constructed with much care, run, crossing the aqueduct of Arcueil, into the reservoir of the *Chateau d'Eau*, at the *Observatoire*, whence it is distributed to various parts of the capital. Lahire states that it yields about fifty inches, and, according to him, "the extent of ground whence the water is derived is not sufficient to feed so great a spring, merely by the rain which falls, though not a drop of it was lost." But this opinion, unaccompanied with any precise calculation of the extent of the ground, and the annual quantity of rain, belongs to that class of vague notions of which science can take no ac-

This example will be sufficient, I imagine, to demonstrate how little the consideration of the rivers themselves, when attentively studied, justifies the theories of ancient naturalists. The abundant liquid currents which they unceasingly carry towards the sea, from the interior of continents, are universally but a small proportion of the mass of rain-water which annually falls in the surrounding country. There is not here, therefore, any more than in the circumstances of springs, good ground for assigning any place to the central vapours in the explication of the phenomena.

This numerical discussion will likewise serve to refute those who have recently employed themselves in seeking for the sources of these springs *in those interior basins in which is to be found that liquid mass which still holds the earthy sediments in suspension or solution.* This hypothesis evidently merits no attention, until it is first proved that the rain-water is not sufficient to explain the phenomena; and till it is also proved that the same water does not penetrate to great depths in the crust of the earth. But, after what has already been said, a tolerably decided judgment may already be formed on both these points. In thus dedicating a few words to this novel theory, I wish to supply some comfort to those persons who are possessed with the apprehensions of the approaching drying up of these interior basins, and consequently with the failure of all our springs and wells. If, on the contrary, it is established that these fountains are fed by the waters from the atmosphere, then it is evident that they can withhold or vary their supplies only in accordance with the variations of the rain, and dew, and snow, and of evaporation.

We have here said nothing of earthquakes, which, it is true, by violently breaking up the different strata of the crust of our globe, and tossing them hither and thither, may, in certain situations, change the position and velocity of subterranean currents. But, as the possibility of these shocks does not prevent us from building our mansions, no more ought it to interfere with us when we are sinking our wells.

count; and besides, it may happen that the spring at Rungis is itself fed by some subterranean stream which has a distinct origin.

ON THE MANNER IN WHICH THE SURFACE-WATER CAN EXIST AND CIRCULATE IN THE VARIOUS FORMATIONS OF WHICH THE CRUST OF THE GLOBE IS COMPOSED.

The solid crust of the globe has not been formed by one single process. The formation of the different rocks and various series of rocks of which it is composed, belong to different epochs, which geologists have characterized by certain definite features. It is at the same time well to remember, that many of those productions which science usually regards as cotemporaneous, differ much from each other in their nature, and external appearance.

The object I have now in view will require me to distinguish only three principal kinds of overlying formations, each of which, however, comprehends many varieties. They are the following, ascending, from below upwards, from the more ancient to the more modern, *the primitive and transition rocks, the secondary, and the tertiary formations.*

Primitive Rocks.

Primitive rocks are but little and rarely stratified. It is still, we must allow, a question with very able naturalists, if granite ever exhibits real stratification. The clifts and fissures of granitic rocks—the crevices which separate each mass from the contiguous one—are in general but small, have little depth, and but seldom communicate with each other. Consequently, in primitive rocks, the waters of infiltration must have very limited subterranean passages; each little streamlet must accomplish its course, so to speak, by itself, and without receiving additions from the neighbouring streams; and, accordingly, observation shews that, in formations of this kind, springs are very numerous and very small, and that they appear very near the places where the infiltration of the rain-water has been effected.

Secondary Formations.

It is needless to furnish in this place any thing like a detailed list of the different species of rocks which compose the secondary strata. We shall rest satisfied with stating that these formations have usually the appearance of immense basins, which resemblance seems to have been acquired by their apparently having originally been vast plains, and by their having subsequently experienced an elevation, in such a way as to circumscribe the horizontal portion in the bosom of hills or of mountains. We shall add that the rocks of the secondary formation are arranged in layers;—that some of these layers, occasionally of great thickness, are composed of loose and very permeable sand;—that in rising towards the extremity of the basins, these permeable beds crop out on the sides of the hills and mountains;—that the surface water may, by infiltration, form in them extended sheets of water;—that these reservoirs, when the beds dip at a high angle, must empty themselves with velocity towards the lower levels;—that in their progress, these running waters, by degrees removing the sand, and even portions of the surrounding rocks, come to form subterranean rivers which displace parts of original massive strata and excavate great voids, where previously there were none.

There is one of these secondary strata, viz., chalk, which is furrowed in every direction by thousands of fissures. And it is evident that rain water may easily find its way through it, and circulate in its mass to the greatest depths.

Tertiary Formations.

The tertiary formations are stratified, that is to say, are composed of a greater or less number of overlying beds, which, like the courses of a wall, are separated the one from the other by distinct and well marked joinings.

This formation, like the former, usually assumes the form of a basin, but commonly of far less extent than the other. We should not forget that this shape appears to be the result of some alteration in the position of the beds. It is during this alteration, too, that the constituent elements of the tertiary series have formed the ridge of slopes and hills which surrounds them.

During this process of change in the total mass of these strata,* commonly all the beds were more or less torn, and bro-

* The greater number of basins, whether belonging to the secondary or tertiary series, really owe their origin to this alteration in the strata, which had originally been deposited horizontally. But sometimes also the secondary or tertiary deposit is formed in a *pre-existing* basin, and bounded by a

ken and detached; so that some of them are exposed and crop out on the sides and summits of the hills. This phenomenon may be represented with sufficient accuracy by folding a quire of writing-paper upon the edge of a paper cutter. When put into this position, as when lying on the table, the upper sheet covers the whole of the second, and the second the whole of the third, and so on. But let us now tear the quire towards the angle we have made, and let us trace this tear through ten or a dozen of sheets, and, as is apparent, each of these sheets becomes visible, and all will be exposed directly to atmospheric influences.

We find, *in the series of strata*, of different kinds, which, always arranged in a given order, go to form the tertiary series, beds of permeable sand, *in many elevations*. The surface water must run through them, first in the portions where the inclination is great, because of the weight of the water; and then in the horizontal branches, on account of the pressure exercised by the water which the remaining portion of the bed has not allowed to escape. It might be only right, therefore, to expect, in every locality, to find embosomed in each more solid tertiary formation, as many subterranean sheets of water as we can find distinct successions of sand-beds reposing upon impermeable strata.

So far, then, as regards the circumstances under which these subterranean waters may be found, there seems to be an entire correspondence between the secondary and tertiary formations, however much they may differ in other respects, so as to require a distinct classification at the hands of the geologist. We shall take occasion to point out, on this occasion, only a single difference, to which M. Jules Burat has already directed the attention of civil-engineers, in the excellent memoir which he has published on the subject. It is this fact—that in the secondary

formation of higher antiquity. In this latter case, the different beds of more recent deposition extend horizontally, till they come in contact with the older rocks, which enclose them as in a circus. The upper bed is only visible, and it alone directly receives the descending rains; the surface water cannot reach the older strata, except across the beds which cover it;—conditions which are little favourable to the formation of subterranean lakes, at least when compared with those which exist in basins, the bounding ridge of which is composed of strata which have undergone the alterations above alluded to.

formations, all the phenomena exhibit themselves on a much larger scale, on account of the prodigious thickness of the strata, of their rarer alternation, and the greater velocity of the currents of the subterranean waters. This at once supplies an explanation of the circumstance that the natural springs in the secondary formation are, at the same time, so rare, and yet so abundant.

We shall now review, in detail, the consequences which we have deduced from the individual forms and characters of these two stratified formations, and shall notice how far observation confirms the accuracy of our conclusions.

Water flows freely, at all depths, in Chalk.

For the proof of this I shall do nothing more than adduce the instance of the many real *jets d'eaux* which proceed, at all heights, from the fissures which indent the steep ascents of Cape *Blanc-Nez* and Cape *Gris-Nez*, in the department of Pas-de-Calais. There Nature may be seen in her secret operations.

Among Stratified Rocks there are great Chasms and Caverns.

When we think of the great labour and art which mankind employ, in erecting even small arches and vaults, for the sustaining of great weights, we are almost averse to allow that in the subterranean regions there can be any thing like vast and noble halls: a very slight examination, however, of a great number of examples, will very soon put us right on this point.

The famous rock of *Torghat*, in Norway, is, as is well known, pierced from end to end by a rectilinear opening 150 feet high, and more than 3000 feet long. How insignificant in comparison of this all the arches of man's formation!

The cavern of *Guacharo*, in the valley of *Caripe* in South America, of which my illustrious friend M. Alexandre de Humboldt has given us so interesting a description, has for its vestibule a vault 72 feet high by eighty feet wide, appearing near the summit of a vast rock of that peculiar species of secondary limestone known under the name of Jura limestone. This cavern maintains all the dimensions of its vestibule, and in a uniform direction, throughout a length of 1455 feet. The superstition of the Indians has not allowed any one to advance further than 2400 feet from the entrance. Along the whole of this extent a river of 30 feet broad may be traced finding a channel in its floor.

The cavern of *Adelsberg*, in Carniola, into which the river *Poick* engulfs itself, and in which the water appears and disappears a great many times, has been already traced by the curious throughout an extent of six miles. A large lake, which can be only crossed in a boat, has hitherto prevented its being farther explored. If we are to believe the accounts of later travellers, many of the numerous compartments of which this cavern is composed, in length, breadth, and height, exceed the largest cathedrals.

The gypseous formations likewise, present a series of grottoes, connected by passages more or less strait, and which sometimes extend to a prodigious size. In Saxony, the grotto of *Wimalborg* communicates with the cavern of *Cresfeld*, which extends to the length of many leagues.

As an example of a remarkable vertical interruption of continuity in the crust of the globe, we may cite, on the authority of *Pontoppidan*, a certain gap, not far from *Frederikshal* in Norway, in which the descent of a stone seems to last for two minutes. If we were to suppose that this descent was effected without interruption; that the stone did not rebound from side to side, and that it was never arrested, now on one side of the descending wall, and now on the other, these two minutes would give us, for the total depth of this cleft of Frederikshal, more than 12,000 feet; that is, almost 1200 feet more than the height of the highest peak of the Pyrenees.

Immense Sheets of Water are to be found in these Stratified Formations.

What other appellation could be applied to the reservoir, for example, which, without ceasing, at all seasons of the year, feeds the fountain of *Vaucluse*. At its issue from the subterranean rocks which form its course, this spring constitutes a real river, the *Sorgue*. When least abundant, its product, notwithstanding, according to the measurement of M. J. Guérin, amounts to 13,000 cubic feet per minute. When most swollen, it supplies.

in the same space of time, a quantity three times greater, or about 39,000 cubic feet. In its medium condition, experiment gives us 28,000 cubic feet per minute, which is equal to nearly thirty-eight millions per day, and more than thirteen thousand six hundred and fifty millions cubic feet during the course of a year. This last number, we may remark in passing, is nearly equal to the *total quantity of rain* which annually falls in this part of France throughout an extent of ninety-six square miles*.

The most striking example which we can mention of a subterranean sheet of water, of a varying level, is that of the Lake Zirknitz, in Carniola. This lake is about *six* miles long by *three* broad. Towards the middle of summer, if the season be dry, its surface rapidly falls, and in a few weeks it is completely dry. The openings by which the waters retire beneath the soil may then be distinctly perceived, sometimes quite vertical, and in other places bearing a lateral direction towards the caverns which abound in the surrounding mountains. Immediately after the retreat of the waters, all the extent of the surface which they covered is put under cultivation, and at the end of a couple of months, the peasants are mowing hay, or reaping millet and rye, in the very spot where, some time before, they were fishing tench and pike. Towards the end of autumn, and after the rains of that season, the waters return by the same natural channels which had opened a passage for them at the time of their departure. The description which we have just given of the inundations and retreat of the water, is the regular and common occurrence; but every extraordinary atmospheric change is apt to interfere with this order. Sometimes a very heavy fall of rain on the mountains with which Zirknitz is surrounded occasions

* After heavy rains, when the fountain of Vaucluse augments very rapidly, its waters have not their accustomed clearness. It is therefore beyond all doubt that it is the rain water which has descended the fissures, which again appears at this spring. Unfortunately our information does not extend farther. It has been recently alleged that the river Durance and the reservoir of Vaucluse, communicate with each other under ground. But we cannot enter upon the discussion of this hypothesis till we know the facts as to the comparative levels of the bed of the river, and the bottom of the funnel whence the fountain springs. Authentic documents prove, that in this well, between the greatest and the least elevation of the waters, there is a difference of 66 feet in the level. Though this circumstance is assuredly very difficult of explanation, yet it would be folly to suppress or disregard it.

an overflowing of the subterranean lake, which advances, during many hours, so as to cover with its waters the land which lies over it.

Very singular peculiarities have been remarked as belonging to these different openings in the earth: some of them supply nothing but water; others supply a passage both to water and to fishes of a greater and smaller size; and there is a third class by which ducks are supplied from the subterranean lake *.

These ducks, at the moment that the water floats them to the surface above ground, swim with perfect facility. They are completely blind, and almost naked. The faculty of sight, however, is very speedily acquired; but it is not till after two or three weeks that their feathers, which are black, except in the head, are so grown as to allow them to fly. Valvasor visited the lake in 1687. He himself caught a great number of these ducks; and saw the peasants catch individuals of the *Mustela fluviatilis*, which weighed two or three pounds, tench of from six to seven pounds, and, finally, pike from twenty to thirty, and even to forty pounds weight. Here, then, it will be perceived, that we have not only an immense subterranean sheet

* These differences in the products, if the word may be allowed, of the different openings of Lake Zirknitz, are not of such difficult explanation as might at first appear. A pipe, or hollow canal in the earth, the inferior opening of which descends below the surface of a subterranean lake, cannot, at the time of the sinking of the level, transmit any thing through it which is *more elevated* than that opening. As ducks swim *at the surface of the water*, all exit by this descending canal is shut against them. If, on the contrary, the lower end of the tube opens at day, that is to say *above the surface* of the lake, it appears quite plain that the subterranean ducks will seek refuge there when the surface of the water is rising, and it may ere long force them up through it. Again, we can explain why certain openings never furnish any fish, by observing, that a canal may be very large above, and may terminate at the other extremity by small openings and narrow fissures.

In the journey which Mr John Russe made in Germany in 1820-21-22, he does not mention ducks amongst the living creatures which the lower lake of Zirknitz brought to light by its overflowing. Hence I was disposed to conclude, that these inhabitants of the subterranean world had been entirely destroyed since the time of Valvasor in 1687; but M. Landresse has put an Itinerary by G. Agapito, into my hand, in Italian, printed ten years ago at Vienna, in which the lake is still represented as *rigurgitando delle anitre senza piume e cieche, as presenting ducks without feathers, and blind.* It is in these subterranean waters of Carniola, that the *Proteus anguinus* is found, an animal which has to so great a degree excited the attention of naturalists.

of water, but a real lake, with the fishes and ducks which frequent the common lakes of the country.

I shall not wander from that path in which I wish to direct the reader, if I show, by one or two quotations, that Carniola is not the only country where subterranean expanses of water are found which are frequented by fishes. It is a fact that France possesses, though on a much more limited scale, lakes similar to that of Zirknitz; so that this last can never be regarded as merely accidental, or a singular anomaly without any assignable cause; on the contrary, it will take its place amongst those regular phenomena whose existence is connected with the nature of the soil and the geological constitution of the globe.

I borrow my first quotation from a work which is nearly a century old, the *Mémoires de l'Académie des Sciences* of 1741. In the 37th page, I find that there is at Sablé in Anjou, in the midst of a kind of moor, a spring, or rather a kind of pit, of some twenty or twenty-five feet in diameter, and whose depth no one has been able to determine. This spring, known in the neighbourhood under the name of the unfathomable fountain, sometimes overflows, and then there issues from it a prodigious quantity of fish, and especially of trouts of a peculiar species. "There is ground to think," remarks the Secretary of the Academy, "that the whole of this locality is formed of the vault of a lake which is situated underneath."

At the other extremity of France, in the department of *Haute Saône*, near to Vesoul, there is a natural pit called *Frais Puits*, which presents phenomena precisely similar. In summer and autumn, when it has rained heavily for two or three days without intermission, the water appears and boils over at the opening of the Frais Puits, and forms a real torrent, which spreads over all the neighbouring country. After this flood, which lasts only for a few hours, pike are sometimes found in the fields and meadows which had been inundated.

Even in flat countries there are caverns into which whole rivers are engulfed.

This phenomenon in a high degree excited the attention of the ancients. Thus even Pliny mentioned as among the rivers which disappeared under the surface of the earth, the *Alpheus* in the Peloponesus, the *Tigris* in Mesopotamia, the *Timavus* in the territory of Aquilia, &c. He also ranks the Nile in the same class, for, according to him, it disappears for the space of three days' journey before its entrance into the Cesarian Mauritania, and also to the extent of twenty days' journey upon the frontiers of Ethiopia. Come we now, however, to examples that are nearer to ourselves, better determined, and more known.

The Guadiana loses itself in a flat country in the midst of an immense meadow. Here we have the explanation of the fact, that, when we are speaking with admiration of some superb bridge in France or England, the Spaniards remark that they have one in Estremadura, upon which a hundred thousand head of cattle can feed at the same moment.

The *Meuse* disappears at *Bazoilles*. It would appear that it is only in later times that this has been the case, for, according to M. Hericart de Thury, although the original bed is now cultivated, it may be still distinctly traced above the subterranean course.

The *Drôme* in Normandy completely loses itself in the midst of a meadow, in a pit of about thirty feet diameter, known to the inhabitants under the name of the *Fosse de Soucy*. But this engulfing takes place only by degrees; for there are other openings in the same locality, which, though they are less remarkable, yet, to use the local expression, *drink up* the greatest proportion of its water.

In the same district of France, the *Rille*, the *Iton*, the *Aure*, and other rivers which might be named, are lost by degrees. There are, from one point to another in the beds of these rivers, great gaps, which are called *bétoirs*, and each of which absorbs a portion of the running stream. On its arrival at the bétoir which entirely drinks it up, the stream is usually reduced to the size of a trifling rivulet.

It would be easy to quote examples such as these, in which rivers entirely disappear from the surface. But how much larger a descent of water would require to be taken into account, if well executed investigations had made known to us all the instances in which there was only a partial disappearance? We shall shortly have an opportunity of remarking that the Loire is one of those rivers in which this occurrence may be observed.

There is often in these stratified formations, distinct sheets of water AT DIFFERENT DEPTHS. The works which have been undertaken in search of coal, near to Saint-Nicolas d'Aliermont, near Dieppe, have proved that there are *seven* great sheets of water. Their respective positions are as follows:

1st sheet of water at a depth of	76 feet.
2d	307 ...
3d	537 ...
4th	645 ...
5th	768 ...
6th	880 ...
7th	1030 ...

All these collections of water rushed with great force towards the surface.

During the boring of the wells of the Port Saint Ouen, the Messrs Flachat encountered FIVE very distinct sheets of water, all of which had the tendency to rise.

The 1st at the depth of	108 feet.
... 2d	138 ...
... 3d	156 ..
... 4th	184 ...
... 5th	206 ...

The same engineers encountered four of these reservoirs of water, whilst boring to the depth of 200 feet at Saint Denis, close to the *Place de la Poste aux Chevaux.*

At *Tours*, the three pools, all having a tendency to ascend, which were met with by M. Degôusée, were found below *La Place de la Cathédrale*,

The 1st at the depth of	292 feet.
... 2d	340 ...
... 3d	383 ...

The sinking of pits in the neighbourhood of London has brought the same truth to light; and the same remark might be made respecting the United States of America.

Sometimes in the heart of these stratified rocks, besides pools of water which are stationary, there are WATER-COURSES, *true subterranean rivers, which flow rapidly in the* EMPTY SPACES *found amongst the impermeable rocks.*

By subterranean water-courses I do not here wish to designate either the rivers, such as the *Poick* of Carniola, which are engulfed in the immense caverns of a mountain; nor the rivers which come out of such caverns, as happens in the cavern *Guacharo.* I wish, on the other hand, to designate those streams of water, which are, as it were, substituted for certain beds, for certain deposits of the original strata, and of which they now occupy the place.

Some surprise may perhaps be experienced when I mention, first of all, that under Paris and its environs, these subterranean water-courses exist. We shall now, however, prove the truth of this remark.

It happened some time ago that some workmen perforated the ground near to the barrier of Fountainebleau, in an establishment which is known under the name of the Brewery of the *Maison Blanche.* As usually happens in these instances, the progress was slow and the work tedious; but, in a moment, it happened that the instrument with which they were boring the earth, suddenly escaped from their hands, and they saw it fall rapidly upwards of twenty feet. If the transverse handle had not been at the top of the first joint of the borer, the instrument might have disappeared altogether; but as the hole previously dug was narrow, it was caught at the depth already mentioned. When the workmen endeavoured to draw up the borer, it then appeared that it was as if suspended,—that its lower end did not rest upon any solid support; in short, that a strong current below was carrying it to one side, and causing it to oscillate. The rapid ascent of the waters of this deep stream prevented the examination from being carried further.

At the Port Saint Ouen, the Messrs Flachat recognised that the third of the five sheets of water which their operations brought under review, flowed in a cavity nearly twenty inches deep. In truth, the borer sunk down suddenly in it more than a foot; and the current must have been very strong indeed, since it impressed the whole borer with a very sensible oscillatory motion. This double result, viz. the existence of the current, and its strength, may also with certainty be deduced from another curious fact. When the point of the boring instrument, filled with debris of the rocks which it had been penetrating lower down, came, in drawing it up, to the spot where this third sheet of water was, it was not necessary to raise it any further; for in this current the whole of the debris was speedily washed away; an effect which evidently would not have been produced in a pool which was stagnant.

At *Stains*, near Saint Denis, M. Mulot also has met a subterranean water-course, in which the borer suddenly sank to the extent of a yard, at the depth of 197 feet below the surface.

At *Cormeilles* also, in the department of the *Seine-et-Oise*, the borer, when it was sunk 220 feet, according to M. Degousée, oscillated like the balance of a pendulum, under the action of a very rapid subterranean current.

But there is another proof more convincing than any that has been yet adduced of the existence of a subterranean river, under the town of Tours.

On the 30th of January 1831, the vertical pipe of the fountain of the *Place de la Cathedrale*, having been shortened about twelve feet, the issue of the water, as might be expected, was immediately increased. The augmentation was about a third part; but the water, previously very clear, having received a sudden increase of its velocity, was agitated. During many hours it brought from the depth of 335 feet the debris of vegetables, "Among which," says M. Dujardin, "might be recognised the branches of thorns, of the length of an inch or two, blackened by their lying long in water; also the stems and roots, still white, of the plants of morasses, also different kinds of grain, in such a state of preservation, that they could not have been above three or four months in the water. Among these seeds, that of the gallium used for coagulating milk, which grows in marshes, was recognised. Fresh-water shells, and land shells, were also found The whole of the debris bore a resemblance to that left after a flood on the banks of small streams and rivers." These facts incontestibly prove that the reservoir of the third subterranean sheet of water at Tours, is not the result, wholly at least, of simple infiltration through a bed of sand; for ere this water could contain shells and bits of wood, it is necessary it should move freely in vertical canals.*

* Since the seeds were not decomposed on their arrival at Tours, M. Dujardin has fixed some time less than a year as the period they had been in the water. Now, as they ripen in autumn, and made their appearance in January, *four months* is likely to have been the correct time. This will probably be al-

If it were necessary to make any addition to the *proofs* which we have already given of the existence of rapid subterranean rivers, in situations where, till lately, they were never suspected, the phenomena of the famous fountain at Nismes might well be mentioned.

In great droughts, the issue from the fountain is reduced sometimes to about 145 gallons per minute; but when it rains heavily in a *north-westerly direction*, and at a distance of between six and seven miles, then, as M. Valz imforms me, an increase in the fountain almost immediately takes place; and its small issue of 145 gallons per minute is succeeded by one of 1100 gallons per minute, whilst in spite of the enormous increase, there is scarcely any variation in the temperature of the water. Thus then, on its raining *only at a distance* in a north-west direction, the fountain of Nismes augments; it therefore follows that it must be fed from *a distance*, through long channels; which accounts for the uniformity of the temperature in the greatest and most sudden overflowings. The increase succeeds the rain at a very short interval: hence the water has flowed *rapidly* through a long distance; which is the opposite of what would happen in infiltration, however permeable the bed might be We conclude, therefore, that the fountain of Nismes is fed by one or more subterranean rivers.

WHAT IS THE POWER WHICH CAUSES THE SUBTERRANEAN WATERS TO RISE, AND PROJECTS THEM AT THE SURFACE OF THE GLOBE?

If water be poured into a tube which is bent into the shape of the letter U, it there assumes a level, and maintains itself in the two branches at vertical heights which are exactly equal.

lowed. I cannot, however, say so much for another statement of the same naturalist, which asserts that the origin of these waters of the wells at Tours must be necessarily sought for in some moist valley of Auvergne or the Vivarais.

" *Pierre de la Vallée* mentions, that in the islands of Strophades, according to the statement of the monks who inhabit them, there is a fountain, which must have its source in the Morea, whence it reaches there, by flowing under the bed of the ocean. Along with the waters of the fountain, there were often transported things which could only come from that continent. On one occasion a drinking cup made its appearance, which was fashioned out of a gourd and adorned with silver." This quotation is taken from the work of Pierre Perrault, entitled *De l'Origine des Fontaines.* But in our times, we must not believe every thing we hear without some little hesitation.

Let us suppose, then, that the left branch of this tube opens towards the top, with a large reservoir which can maintain itself always full; that the right branch is cut across towards its lower part; that only a short portion of its vertical part is left, and that this portion is fitted with a stop-cock. When this stop-cock is open, the water will be projected into the air, through the remaining portion of the right branch, to exactly the height it would have risen if this branch had remained entire. It will ascend as far as it has descended from the level of the reservoir, which, without ceasing, supplies the opposite branch *.

The two hypotheses I have just alluded to have been realized on a great scale, the former in the *soutérazi* of the Turks, and in the greater number of conduit pipes which serve to distribute the water of an elevated spring to the different parts of a town, and the different stories of houses; and the latter in the subterranean conduits which are destined to produce jets d'eau, as, for example, those of Cassel, Versailles, Saint Cloud, or that in the garden of the Tuilleries. When the Romans wished to conduct water from one hill to another, they, at a great expense, constructed in the intermediate valley aqueduct bridges, such as those of the Pont Du Gard, or such aqueducts as that of Jouy, near Metz, &c. &c. The Turks manage the matter in a way that is infinitely more economical. They place along the declivity of the first hill a pipe of metal, or a tunnel built of bricks or stones; they carry this along the intermediate valley, making it follow the different inflections it may meet, and finally cause it to ascend the slope of the second hill. In virtue of the principle stated above, the water which runs in this pipe, rises, after having crossed the valley, to very nearly the same height whence it had descended. This is the origin of the name *soutérazi*—*the equilibrium of water*—which the Turks give to the conduit pipes which they have substituted for the aqueducts.

Let us now suppose that the tube is carried to the middle of the valley only, and that there a single opening is made for its

* Experimentally, we find that the jet of the water is somewhat less; but the difference does not interfere with the principle: it depends upon the friction, the resistance of the air, and the opposing currents of the ascending and descending liquid particles.

escape, which opening is on its upper side; the water will be projected perpendicularly, and this jet will rise higher in proportion as the descending current has a long fall. This is the construction of all jets d'eau. The *demi-soutérazi*, which produces the grand jet in the Tuilleries, derives its waters from a reservoir situated upon the heights of Chaillot.

This grand hydrostatic principle, of which we have just mentioned two important applications, is wholly independent of the form of the pipe in which the water is contained. It may be circular or elliptical, square or polygonal, straight and of great length, or having many windings and ramifications; notwithstanding every modification of this sort, the water will equally rise to the same height, whenever it has free course to obey the pressure to which it is subjected.

Let us now recall to our recollection the manner in which the rain water penetrates certain beds of the stratified series; not forgetting that it is only upon the slopes of the hills, or at their summits, that these beds are exposed, on edge; that it is there that they admit the water, which, therefore, always occurs in somewhat elevated situations: let us reflect, moreover, that these *water carrying* beds, after having descended along the sides of the hills, which formerly broke them up when they elevated them, extend themselves horizontally, or nearly so, along the plains; that there they are often imprisoned, as it were, betwixt two *impermeable* beds of clay or hard rock,—and we may then easily conceive the occurrence of subterranean waters, that are naturally in the same hydrostatic conditions of which the pipes of common conduits, or the *soutérazi*, supply us with artificial models; and the sinking of a pit in the valleys, through the upper strata, down through the more elevated of the two *impermeable* beds betwixt which the water is confined, will form, as it were, the second branch of a pipe, in the form of the letter U, already alluded to in the commencement of this section,—or, we might say, of a reversed syphon,—or, finally, of a *soutérazi*; and the water will rise in this pit to a height corresponding to that which the water maintains on the side of the hill where it commences to descend. From these statements every one may understand how, in any given horizontal plane, the different subterranean waters, which may be placed at different elevations, may have very different powers of ascending; and also how the same water should here be projected to a great height, and should there rise no higher than the surface of the soil. Simple inequalities of the level would clearly appear to be the cause, and a sufficient as well as natural cause, of all these apparent anomalies.

The explanation which we have thus furnished of the ascension of water in wells is so natural, that it was the first which offered itself to the intelligence of those who directed their attention to the subject. As early as 1671, J. D. Cassini remarked, "These waters (those of the artesian well of Modena) come perhaps by subterranean channels from the height of Mount Apennine, which is not more than ten miles distant from this spot." At the present time, however, confidence in this view seems to be somewhat shaken: let us now inquire if on any sufficient grounds.

As is well known, there exist in Iceland certain springs called *geysers*, which project into the air, and even to considerable heights, columns, sometimes of hot water, and sometimes only of steam. The cause of this curious phenomenon has been supposed to exist in the elastic force of the steam; and it must be allowed that the supposition is in perfect harmony with all the facts which have been stated by those who have described them. But does it follow, that because in Iceland, that is to say, in the neighbourhood of many active volcanoes, steam frequently produces a jet d'eau, we are thence necessarily to conclude, that in countries which are not volcanic, the projecting fountains also depend on the action of vapour, and that compressed air is the only assignable cause. This seems to be any thing rather than a necessary conclusion. But besides, it has been observed concerning these geysers that they are intermittent, and that a long cessation occurs between two consecutive eruptions. But the very reverse of this is the case with the fountains, which flow with a uniform stream for days and months, and sometimes for whole years. All comparison, therefore, of phenomena so entirely unlike, seems most gratuitous and injudicious.

Compressed air which is shut up in a subterranean cavity, has not the power of propelling water along the ascending pipe of a projecting fountain, except in so far as it may dilate the bulk of the water; and in this dilatation, the air would gradually lose a portion of its compressing power, and by this the velocity of the flow of the fountains would be diminished. The supporters of this hypothesis assert indeed, that there is always running into these subterranean reservoirs, a quantity of water sufficient to maintain matters just as they were, and in such a condition, that this compressing air is never allowed to dilate itself to an extent that will be *apparent;* but we may inquire if they have ever remarked that these fancied columns of compressed water could not play the part attributed them, except at the moment when the pressure they should exercise would overcome the elasticity of the confined air? and at this moment would it not be the overflowing liquid column which would in reality propel the water in the ascending pipe? We may also inquire why a power which can produce such an effect at one moment, cannot do it for a continuance?

It is true that, in many machines, and in gasometers, and likewise in those wheels which are known under the name of fly-wheels, there are means devised for regulating irregular velocities; but were these considered as isolating moving powers, they would never exhibit any thing like the regularity that is observed in the flow of these wells and fountains.

We shall at present pass by other objections not less serious, which might be made against this theory, grounded upon the action of compressed air in these watery deposits, to examine, in a very few words, another very odd hypothesis, which has nevertheless been very popular for some time.

It being conceded, that the sheet of water into which the pit is sunk, is always included between two impermeable strata, it has been maintained that the upper of these strata, being charged with the weight of all the superincumbent beds, must thereby be bent downwards, and so must press the fluid on which it rests in the same direction, which would consequently dispose the water to rise, and be the true cause of its ascension.

Let this pretended pressure and bending be, for a moment, admitted; then three distinct contingencies will present themselves for consideration; either the yielding stratum will be steadily moving from above downwards, till it come in contact with the lower impermeable stratum; or it will stop before it so come into contact, in a state of equilibrium; or, finally, it will be subjected to an oscillatory movement. But none of these suppositions agree with what is known concerning the regularity of the flow of many fountains. In the last of these hypotheses, the flow would be intermitting; in the second, the stream would entirely stop, after the issue had for a time been gradually diminishing; and, in the first, there would, sooner or later, be an entire cessation of the stream, especially in those situations, by far the most numerous, where the water-carrying bed is of very limited thickness.

It would be an easy matter to produce other objections to these theories; but I conceive it will be wiser to examine the bearing of the only specious difficulty which has been stated against the accuracy of the view, that these fountains assimilate in principle to reversed syphons—to *souterazi*.

It is this, that some of these fountains, as, for example, those of Lillers in Artois, throw up their waters in the middle of immense plains. The most insignificant hillock is not to be descried in any direction, and where then, it is demanded, are those hydrostatic columns whose pressure affects these subterranean waters from the level of their most elevated sources? I answer, they must be sought for, even beyond the sphere of vision, at the distance of forty, of eighty, of one hundred and eighty miles, and even more, if necessary. The existence of a watery subterranean communication of 300 miles of extent, evidently cannot be a serious objection, except to those who would pretend, in opposition to the testimony of science, that 300 miles of country may not have the same geological constitution. But, in addition to this reasoning, I shall produce a fact which decides the question.

At the bottom of the ocean, there are springs of fresh water, which are sometimes projected vertically to the very surface. The water of these springs comes *evidently from the land*, by natural channels, which rise higher than the surface of the sea. A few years ago, Mr Buchanan, a passenger in one of the ships of an English fleet, which was completely becalmed in the Indian Ocean, discovered an abundant spring of fresh water, at the distance of 125 miles from Chittagong, and of about 100 miles from the nearest point of the neighbouring coast of the *Junderbunds.* Here, then, is a manifest instance of a subterranean channel of water of more than a hundred miles extent. And so soon as an incontestable fact extends to such a number of miles as this, all the objections, such as we have just mentioned, that are based on the consideration of distance, immediately, of course, fall to the ground.

On the effects produced by Tides on some of these Fountains.

M. Baillet has observed that the elevation of the projecting fountain of *Noyelle-sur-Mer*, in the Departement de la Somme, rises and falls with the tide. I believe that it is the same with all the similar fountains which have been sunk in the neighbourhood of Abbeville.

Where no means are afforded us of appreciating the changes which take place in the level, then we may determine, in a manner not less satisfactory, the influence of the flowing and ebbing of the tide, by measuring, at convenient epochs, the quantity of water which issues from the fountains.

Thus at Fulham, not far distant from the Thames, in the property of the Bishop of London, there is an artesian well, about 300 feet deep, which supplies now eighty and now sixty gallons per minute, according as the tide is high or low.

Let us inquire if this effect of the tides is as difficult of explanation as, at first view, it would appear to be.

If, on the sides of a vessel, of any shape, filled with water, we drill a hole, the dimensions of which, when *compared to the size of the vessel*, is *very insignificant*, the dribbling which will take place through this opening, will not affect sensibly the state of the original pressures. And so with two, three, or ten such openings, so long as the whole of them put together are still small—they will leave undisturbed the pressure which takes place on every part of the vase which is somewhat removed from these openings; they will leave it such as it was, in a state of equilibrium, as when the liquid was without any motion. But, on the other hand, if we were to make the opening, or the openings, somewhat larger, all this would be immediately changed; and the sizes which we gave the holes would influence the pressure on every point; so that if one of the openings was lessened, the velocity of the stream would immediately increase in the others.

These principles, demonstrable by hydrodynamics, apply most readily to the phenomena which now engage our attention.

Let us admit that the subterranean river which feeds an artesian well, also partially discharges itself into the sea, or into a river affected by the tides, and this by an opening of considerable dimensions compared with its own size. According to what we have stated above, if this opening be diminished, the pressure will immediately increase in all the points of the natural or artificial channels which are occupied by the waters of the river; the flow by the well will become more rapid; or, what is the same thing, the level of the water will rise. Thus, then, every one will understand, that the flow of the rising tide immediately above the opening by which a subterranean river discharges itself, will diminish, by the augmentation of the exterior pressure, the quantity of water which this river will supply in a given time. The effect is precisely the same as would result from a diminution of the size of the aperture. The flowing and ebbing of the tide, therefore, will produce a corresponding flowing and ebbing in the spring of the well. And such, in a few words, is the explanation of the phenomenon which has been observed at Noyelle and at Fulham.

Concerning the Temperature of the Water of Artesian Wells.

Of all the scientific questions which have for some years engaged the attention of learned men, one of the most curious, beyond doubt, is, whether the globe still maintains any traces of its *original heat.* Fourier has brought the solution of this great question in natural philosophy to an observation which is sufficiently simple; he has proved, in short, that if the earth received all its heat from the sun, the temperature of its strata would, in every climate, be the same at all accessible depths, and also, that it would be found equal to the mean temperature of its surface. But the observations which were made in a great number of mines, were at variance with these conclusions. These observations, however, have not brought conviction to every mind. The gallery of a mine presented itself to many imaginations as a sort of laboratory, in which chemical action was unceasingly producing heat. It was also argued, that the presence of the workmen, and the lighted flambeaux, the explosions of gunpowder, &c. &c. produced the effect; and although minute calculations had demonstrated how entirely all these causes, when united, were insufficient for the explanation of the phenomenon, still many obstinately remained in a state of doubt. An observation which I made in October 1821, whilst, in concert with Messrs Colby, Kater, and Mathieu, I was connecting, by geodesic operations, the opposite coasts of France and England, opened to my view a mode in which the problem might be solved in a manner which would be wholly unobjectionable. I then found that the temperature of the springs which rose at the foot of the cliff of Cape *Blanc-Nez* was notably higher than the mean temperature of the water of the neighbouring wells of *Montlambert*.

From that moment the determination of the temperatures of the projecting fountains presented itself to my mind as a subject of research full of interest; it appeared to me that the water of these fountains could not fail, especially if they were at all abundant, to reach the surface with the same degree of heat which the interior beds, usually horizontal, and between which the waters were confined, possessed. At all events, it was not to be doubted that, in the same country, if the earth really had a peculiar proper heat, and this was precisely the subject under discussion, the *maximum* of temperature ought to be found in those waters which came from the deepest springs. Accordingly, for nearly fourteen years I have lost no opportunity of collecting, by myself, or with the help of friends, thermometrical documents which ally themselves in the closest way with the history of the globe. I hope soon to be able to present these to the public, and I shall not fail to combine with them the results to which they lead. On the present occasion, however, I must limit myself, with the help of a few selected results, to demonstrate the problem, that everywhere the temperature of artesian wells is higher than that of the surface, in the ratio of 2° for every sixty or eighty feet of depth (1° Cent. for every twenty to thirty metres of depth.)

				Metres.
Paris, ...	Mean temperature at surface,	+ 10.6 Centig.		
	Do. of Well of Port St Ouen,	+ 12.9	Depth	66
Departements du Nord, and du Pas-de-Calais,	Mean temperature at surface,	+ 10.3		
	Do. Well of Marquette,	+ 12.5	Depth	56
	Do. Well of Aire, . .	+ 13.3	...	63
	Do. Well of St Venant,	+ 14.0	...	100
Sheerness, mouth of the Medway in the Thames	Mean temperature at surface,	+ 10.5		
	Temperature of Well, . .	+ 15.5	Depth	110
Tours, ...	Mean temperature at surface,	+ 11.5		
	Temperature of artesian well,	+ 17.5	...	140

Depths of the most remarkable Fountains which have been opened by the hand of man.

We have already alluded (page 206) to pits sunk by the Chinese to the depth of 1800 feet, in the province of Kia-ting-fou, by which they hoped to procure a supply of salt water; but as no water ascended the pits, we cannot rank them in the list of wells properly so called.

The seventh sheet of water, found near Saint Nicolas-d'Aliermont (see p. 224), was at the depth of 1030 feet. The water from it rose to the surface. As it was not water but coal that was sought for, the works were abandoned; and the only result that remained, was the formation, without intending it, of a copious fountain, whose waters issued from a source more than 1000 feet deep.

The pit recently sunk at Geneva to the depth of 682 feet, has not reached any body of water which has a tendency to rise.

At Suresne, near Paris, the residence of M. Rothschild, the Messrs Flachat have worked a pit, previously begun by M. Mulot, to the depth of 663 feet. This pit has now penetrated the chalk to the extent of 537 feet. The work has been suspended, when there is only about 60 feet more of the chalk formation remaining, upon penetrating which, there would be every prospect of finding water. The desirableness of prosecuting the research is most apparent.

The fountain of *Cheswick*, in the Duke of Northumberland's park, projects its water about a yard above the surface of the soil, and comes from the depth of 582 feet.

The deepest fountain in the department of Pas-de-Calais is situated between Béthune and Aire. Its waters project seven feet above the ground, and come from a depth of 461 feet.

The artesian well which affords such an abundant supply in the cavalry barracks of Tours, is fed by a body of water which M. Degousée found at the depth of 259 feet. The water of another well, which was finished in 1834, in the silk manufactory of M. Champoiseau, springs from a depth of 273 feet.

*Concerning the Daily Issues from some of the principal Fountains.**

Bélidor has already mentioned, in his *Science de l'Ingénieur*, a fountain which is situated in the monastery of *Saint André*, a couple of miles from Aire in Artois, the waters of which rise to the height of eleven feet above the ground-floors, and which furnishes nearly two tons of water per minute.

The well which Messrs Fabre and Espériquette have sunk, at *Bages*, near to Perpignan, in the property of M. Duvand, supplies 333 gallons per minute.

The well which M. Degousée has sunk in the cavalry barracks at Tours, measured at six feet above the ground, furnishes 237 gallons per minute.

Of the many wells which exist in England, the one whence,

* Near Orleans, there is a very abundant spring known under the name of *Bouillon* or *Source of the Loiret*, and which I think ought to be considered as a natural projecting fountain. During the drought of the year 1801, one of the worst of which the annals of meteorology has preserved the remembrance, the Bouillon nevertheless, according to the measurement of M. de Tristan, yielded 733 gallons per minute. It has been very generally thought, that we must go to the Sologne to seek for the origin of the water supplied by the Bouillon and some other neighbouring streams; but M. de Tristan has combated this opinion with unanswerable arguments. He has also shewn that the overflowings of the spring coincide with those of the Loire, even when its increase, as in 1800, is produced, at the end of spring, not by rains, but by a sudden melting of the snow which covers the mountains of central France. There can be little doubt, therefore, that there is a subterranean communication betwixt the Loire and the Bouillon. It is true that the water of the Bouillon does not appear troubled, till a day or two after the rise is seen on the river. But this is not to be wondered at. The entrance of the subterranean channels must, in some degree, act as filters. The sensible variations of temperature also, which the water of this spring experiences in the different seasons of the year, shew that the channels through which it flows are far from being very deep.

according to my knowledge, there is the most abundant supply of water, is that in the copper manufactory of Merton, in Surrey; its issue amounts to 200 gallons a minute.

The artesian well of *Rivesaltes*, for which the inhabitants are so much indebted to Messrs Fabre and Espériquette, engineers, furnishes 176 gallons in the same time.

The well lately sunk near to *Lillers*, in the department of the Pas-du-Calais, with a depth of 140 feet, affords a supply of 155 gallons per minute.

Of Artesian Wells whose waters have been employed as Moving Powers.

At the village of *Gouéhem*, near *Béthune*, four wells have been sunk in a meadow to the depth of 120 feet. The waters which issue from them are converted into the water-course of a flour-mill, and subserve other agricultural processes.

At *Saint Pol*, there is another mill, the only moving power of which is the water from five projecting fountains.

At *Fontès*, near Aire, the waters of ten such wells are made to turn the mill-stones of a large mill, as also to blow the bellows and beat the hammers of a nail manufactory.

At *Tours* M. Degousée has excavated a well, in the silk manufactory of M. Champoiseau, to the depth of 430 feet, which pours 237 gallons of water per minute into the troughs of a wheel of twenty-one feet diameter. This wheel works the looms of his manufactory.

At Tooting, near London, the fountain of an apothecary puts a wheel of four feet diameter in motion, and this sets a pump to work, which raises water to the top of a house three stories high.

Of the advantage to which Industry, in various circumstances, has turned the Waters of Fountains.

On the present occasion we need not dilate on the benefits these waters confer on public health, nor on their use in irrigation, &c. &c. We shall only point out their application to a few purposes which are less generally known.

These springs have been put in requisition even in countries where more common water-courses are not unfrequent. Their constant and high temperature permits them to be applied to the movement of machinery during the most severe winters, whether it be directly, when they are abundant, or, in other cases, only as a means of washing away the ice, which is apt to stop the movement of the water-wheels.

In Wurtemburg, M. Bruckman, by transmitting through metallic pipes, conveniently placed, a current of water, at a temperature of 54° Fahr., which is derived from several natural springs, keeps up a temperature at 47°, in various manufactories where the external cold lowers the thermometer to zero. This is a simple imitation of a plan which has been long practised in the village of *Chaudes-Aigues*; the results, however, are worthy of consideration.

Greenhouses also are in existence, in which the temperature is maintained very equally, by the effects of the constant circulation of a large quantity of water, derived from these sources.

During heavy rains, the work of paper-mills is often interrupted, on account of the impurity of the water. These forced stoppages come to an end, when the constant limpid supply of a projecting fountain can be employed.

In some localities the invariably pure waters of a steady temperature, proceeding from these springs, have been the means of establishing very lucrative artificial cress-plots. The beautiful growth of cresses in those parts of the beds of rivulets where these natural springs existed, has suggested this application. It is positively stated that the artificial cress-plots of Erfurt yield not less than £12,000 per annum.

The very fine lint which is intended for the manufacture of cambric, lawn, lace, &c. is steeped in the Department *du Nord*, with very particular care. In a single *commune*, between Douai and Valenciennes, there are ten or a dozen ratting-pools, which are fed entirely by water from a projecting fountain. It has been thought that the purity of these waters, and the invariability of their temperature, by accelerating the solution of the gum-resins, preserve the valuable qualities of the filaments of the lint in the highest degree of perfection.

In fish-ponds, the fish are apt to die during the winter, from the severity of the cold, and in summer from the heat. By turning the invariably temperate waters of an abundant artesian well into them, the extreme variations which the seasons induce are prevented. This experiment, it is said, has entirely succeeded in the ponds of St Gratien, near to Montmorenci.

Sometimes Pits are sunk for the purpose of transmitting into the interior of the earth, water, retained at the surface by strata of impermeable clay or stone, and thereby rendering extensive districts mere morasses, unfit for cultivation.

The pits by which descend into the interior of the earth those quantities of water, which, without this expedient, remain on the surface, may be called *negative artesian wells.* Necessity, the mother of so many important inventions, early suggested to mankind the idea of imitating nature in this point.

The plain of *Paluns*, near Marseilles, used to be a great morass. It appeared impossible to drain it by the help of the common surface channels. King René, however, caused a great number of pits or drain-wells to be sunk, which are known in the provençal language by the name of *embugs* (funnels).* These pits transmitted, and now transmit into the permeable strata situated at a certain depth, those waters which made the whole country a barren waste. It is positively stated that it is the waters taken down by these *embugs* of Paluns, which, after a subterranean course, form the projecting fountains of the port of *Mion*, near to Cassis.

The river *Orbe*, in the Jura, which descends from the lake of the Rousses, conveys into lake Joux much more water than evaporation removes from it. This latter lake, whence there issues no river, preserves notwithstanding a stated elevation which is nearly uniform. "It is," says Saussure, "because nature has provided for these waters subterranean issues, by which they are engulfed and disappear. * * * * As it is of the greatest consequence for the inhabitants of this valley to preserve these natural drains, without which their arable lands and their habitations would be immediately overflowed, they preserve them with the greatest possible care; and when they perceive that they do not take off the water with sufficient velocity, *they themselves open*

* It is the property of absorbing, of drinking up the surface waters, possessed by certain natural and artificial openings, which has given the names of *boit-tout*, of *betoirs* or *boitards*, to these drain-wells in certain districts.]

new ones. For this purpose, all that is necessary is to sink a pit fifteen or twenty feet, having a diameter of about ten feet, in the thin and vertical strata, the summits of which appear on the surface. The name of *entonnoirs* (funnels) is given to these pits. * * * * It is," adds Saussure, " the waters absorbed by all these entonnoirs, that are observed to rise from the earth, and form a large spring, which is also called *Orbe*, at the distance of two miles below the southern extremity of the lake." In this passage of two miles, the absorbed waters descend 680 feet.

A manufacturer of potato-starch at Villetaneuse, a small village about three miles from St Denis, in the winter 1832–3, by means of a pit sunk to the depth of certain absorbing stratified beds, got rid of not less than 16,000 gallons of impure water per day, the stench from which had given rise to serious complaints, which probably would have compelled him to give up his establishment. After six months of daily absorption, nothing was found at the bottom of the pit except sand, and this has been uniformly the case from the first.

By the same kind of process, the superintendents of the common sewers of Bondy freed themselves, every twenty-four hours, of about 3000 cubic feet of water, which impeded their operations.

I shall close this subject by publishing the very ingenious use to which M. Mulot has applied the absorbing properties of gravelly strata, in the solution of a problem which was of the greatest importance to the neighbourhood of St Denis.

The water of a fountain which had been opened in *La Place de la Poste aux Chevaux* in that town, became, during the summer, an excellent instrument of cleanliness, but frost coming with the winter, ice was formed in the public ways, and very much endangered all passage. The inconvenience was so great, that it almost led to the abandoning the idea of opening a new fountain on the *Place aux Gueldres*, when M. Mulot conceived the idea which I shall explain in very few words.

The water, of a very superior quality, which comes from a bed 200 feet deep, is made to ascend in a metallic tube of a certain diameter. A tube, which is *considerably larger*, envelopes this first, and descends 170 feet to a reservoir of very good water, though not quite so excellent as the other. It is exclusively in the circular space between these two tubes, that the water of the reservoir 170 feet down can ascend. Once more, a third tube, *considerably larger* than the second, and including it, descends to the depth of one of these absorbing beds of which we have spoken so much. The circular space which is included between the middle and the exterior tube sends up no water: on the contrary, its sole use is, during the winter, to return into the bowels of the earth the superabounding waters of the two other pipes, which, were they to overflow into the street, would become a sheet of ice. In this case, the water which is reabsorbed being pure, there can be no objection to its descent, as there was at the works of Villetaneuse and Bondy, viz. the apprehension that the waters of the neighbouring wells might be injured by impure infiltration.

Concerning some anomalies which have been observed in the Sinking and in the Play of certain Fountains.

At Blingel, in the valley of Ternoise, of three bores which were undertaken in 1820, the first turned out a beautiful projecting fountain; whilst the other two, on the contrary, have not furnished a drop of water, though all the three are very near each other.

The districts of Lillers, of St Pol, and St Venant, present irregularities of precisely the same kind.

At Bêthune, a bore, after having pierced seventy feet of alluvial soil, and thirty feet of limestone, conducted to the surface a beautiful limpid jet d'eau. In the garden of the contiguous property, a similar operation of boring has not produced a single streamlet of water, even though the chalk has been penetrated more than 100 feet.

But these facts, which might be multiplied to infinity, cannot with propriety be considered as remarkable. Let it be remembered that these subterranean waters do not form sheets of a great extent, or more properly speaking, do not form sheets at all, except at the surface of separation of two distinct mineral beds; that, on the contrary, in the thickness of those of the beds which are least compact, as, for example, in chalk, the water neither exists in any certain defined limits, nor circulates except in trenches, betwixt which are found masses of perfectly sound chalk-masses, which are without fissures and impermeable. If the piercer enters into one of these trenches, water will gush up, more or less, according to the pressure which it there sustains. If, on the other hand, the work is unfortunately carried on in a very compact portion of the chalk, the whole will be only labour lost. But in this there is nothing to excite surprise. If, instead of expecting water in the interior, or even in the upper part only of the mass of chalk, the soundings were carried to the impermeable bed upon which this mass rests, then there would be encountered not only streamlets,—not only liquid trenches, but a plentiful reservoir; and the success of the operation would be in no degree doubtful.

There exist certain localities, and the city of Tours is one of them, where wells may be sunk, and approximated to each other, almost indefinitely, without injury being done to any of them. There are other places, on the contrary, where every new well immediately produces a diminution of the issues of all the others, or a lowering of their waters. But these differences will not surprise those who have read with attention what has been said above regarding the influence of the tides upon these fountains. (See p. 233.) In truth, they will perceive that in the former alternative, the sum of the openings by which the waters ascend is *very small*, when compared to the extent of the mass of water whence they spring; and, in the latter, this comparative smallness of the dimensions necessary to the steadiness of the hydrostatic pressure, is not present. These phenomena, therefore, are nothing more than a kind of experimental verification of the hydrodynamic principles which we have already stated.

The jets of two fountains in the paper manufactory of M. de la Garde, near to Coulommiers, experienced *a rise* of more than a foot and a half in the great drought of 1827, that is to say, during a time when the great majority of common springs were dried up. Although this state of things did not continue above a few days, yet it is not the less remarkable. No satisfactory explanation has yet been offered of it. I ought not, however, to omit to add, that after this extraordinary appearance, the waters of the two fountains gradually fell, without, however, surpassing in this descent their usual limit.

At the time of a thaw, which had been preceded by a great fall of snow, M. Desguirandes, the Mayor of *Choques*, was alarmed by an extraordinary noise. He immediately descended to his garden, and saw, with astonishment, the projecting fountain elevating itself to three times its usual height. This lasted only for five or six hours. This fact, for the knowledge of which I am indebted to M. le chef de bataillon du génie Bergère, it appears to me, may be considered as a proof that the ascent of the water in these wells is truly the consequence of a hydrostatic pressure. At the moment of the above occurrence, the thaw must have been the means of filling, throughout all their extent, the subterranean fissures which were situated higher than the town of Choques, which usually, and even during the time of rain, were either not quite full of water, or only contained interrupted patches of it. Every one knows, that a very small stream, even a capillary one, is sufficient to produce the strongest pressure in an indefinite liquid mass.

There is in Rochelle, at the distance of 215 feet from the shore of the sea, a well, in which the sheet of water reached, unfortunately does not project a stream above the surface of the ground. The surface of the water is 21 feet below ground. The total depth of this well is nearly 584 feet. For four years the level of this liquid column, of the length of 563 feet, did not vary in any sensible degree. But in 1833, some attempts having been made to increase the depth of the well, its waters were observed to undergo the most extraordinary oscillatory movements.

On the 1st of September a fall of 147 feet took place.

On the 2d there was a fall of 156 feet.

On the 2d of October the water was at its former level.

On the 3d there was a fresh fall.

On the 4th the fall amounted to 30 feet.

From the 5th to the 14th there was a rise of 9 feet.

From the 14th to the 18th (5 days) there was a fall of 145 ft.

On the 19th a rise began.

From the 19th to 16th November, the rise equalled 116 feet.

From 14th November to 16th there was a fall of 15 feet.

On the 16th a rise again began.

From the 16th to December 15th, there was a rise of 34 feet.

These oscillations, assuredly most extraordinary, as much from their irregularity as their extent, would require to be observed for a much longer period before any explanation could be offered with any prospect of success.

Are these Wells likely to become exhausted?

This is a question that is very often put. As an answer, we shall mention two facts which are well calculated to dispel all fears on the subject.

The fountain of *Lillers*, in the department of Pas-de-Calais, the sinking of which extends as far back as 1126, has uniformly projected its waters to the same height above the surface, nor has the quantity which it furnishes in twenty-four hours ever varied.

The well of the monastery of Saint André, appears now to be, so far as it regards the height of its jet, and the quantity of water which issues from its upper orifice, in precisely the condition in which it was when Bélidor observed it more than a century ago.

Of Wells whence gas issues.

In searching for water in the bowels of the earth, sometimes, instead of this liquid, great reservoirs of some gas are discovered, which immediately rises to the surface. This gas is usually inflammable; sometimes it is pure hydrogen, but more frequently carburetted hydrogen,—that gas which so frequently collects in coal-pits, and gives rise to such dreadful explosions, or, in other terms, that gas which is now so much employed for domestic purposes.

The Chinese have many wells of this description. The gas which was disengaged from that which the Abbé Imbert visited a few years ago, was conducted by long pipes, under more than three hundred gasometers, whence it was transmitted to be burnt. Streets, halls, and work-shops, were thus illuminated, and it was conducted to the spot required through the medium of tubes constructed of the bamboo.

There are in the United States of America many villages in which, for the purpose of illuminating the streets and the houses, those streams of gas are employed, which are without intermission disengaged, and for a great number of years, from the openings which had been made in search of water *.

Usually the reservoirs of gas contained in the bowels of the earth cannot furnish a supply of any long continuance. At Cormeilles, in the department of Seine-et-Oise, there was so abundant a discharge of hydrogen gas, through an opening made, under the direction of M. Degousée, whilst sinking a well, that the workmen could not work during a whole day. After three or four days, however, all traces of it had disappeared. This phenomenon, accompanied with very much the same circumstances, has also very lately occurred at Trieste.†

Some Remarks on the Subterranean Course of Water, and on the Absorption of Gases by Water in the Interior of the Earth. By Gustav Bischof.

In reference to the subterranean course of water, we must distinguish the following cases:—

1. The water which is afforded by the atmosphere filters through permeable layers of earth and rock, and arrives at strata which resist its passage. If these strata reach the surface at a lower point, the water makes its appearance in the form of springs.

In such a case, it is not necessary that the water should entirely fill the canal; but it can, like a subterranean rivulet, flow down in contact with atmospheric air. This is the case more par-

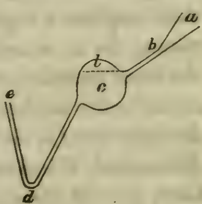
* The following passage occurs in Pliny. "There arises perpetually from Mount Chimera, near Phaselis, a flame which burns night and day." Captain Beaufort found this flame in 1811. It is evidently the result of the disengagement of gas by some natural fissure of the earth. Its antiquity and continuance seemed to justify its quotation here.

† Annuaire pour l'An 1835.

ticularly in limestone and quadersandstone mountains, and generally in those formations in which fissures abound. Thus, for example, in the chalk hills of the Westphalian flœtz formation, springs occur which are in reality subterranean rivers, such as the springs of the Jordan, the Lippe, the Pader,* &c.

2. The water of the atmosphere penetrates by clefts to a greater or less depth in the interior of the earth, fills all the clefts connected with those by which it entered, reascends by them according to the laws of hydrostatics, and comes to the surface as springs at one or several points which are at a somewhat lower level than the spot where it commenced its course.

This case can only occur when all the communicating fissures are, like hydraulic pipes, entirely filled with water. The water, however, may flow for some time in open canals, as in the preceding case, before it reaches the close fissures. The pressure of the height will only begin to exert its influence from that point. Until then, the water comes in contact with atmospherical air, and absorbs it. For example, the following case may occur. The water flows from *a* to *b*, in an open canal, and from *b* to *c* in an inclosed channel, which at *c* becomes enlarged, and at *l* contains atmospheric air. On account of the pressure exerted by *b c*, the water absorbs a larger portion of atmospheric air than it can under the ordinary pressure of the atmosphere; it then flows in close canals to *d*, ascends again to *e*, and there flows out as a spring. Under such circumstances, we can understand that the water allows the air it had absorbed under the pressure of the water *b c* gradually to escape as it approaches its outlet, and the water, when it flows out, will retain only so much air as it can under the usual pressure of the atmosphere. This is the cause of the frequent occurrence of a disengagement of gas at *e* in springs in limestone mountains. Several gaseous exhalations of a similar nature, which I have had an opportunity of examining, afforded a small-



* Compare my paper in the new "Jahrbuch der Chemie und Phys." 1833, Part xiii. p. 272.

er proportion of oxygen than is contained in atmospheric air, and, indeed, sometimes consisted entirely of nitrogen.* This it is easy to understand, when we consider that, by the oxidation of various substances partly inorganic (carbonate of iron, liver of sulphur, &c.), partly organic (organic remains, acids of springs†), &c., which the water, containing a quantity of atmospheric air, meets during its course, that oxygen may be lost. In this manner, when carbonaceous organic substances are oxidyzed, carbonic acid is produced, which, on account of the facility with which it is absorbed, will be retained, and renders the water an agreeable beverage. If the circumstances we have mentioned remained the same, the enclosed air at *l* could be gradually entirely absorbed by the water. But when, in dry seasons, the atmospheric water is not sufficient to fill the canal *b c*, new atmospheric air enters the hollow *c* from above, and afterwards, when the canal *b c* is filled in a wet season, is again gradually absorbed by the water, and so on.

When atmospheric water penetrates to a great depth, and there acquires a higher temperature, it loses the power of retaining the air absorbed at the ordinary temperature and under the usual pressure, and, on this account, it gives it off when it comes to the surface. Hence the frequent phenomenon of the disengagement of air from hot springs, as, for example, at *Aachen*, *Burtscheid*, *Wiesbaden*; from the warm *Paderquellen* at Paderborn, &c. A circumstance, well worthy of attention, is in favour of this view, viz. that the last mentioned springs disengage more gas the warmer they are.‡

Conformably to the views already given, the air disengaged by warm springs will contain less oxygen than atmospheric air does, and often only nitrogen with or without carbonic acid gas, for the higher the temperature of the water, so much the easier is the oxidation of the substances capable of oxidation. Thus, L. Gmelin and Lade found that the gas evolved by the *Kochbrunnen*, at *Wiesbaden*, consists of 82.3 carbonic acid gas, and 17.7 nitrogen.§ Monheim found in the gas evolved by the

* Neues Jahrb. der Chemie und Phys. 1833, part xiii. p. 257.

† Annalen der Phys. und Chemie, vol. xxix. p. 3. and p. 238.

‡ See my paper, p. 265.

§ Annalen der Physik und Chemie, vol. vii. p. 467. It is clear that the

Kaiserquelle, at Aachen, only nitrogen, carbonic acid gas, and 0.5 per cent. sulphuretted hydrogen. I found, however, 7 per cent. oxygen. Monheim found in the *Pockenbrünnchen*, at Burtscheid, only nitrogen, carbonic acid gas, and 0.1 per cent. sulphuretted hydrogen; but, according to my analysis, oxygen exists in the proportion of 2 per cent. Monheim found that the gas of the *Trinkquelle*, at Burtscheid, has nearly the same composition as that of the *Pockenbrunnchen*. In the gas of the *Kochenbrunnen*, and of the warmest of all the thermal springs of Burtscheid, the same observer found, besides the nitrogen and carbonic acid gas, also 0.1 to 0.15 per cent. oxygen.* My researches give, as the mean of three analyses, 47.3 carbonic acid gas, 52.1 nitrogen, and 0.6 oxygen.† Finally, Anglada found that the gas evolved by the sulphureous springs of the Pyrenees consists of pure nitrogen.‡

3. Atmospheric water enters clefts which are filled with carbonic acid gas derived from peculiar processes in the interior of the earth. In this case, which is one that occurs more especially in districts of extinct volcanoes, the gas is absorbed by water, and acidulous springs are produced.

Since carbonic acid gas is not only absorbed by water in much larger quantity than atmospheric air, but also since, at a temperature of 0° R., it is liquefied by a pressure of 36 atmospheres, it is evident that, under these circumstances, carbonic acid can in every condition be taken up by water. Carbonic acid, at a depth of 1152 feet beneath the earth's surface, under the pressure of a column of water of that height, could therefore exist only in a liquid form. Since, however, at such a depth, according to the observations on record, a temperature prevails

large portion of carbonic acid gas, in proportion to the nitrogen, can only to a very small extent be derived from atmospheric air. Streams of carbonic acid gas must therefore be added.

* "Die Heilquellen von Aachen Burtscheid," &c. Aachen und Leipzig, 1829, p. 209, 232, &c.

† The remark I made in regard to the *Kochbrunnen* of Wiesbaden, is also applicable here.

‡ Memoires pour servir à l'Histoire Générale des Eaux Minérales Sulphureuses et des Eaux Thérmales. Paris, 1828. And, Ann. de Chim. et de Phys. tom. xx. p. 246.

which exceeds the mean temperature of the earth's surface by about 11° or 12° R., the carbonic acid cannot at that place be liquid. As it appears from the experiments of Davy and Faraday that carbonic acid is condensed at a temperature of —8° R. by 20 atmospheres, at 0° R. by 36, and at 5.6 R. by 40,* it results, that the increase of temperature of carbonic acid gas by 1° R. requires an increase of pressure of about $1\frac{1}{2}$ atmospheres. Now as, according to the observations hitherto made, the increase of temperature towards the interior of the earth is about 1° R. for 96 feet, in round numbers, it follows that this depth, considered as a column of water, is about equal to the pressure of 3 atmospheres; and thus, the increase of the hydrostatic pressure is much greater in proportion than the pressure required for the condensation of carbonic acid gas by the increase of temperature. According to these suppositions, the hydrostatic pressure will always, at a certain depth, overcome the increased expansive power which the carbonic acid gas has acquired from the increase of temperature, and therefore, at such a depth, the carbonic acid can exist only in a liquid condition. Water which mixes with liquid carbonic acid will receive a heat exceeding the mean temperature of the place by at least 11° or 12° R. Since, however, by much the larger proportion of acidulous springs exceed the temperature of the place by only a few degrees, *such springs cannot have been produced by mixture with liquid carbonic acid.*

There is, however, here a case to be excepted, when warm springs, during their passage from beneath, become mixed with cold springs, so as to have their temperature reduced. It cannot be doubted, that, by means of at least a year's continued observations, such a case can be ascertained. The greater the depth whence the springs arise, the more constant is the temperature, and the greater the supply of water. When such springs, during their progress towards the surface, become mixed with others which are variable in their temperature and in the quantity of water, the mixture acquires the same characters. So far, however, as my observations extend, it appears, that springs having a temperature which exceeds the mean of the crust of

* L. Gmelin's "Handb. der Theor. Chemie," 3d edition, p. 124.

the earth of the place by 2° or 4° R., have a remarkable constancy in their temperature and the quantity of water. I have made observations for several years on three springs, of which one makes its appearance at about fifty paces from the others. During more than a year, I observed their temperature and quantity of water at least once a month. Two of them abound in carbonic acid, the third is a common spring. The maximum of temperature of the two former is 11°.6 and 9°.5 R., the minimum 11°.4 and 9°.3 R.; the whole yearly difference therefore only 0°.2 R.; whereas the maximum of the common spring is 8°, the minimum 6°.4, the yearly difference therefore 1°.6 R. No difference can be observed in the quantity of water given out by the two mineral springs during the year, whereas the common spring sometimes pours out more than twice as much as at others.

If we assume that the warmer of the two mineral springs is produced by the mixture of warm water having a constant temperature of 24°.4 R., with the warm common spring having a temperature of 6°.4 to 8° R.; then one part of water of 24°.4 must be mixed with three parts water of 6°.4 to 8°, in order to maintain the temperature of 11°.4 to 11°.6. But, according to this supposition, the temperature of that spring would vary from 10°.9 to 12°.1, and there would thus be a yearly difference of 1°.2; whereas the real difference is only 0°.2. This difference would be still greater if, as is actually almost the case, the maximum of quantity of the common spring should be combined with the minimum of temperature, and the reverse.

From this simple observation, it appears that the mineral spring of 11°.5 could not be produced by a mixture of water of 24°.4 with water which varies as that of the common spring. According to what has been said, water of 24°.4 R. must come from a depth where carbonic acid would be liquid: thus, when the matter is considered also in this point of view, the probability is diminished that those acidulous springs whose temperature exceeds by only a few degrees the mean temperature of the place, can be produced by mixture with liquid carbonic acid.

Under the ordinary pressure of the atmosphere, one measure of water, according to Saussure, absorbs 1.07 carbonic acid gas; under higher pressure we can increase this absorption to double or triple the amount of volume. In the interior of the earth the absorption must, doubtless, under the continually increasing pressure of water, amount to a much greater volume. When, however, water impregnated by carbonic acid gas under such high pressure gradually approaches the surface, a part of the gas is separated from it, and makes its appearance in more or less considerable streams. Berthier * is of opinion that this disengagement of gas (in most of the hot mineral waters that contain gas) is derived chiefly from a stream of carbonic acid gas, which is produced simultaneously with the mineral water, and which is much too considerable to be absorbed by the water; and he even thinks it extremely probable that it is only by the influence of the pressure exerted by the carbonic acid gas generated in the subterranean laboratories that the water is brought to the surface. Although this opinion formerly seemed to me a probable one †, yet, now since I have had opportunities of making observations on the gases evolved from mineral waters, I cannot admit unconditionally its correctness. I believe, at least, that streams of gas which merely accompany the springs, and are independent of them, are rare. Whether this case occurs or not depends on the relative proportions of water and gas, on the amount of the pressure of water, and on the temperature of the water. The greater the quantity of water in proportion to the gas which is evolved from the interior of the earth, and the higher the column of water which exercises the pressure, and the colder the water, so much the more easily is the gas absorbed. Hence it is, when the gas meets the water in the lowest part of its hydrostatic course, and when the canals of water proceed downwards to a great depth in the earth, that the various relations are favourable for the entire absorption of the gas. When, on the other hand, the gas enters the canals of water nearer the surface of the earth, it may easily happen that only part shall be absorbed, while the larger proportion passes freely through the water. Since, in the interior of the earth, the temperature of the earth increases with the hydrostatic pressure, the power which water has of absorbing carbonic acid gas diminishes with

* Annal. de Chim. et de Phys. t. xix. p. 27.

† Die Vulkanischen Mineralquellen Deutschlands und Frankreichs, &c. p. 215.

the depth, but in a much smaller proportion than it is augmented by the higher pressure. According to Henry's experiments (confirmed in regard to carbonic acid gas by Saussure), water under a hydrostatic pressure of 96 feet will absorb three times as much gas as it can under the ordinary pressure of the atmosphere. But, as mentioned above, the temperature increases about 1° for 96 feet of depth. Now, according to the experiments of Henry, if we consider the power which water at 10°.22 R. has of absorbing carbonic acid gas = 1, then for each degree of Reaumur up to 23°.56 R., that power will be reduced by 0.058*. According to Dalton, the decrease of the power of absorption of water would amount to much less for each degree from 0° to 80° R., if, namely, water at every temperature absorbs the same volume of gas. Thus, for example, the power of absorption of water would from 10° to 11° R. diminish only $\frac{1}{213+10} = 0.0045$. For our present purpose, it is a matter of indifference whether Henry's or Dalton's results are nearer the truth, for it is quite sufficient that the diminution of the power of absorption of water with the increasing temperature of the interior of the earth, need not be taken into consideration at all, in opposition to the great increase of this power derived from the augmented pressure of the water, and that hence such a diminution may be entirely left out in our calculations.

* Gilb. Annal. vol. xx. p. 155. If we reduce Fahrenheit's to Reaumur's degrees, we obtain by comparison of the 1st and 2d experiments for an increase of temperature of 1° a diminution of the power which water has of absorbing carbonic acid gas amounting to $\frac{84}{108.13,34} = 0.058$. By a comparison of experiments 6 and 7, we obtain $\frac{70}{108.13,34} = 0.062$; and by comparison of experiments 7 and 9, $\frac{45}{70.11,11} = 0.058$. These results correspond well with one another, and if we consider as unity the power which water has of absorbing carbonic acid gas between 10° 22 and 23° 56 R., we may regard the diminution as equal to 0.06 for each degree of Reaumur. In the new edition of *Gehler's Physikal. Wörterbuch*, vol. i. art. Absorption, p. 50, there are comparisons of each two of the above quoted experiments, in which equal quantities of water and carbonic acid always came in contact, but where very unequal diminution of the power of water in absorbing the gas was found. This arises from the differences of the absorbed quantities of gas being compared with each other in unequal absolute quantities of the gas absorbed at a lower temperature. Henry's 1st, 3d, and 4th experiments shew,

The rare opportunity has been presented me of measuring the quantities of carbonic acid gas and water which some mineral waters afford. I found the quantity of gas which flows out from an acidulous spring, which may be considered as one of the richest in carbonic acid, to be 4237 cubic feet in twenty-four hours, and that of water afforded in the same time 1157 cubic feet. As the water contains 1.65 times the volume of free and half-united carbonic acid gas, the whole quantity of the absorbed and the evolved gas amounts to 6146 cubic feet in twenty-four hours, and, therefore, 5.3 times the volume of water. The temperature of this mineral spring exceeds the mean temperature of the place by about 4° R.; and the spring must therefore come from a depth, where there is an hydrostatic pressure of about 12 atmospheres.* If we assumed that the carbonic acid meets the water at such a depth, then the latter could absorb more than twelve times its volume of the former, therefore more than double that it actually contains and gives off at the surface. Hence, if the gas meets the water at half the depth of the course of this spring, at a depth of 170 feet beneath the surface, the hydrostatic pressure at that depth would still be sufficient to take up 5.3 times the volume of gas.

Another mineral water, from which there is also a very considerable disengagement of gas, and in which, owing to the peculiar construction of the well, the relative quantities of gas and water can be measured with still greater accuracy, affords in twenty-four hours 3063 cubic feet of gas, and 3645 cubic feet of water. As the water contains 1.55 times the volume of free and half-united carbonic acid gas, the whole amount of absorbed and evolved

however, that the water at equal temperatures, even where there is so much carbonic acid gas present as is required for its saturation, absorbs unequal quantities of gas; and experiments 5 and 6 shew, that, when less gas is present than is sufficient for saturation, still all the gas will not be absorbed. Hence when, under these circumstances, in equal low temperatures, unequal quantities of gas will be absorbed, this will also be the case in high temperatures. Thus it is not the differences of the quantity of gas absorbed at different temperatures which can be compared; but it is the proportions of the same with one another at different temperatures.

* I shall not here explain that the increased temperatures of mineral waters, compared with that of common springs, depends chiefly on the depth of their origin; but I shall endeavour to prove this in another place.

gas in twenty-four hours is 871.3 cubic feet, therefore 2.4 times the volume of the water. The temperature of this mineral well is greater than the mean of the common springs at that place by about 4° R., and the spring must therefore come from a depth where there is a hydrostatic pressure of about 12 atmospheres. If the carbonic acid meets the water at this depth, then twelve times the volume could be absorbed, that is, more than four times the quantity contained in it, and given out at the surface, &c.

I am not aware that any similar measurements, which naturally presuppose an air-tight construction of the well, have been made. Trommsdorff * has indeed measured the quantity of carbonic acid gas which is evolved from the gas spring at *Kaiser-Franzensbad*, and also that of the water afforded by the four mineral springs, and of the free and half-united carbonic acid; but he could not measure the free carbonic acid gas which flows from the springs. The quantity of the gas from the gas spring, viz. 5760 Vienna cubic feet in twenty-four hours, appears very great; if we compare this with the quantity of water which the four mineral springs afford, 259 cubic feet in twenty-four hours, it may well be assumed that this quantity of water can, at a depth beneath, retain absorbed not only the gas which it contains and gives off, but also the gas of the gaseous spring, and that the latter nearer to the surface, under diminished pressure of water, is separated from the water, and through a side canal appears as a gas spring at the surface.

In this manner most of the carbonic acid gas springs, that is, exhalations of gas without the flowing of water, have been produced. The volcanic Eifel, and the environs of the Laacher-See, present many such gaseous springs or exhalations; one of them, that called the *Brudeldreis*, near Birresborn, was described ten years ago by Professor Nöggerath and myself.† These exhalations sometimes issue from alluvial soil or loose earth, and we recognise their presence only by the stunted vegetation and the suffocated little animals on such spots. There is no hissing noise, and the smell of the carbonic acid gas can be perceived only by placing the face close to the ground. In other places these exhalations come to the surface with a hissing noise from

* Kaiser-franzensbad bei Eger von Osann und Trommsdorf, 2d edit. p. 134.

† Schweigger's Journ. fur Chemie und Physik, vol. xliii. p. 28, &c.

fissures and clefts of mountains. Again, in other localities, such streams of gas are given out from little hollows which are filled with atmospheric water, and where the gas springs present completely the appearance of a mineral spring having an abundant disengagement of gas. It is easy, however, to distinguish such gaseous springs from mineral springs, as the former have no flowing of water, and exhibit no iron ochre deposits, or very slight ones, whereas, in most cases, mineral waters which are rich in carbonic acid gas abound also in iron.

That, in fact, these gaseous springs are nothing else than exhalations from mineral springs, flowing at a greater depth in the earth, can be proved by various appearances. In general, they occur at a higher, often at a much higher, level than the rivulets flowing near them, while the mineral waters appear generally at the same or a very little higher level. From hydrostatic laws, it is easy to understand, that, in valleys and near rivulets, springs cannot rise at a much higher level, if the bed of the stream, and also the source of the spring, have not a rocky bottom. It is also known, that it is very difficult to force the surface of the spring several feet above the level of the rivulet, in order to secure the former from floods. If, then, a mineral spring, rich in carbonic acid gas, ascends obliquely from beneath, and appears at the surface in the bed of a rivulet, at the deepest part of the valley, it may happen that no gas, or only very little, is given out, owing to its already, at an earlier period of the course of the spring, having found a passage of escape through the loose soil. Thus I am acquainted with a plentiful mineral spring, which flows out a few feet above a rivulet from the steep part of the bank, and from which there is not the smallest gaseous exhalation perceptible. The abundant deposition of iron-ochre shews that the spring must have contained a considerable quantity of gas; and we have not far to seek for it: for, a few hundred feet above the point at which the mineral spring flows out, at a level about 20 feet higher, there is a cavity so filled with carbonic acid gas, that it is only at the risk of losing his life that one can dare to enter it. Probably the *Brudeldreis* already mentioned is nothing else than the exhalation of gas from the course of a spring whose origin is to be assigned to the *Birresborn* mineral spring, which is very near it, and almost at the same level; and, in the same manner, the *vapour cavern* of *Pyrmont* (the gaseous exhalation from the bunter sandstone, which is 66 feet above the level of the spring used for common purposes) may be merely a stream of gas which flows from the course of the spring.

It is easy to perceive that such gaseous exhalations from the channels of springs which flow out at lower positions, can most easily appear at higher points, if the mouth of the spring is in the rivulet or stream itself, and if the water there is very deep; for, since none of the gaseous exhalations from mineral waters observed by me in the volcanic *Eifel*, and in the vicinity of the *Laachersee*, have much force, so that they could not overcome a higher pressure than that of a three or five inch column of water, it is evident that a mineral spring, rising in a rivulet or river several feet deep, can exhibit no disengagement of gas, but that the gas separated during the course of the water will come to the surface, where there is no water pressure to overcome; therefore, upon dry heights, after having penetrated through fissures and splits of the rock, or loose soil; and thus the appearance will be presented as if the gaseous spring were altogether independent of the water spring.

By observing the perpendicular ascent of gas-bubbles from mineral springs, one is easily induced to believe that there is a perpendicular direction from the greatest depth, where disengagement of carbonic acid has its origin. That this can rarely be the case, is proved by the internal structure of the earth, so far as is made known by escarpments of rock, and by mining operations; for the fissures in rocks, which form the canals for springs, proceed in very various directions from the interior to the surface of the earth. During the fitting up of several mineral springs, having a considerable exhalation of gas, at which I was present, and partly directed the work, I have several times remarked that the water and gas canals often proceed in a nearly horizontal or in a slightly inclined direction. A very rich gaseous exhalation, which was lost during the quarrying of the rock, was again found at a horizontal distance of a little more than twenty feet. At another spot, a disengagement of carbonic acid, in bubbles, was remarked in a small hollow, when the latter was filled with rain-water; but in a dry season the presence of the gas could be recognised only by the smell, and the suffocated animals lying at the bottom. A small shaft was sunk at the place, and, at a depth of 9 feet, a mineral spring, having abundance of water and gas, was found. As the water, with its gaseous exhalation, did not rise perpendicularly from beneath, but sidewise from a cleft in *Trass*, the passage of the spring was followed for some distance: it was found to continue its course for 10 or 12 feet, in a nearly horizontal direction, and probably proceeded much further in the same line. In this case, one might easily have been induced to consider the disengagement of gas in the small hollow as a gas spring, if the excavation had not shewn that it is a gaseous exhalation from a mineral spring existing beneath.

Although, then, from all these circumstances, it is very probable that most of the carbonic acid gas disengagements from the earth, are nothing else than exhalations from deep-flowing mineral springs, yet I will not assert that there are absolutely no gaseous springs. In a mountain which has been cleft by previous volcanic eruptions, by the elevation of half melted masses, and by their subsequent cooling and hardening, it is hardly conceivable that fissures which descend from the surface of the earth to a more or less considerable depth, can be filled with gas alone, and so form gas canals; but it is rather to be believed that they are filled with water, which absorbs the carbonic acid gas beneath, under a high hydrostatic pressure, and again gives it off at the surface. On the other hand, in a mountain not much cleft, the gas canals, which must be considered as necessary beneath, may approach very near the surface, and there unite with wider canals filled with water. We may imagine that, at this inconsiderable depth, only a part of the carbonic acid gas will be absorbed by the water, while the larger portion, unabsorbed by the resisting water, ascends, and appears at the surface as a gaseous spring. Such relations seem to exist at Meinberg, in Lippe-Detmold. The mineral springs of that place are remarkable for a very variable temperature, which, during the year, ranges from 5° to 11° R. This variableness allows us to presume with certainty, that the formation of the mineral springs, that is, the absorption of the carbonic acid gas by the water, must take place very near the surface of the earth. We can even assign a proximate depth. All springs which come from an inconsiderable depth, as that is a depth to which the influence of the external air penetrates, will naturally exhibit no constant temperature. The depth, however, at which the temperature of the earth begins to be constant, cannot be the same at all parts of the earth, as it is evidently a function of the extent of the thermometrical variations of the temperature of the air of the place; the smaller this extent, the smaller the depth, and the reverse. Hence this depth will be greater in low latitudes than in high ones. Thus Boussingault* found, that, in the Tropics, between the 11th degree north and 5th south latitude, this depth amounted to hardly one foot, as the thermometer, when sunk in a covered hole 8 to 12 inches deep, did not vary at all, or only, at most, a few tenths of a degree. On the other hand, Arago found, that, at Paris, at a depth of 25 feet, the thermometer was still not constant. D'Aubuisson fixes this depth at between 46 and 61 feet, and Kupffer at 77 beneath the surface. In the northern part of Siberia,† this depth seems to extend beyond 90 feet, as even at that depth the soil was found to be frozen. According to these observations, it would appear that the depth at which the carbonic acid gas joins the water canals at Meinberg, must be about 50 feet beneath the surface.‡

It is also in favour of the formation of this mineral spring at so inconsiderable a depth, that the carbonic acid gas which is disengaged possesses a much greater power of expansion than any gaseous exhalation does from the many mineral springs which

* Annal. de Chim. et de Phys. t. liii. p. 225.

† Annalen der Physik und Chemie, vol. xxviii. p. 631. Poggendorff's Annal. vol. xxxii.

‡ It is nevertheless to be remarked, that even the temperature of wells, which constantly exceeds the mean of the place, can yet shew, during the year, some variations, and can follow the course of the temperature of the external air. Thus the mean temperature of a salt spring at Werl, in Westphalia, deduced from twelve months' observations, is 9°6743 R., the maximum in July 10°32, the minimum in December 9°. However, we must assume that this salt spring comes from a depth where a temperature exceeding the mean of the air prevails; for this at Werl is between 7° and 8° R. Water, therefore, can penetrate so far without losing entirely the temperature it brings with it from without. Since, however, the mean temperature of the Meinberg mineral spring is pretty nearly the mean of common springs of the place, or the corresponding mean of Meinberg, the water of this mineral spring cannot reach the place where the increase of the temperature of the interior of the earth commences.

I have examined in the neighbourhood of the Laacher-See. None of these last can overcome the force of a column of water more than 5 inches high; while, as I found, the gas streaming out at Meinberg overcame with ease the pressure of a column of water 12 inches high, and could without doubt have overcome a column of water several feet high. This comparatively considerable expansive force of the streaming out gas, induces us to believe that it comes as gas from its source, without having been absorbed by water; for gas which is disengaged from the water, by which it had been absorbed, in consequence of the diminution of the hydrostatic pressure during the progress to the surface, can naturally have an expansive power only equal to, or very slightly exceeding, that of the pressure of the external air.

Those who explain the ascent of mineral springs by the operation of the pressure which the water suffers from the carbonic acid gas generated in the subterranean laboratory, do not reflect that the regularity in the pouring out of the spring is irreconcilable with that supposition. I have had many opportunities of observing mineral waters, which are rich in carbonic acid gas, uninterruptedly at different periods of the day and year, and have always observed a singular regularity in the springing out and flowing off of the water, and in the disengagement of the carbonic acid gas. The latter issued from the mineral springs abounding in carbonic acid in uninterrupted streams, so that the whole spring seemed to be in a state of ebullition; while from the springs having less carbonic acid, the gas ascended either in innumerable small bubbles, or periodically in single larger ones. Otherwise the size of the bubbles is regulated by the nature of the ground; if the spring comes from large clefts in the mountain, the bubbles are large; but if from many small openings of a porous rock, for example from *Trass*, the supplies are often not larger than the gas pearls of Champaigne wine. From various examples of remarkable regularity in the disengagement of carbonic acid gas, I select the following. Eight years ago I saw in a mineral spring, besides many small gas bubbles which rose uninterruptedly, also some larger ones which regularly, at an interval of one and one-fifth seconds, followed one another without interruption; and seven years afterwards, when I again visited the spring, precisely the same phenomenon was exhibited. If the ascent of the water took place like Hero's ball, then the water and gas must alternate with each other, as is the case in the *Sprudel*, and the *Neu Brunn* at *Carlsbad*,* where the spring appears, as it were, by fits and starts; and also in a much larger scale in the *Geyser and Strok* in *Iceland*.† But in all mineral springs, where there is a periodical ascent of carbonic acid gas, there is no irregularity in the issuing forth of the water. It is easy to see that the manner of the disengagement of the carbonic acid is dependent on the varying direction and the width of the *veins of the spring*, or small hollows in places where these veins proceed with a slight inclination, and in which are formed local accumulations of gas, and also on other differences in the form of the subterranean water-course. The phenomena observed during the boring for mineral springs and artesian wells, shew that here and there, in the interior of the earth, there are large clefts filled with carbonic acid gas, and also with other kinds of gas‡.

Since, therefore, the flowing out of springs is, with very few exceptions, a result of the hydrostatic pressure of water reservoirs situated at a higher level, we must propose the question, how a gas can have access to a close subterranean water-course without the pressure being disturbed. For we can hardly imagine processes in the interior of the earth, in which, by the mere meeting of waters with stony masses, perhaps with carbonate of lime, carbonic acid can be absorbed without having been previously separated. Even though, in opposition to what we have said above, we were to admit that carbonic acid absorbed by atmospheric water always existed in a liquid condition, yet the water must speedily, after having taken up the liquid, reach the place where the acid had its origin. As, however, the comparatively inconsiderable quantity of fixed constituent parts in acidulous springs shows no traces of energetic processes in and with the water, such will be rather disturbed than favoured by the pressure of the water.

* Gilb. Annal., vol. lxxiv. p. 126. † Gilb. Annal., vol. xliii. p. 50.

‡ See amongst other authorities, *Brandes, die Mineralquellen, &c. Zu Meinberg*, Lemgo 1832, p. 231. Die Artesischen Brunnen in und um Wien von v. Jacquin und Partsch, Wien 1831. Hericart de Thury in Ann. de Chim. et de Phys. vol. liii. p. 208.

In order to ascertain the influence which the junction of a gas with a hydrostatic course would have, I united two glass tubes, four feet in length, with a brass tube, so that they formed an inverted syphon. With the brass tube there was, forming a right angle with it, a second tube with a cock, having a narrow opening for the key. Into this side tube there was a small tubular retort cemented. When the cock was closed, the apparatus formed an unbroken water conduit. Even when it was not closed, the water ran uninterruptedly up out of the shorter limb so long as it was poured into the larger one, for the air inclosed in the retort was merely somewhat compressed, without being able to enter or come out, owing to the narrow opening of the key of the cock. When carbonic acid gas was evolved, and the cock was opened, the gas entered the water course in separate bubbles, rose in the shorter limb, and separated itself from the water of a small basin placed there. During the disengagement of carbonic acid in this true representation of a mineral spring, the water flowed uninterruptedly from the basin, and the column of water varied little in the larger limb. Since then, under these circumstances, where each gas bubble that enters the water-course entirely fills the tubes, and when it escapes, must produce a momentary interruption of the running of the water, yet there is no perceptible disturbance of the flowing off; this can happen to a still smaller extent in nature, as there the bubbles of gas rarely fill the canals of water. Finally, as the junction of the carbonic acid gas with the water course takes place beneath under a high hydrostatic pressure, the gas is therefore immediately absorbed, can thus produce a smaller disturbing effect on itself, and gradually again makes its appearance when the pressure of the water at the higher points of the course is diminished.

In order, then, to explain the absorption of the carbonic acid gas by the water, and the subsequent decomposition of the component parts of this carbonic acid-water,—to explain, in one word, the formation of a mineral spring rich in carbonic acid, we have only to assume, that, in the interior of the earth, narrow canals coming from beneath join larger ones, that they bring carbonic acid gas, and that the larger canals are filled with water.*

* From *Poggendorff's Annalen der Physik und Chemie*, second series, vol. xxxii. no. 16.

On Opal, and the Amorphism of Solid Bodies. By Professor FUCHS of Munich.*

MINERALOGISTS and chemists have gradually formed the opinion, that solid inorganic bodies are all of crystalline structure, and that those in which we cannot detect any traces of crystallization, viz. compact minerals, must be regarded as aggregates of extremely minute crystals, or, as it were, of crystal germs. Most of the compact minerals are without doubt of this nature; and we convince ourselves of this more especially by the gradual transition of crystalline,—granular and radiated masses, to compact, which we with reason unite, the one with the other, if they exhibit similar physical properties and chemical composition. But this view of the subject is not universally valid; all compact masses cannot be regarded as such aggregates; such a connection with crystallized bodies is not shewn by all; there are several which do not present a trace of crystallization, and which are therefore called *formless* or *amorphous* bodies. Permit me to make some remarks on these substances, and to present some considerations on their peculiar condition and importance; in which I shall refer not only to minerals, but also to other similar substances. I commence with Opal, which seems to me one of the most important of the amorphous substances, as it throws much light on the others.

Pure opal is essentially nothing else than amorphous and compact silica, of which one may convince himself either by regarding it with attention, or by comparing it with pure and perfectly formed quartz, viz. rock-crystal, which represents crystallized silica. But opal, having external crystalline planes, has never been met with, and its internal structure is such that, in regarding it, we cannot imagine that it exhibits the slightest germ of crystallization. Its smooth and shining fracture, and generally its whole habit, does not permit us to entertain any idea of crystalline structure, since, when it is not accidentally fissured, it presents a continuous mass similarly connected in all directions, so that in this respect it may be compared to liquid bodies, in which we cannot imagine that there is any thing of a crystalline nature, even in the most finely subdivided portion.

Opal is distinguished from quartz in a remarkable way by its

* Read to the Academy of Sciences of Munich the 9th March 1833.

very inferior specific gravity, much inferior hardness, single refraction of light, and especially by its chemical characters. When reduced to powder, it unites with lime in the moist way, and becomes hardened under water, a property which the quartz does not possess, even when it is reduced to the finest powder, as I have already shewn on another occasion. Quartz powder is dissolved by a boiling solution of potash with great difficulty and slowness, whereas opal powder is dissolved in a few minutes; nay even entire fragments of this substance do not resist very long the power of the solvent. At the usual temperature quartz is not at all acted on by potash, but the opal is gradually entirely dissolved by it; and that not merely when in powder, but also in fragments. All the varieties of this mineral do not exhibit in this respect the same phenomena; some are dissolved in two or three months, while others require four or five months, which might be concluded from the considerable difference in coherence. The hyalite offers the strongest resistance.*

Accordingly, there is a great difference between quartz and opal, and the cause can hardly be any other than that the former is crystallized and the latter is not. But as the opal always contains more or less water, many are of opinion that it is a hydrate of silica, and must therefore differ from quartz. *Breithaupt*, who first noticed the peculiar condition of opal and similar minerals, has made the singular assertion, that it cannot be crystallized because it is a hydrate. But the quantity of water contained in opal varies from 3 per cent. or less, to 12 per cent. and upwards, and is therefore not constant as in real hydrates, and, for the most part, in such as are capable of crystallization; the opal also, when it has lost all its water by heat, is still opal, has the same appearance, and is dissolved by potash in the same manner as before Even by fusion it is probable that it would not be converted into quartz. I must here remark that, generally, it is a property of most uncrystallized bodies to absorb more or less water, in uncertain quantities, or, when they are found in the same way as opal, to retain the water when they become dry.

It has often been asserted that opal passes into those varieties of quartz which have been called calcedony and flint, and which

* Melted silica would probably yield the opal having the greatest coherence.

are to be regarded as fine granular crystalline masses. If this were the case, we should obtain another view of opal, as it could then be regarded as a crystalline fine-granular member of the quartz series, although much would still remain obscure. It is in fact not to be denied that there are varieties of calcedony and flint which have much resemblance to opal, so that one is often doubtful whether to refer them to the opal or to quartz. But the supposed passage is nothing else than a mixture of these minerals, of the calcedony and flint, with opal, whereby the whole becomes more shining and acquires a higher degree of transparency, because the crystalline portions of quartz are surrounded by opal. It appears to me probable, that if not all, yet certainly almost all, calcedonies and flints are penetrated by a larger or smaller quantity of opal; and this I conclude to be the case from the result of the following experiment. A flat cut portion of calcedony, which had a pale bluish-grey colour, and was strongly translucent, was placed in moderately concentrated liquid potash, and left there in a well closed glass. As I remarked no change during four months, I believed that it would not be acted on, and paid no farther attention to it. At the end of nine months, however, I again looked at it, and found it white and opake. I left it some time longer, but could perceive no further change. At the end of a year I took it out of the liquid, in order to examine it more attentively. It had lost 3.9 per cent. of its weight, was, however, nearly as smooth and shining as previously, but, except in some slender stripes which were not previously to be remarked, and which probably consisted of pure quartz, was perfectly opake, and resembled much the mineral called cacholong. In the potash there was silica which nearly amounted to the loss of weight of the calcedony. Thus was this calcedony proved to be a mixture of quartz and opal, which latter was extracted by the potash, and it is thus rendered extremely probable that the cacholong belongs not to the opal but to the quartz.

Flint would, doubtless, if subjected to the same process, afford a similar result. The white, dull, and opake portions, which are not rare in this substance, are very probably nothing else than extremely fine granular quartz or flint, without opal. The mixture of opal is probably the cause that flint is suited to its employment as gun-flint, much more so, it is well known, than hornstone, which seems to want opal entirely, except when it approaches flint or calcedony. It deserves to be remembered, that the specific gravity of these minerals is less than that of rock-crystal, a circumstance which is also in favour of their containing opal.

Opal does not always consist of pure opal alone, but not unfrequently includes some finely subdivided quartz. A milk-white opal which had remained half-a-year in a potash solution, left a skeleton, which, on being shaken, fell to powder, which was similar to quartz powder. Probably the not yet sufficiently explained phenomenon of the play of colours in precious opal has its origin in a certain arrangement of fine mixed portions of quartz, which causes the light to be differently refracted. This view is rendered more probable by the circumstance, that no transparent opal has a play of colours, but only translucent or feebly transparent varieties, which probably are rendered thus opake by the quartz mixed with the opal. More accurate results might be obtained by treating the opal with potash. By this process, also, we might ascertain which of the friable minerals that have sometimes been considered as quartz, sometimes as opal, belong to the former, and which to the latter of these substances. Prepared silica is to be regarded as an opal, since, even when it has been strongly heated, it agrees with that mineral in chemical characters.

From the comparison of the opal and quartz with one another, we obtain the important result, that the same material *substratum*,—in this case silica,—can occur sometimes crystallized, sometimes amorphous, and, at the same time, apart from the form, can possess extremely different properties. I consider this condition not less worthy of attention than *dimorphism*, or the occurrence of the same substance in two distinct forms; and the more so, as amorphism is, as I shall afterwards shew, by no means a rare phenomenon. We must accordingly distinguish two conditions of consolidation, viz. the crystalline and the non-crystalline, and we must not regard as the same consolidation and crystallization.

We are acquainted with many bodies only in a crystalline, and many only in an uncrystalline condition. Many allow a change into both conditions. Of some, especially of those existing in a state of powder, we cannot with certainty say to which class they belong. Uncrystalline bodies are produced by the dry as well as by the moist method. All, however different they are in regard to material substratum, have, like all liquids, nearly the same appearance, in whichever of the two modes they may have been produced. All possess only single refraction. The formation of bodies having a regular figure has for a long time been termed crystallization. In the production of bodies without form, we can distinguish the vitrification when they are produced in the dry way, and the coagulation when in the moist way. These expressions have been long in use, but no correct and clear ideas were connected with them. Opal is one of the bodies formed by coagulation, and is often met with quite soft in the beds in which it occurs. I will now mention the most remarkable amorphous bodies, and at the same time make the necessary observations.

Common glass deserves to be first noticed, as a perfectly formless body. It is equally devoid of traces of crystallization as the opal, and has, in common with that mineral, single refraction. Most glass, however, is also capable of crystallization, and then usually forms a crystalline mass, which is no longer transparent, but is only more or less translucent, since it consists of a mass of innumerable minute crystals. It is only necessary for me to mention here Reaumur's porcelain. This alteration of glass, termed devitrification *(entglasung)*, occurs not unfrequently in the manufacture of glass, and often causes great difficulty. It happens especially when the mass of glass has a very complicated composition, and is very easily rendered liquid. The separate crystals sometimes met with in glass, are generally needle-shaped; but I have seen some of them having distinctly the form of four-sided prisms and square pyramids. The name of glass is no longer proper for such crystalline masses: our never-to-be-forgotten Frauenhofer named them glass-stones; and generally they are called devitrified glass. The glass-stone is distinguished from glass, not only by possessing form, but also by other properties, having a greater degree of hardness than common glass of the same composition, a different specific gravity, &c.

We may assume that glass and glass-stone differ in the same degree as opal and rock-crystal. However, glass-stone does not always exactly agree in chemical composition with the glass from which it has been produced, for a certain relation in composition is formed during crystallization, which very often does not exist in glass. Hence the mass of glass generally crystallizes only partially, or a mixture of glass and glass-stone is formed. I have, however, also seen glass-stones in large masses, in which no trace of real glass could be detected. That other bodies, having a fixed composition, are capable of being vitrified, is proved to us by many crystallized minerals, especially silicates, which, without suffering any change in their chemical composition, afford perfect glasses by fusion. The same substance, therefore, can appear at one time as glass, and at another as crystal. Slags of all descriptions belong also to the glasses, and of these many shew a great tendency to crystallization.

The bodies capable of vitrification have the peculiarity, that, by fusion, they never become so liquid as others, but always remain viscid, and may be drawn out in threads. We may therefore regard glass-fusion as only a condition of great ductility. Hence it is so difficult to fuse into a homogeneous mass the dissimilar bodies existing in this liquid. Hence the chief difficulty of procuring glass free from waves and stripes. And if such a mixture is made as to have a high degree of fluidity, it is always to be dreaded that it will crystallise, or be converted into glass-stone.

Of vitrified minerals the following deserve particular notice,—*obsidian*, *pitchstone*, and *pearlstone*, and I have no hesitation in adding *leucite*. This last substance, which has given its name to a form of the tesseral system, is, in my eyes, no crystal, but, so to say, a crystal-model, enclosed, it is true, by crystalline planes, but uncrystalline and glass-like in its interior. On account of its resistance to fire, it can retain its regular external outline in volcanic fire, while the form of the smallest portions, and therefore the crystalline structure, is lost. The unprejudiced observer will in vain seek for the cube which Haüy has assumed as the fundamental form of this mineral ; and if traces of such a structure were found, they would only be remains, and proofs of original structure, such as we meet with in other destroyed crystals. If we compare the leucite with analcime, we can hardly resist the thought, that it has originally been analcime,—potash-analcime making with the soda-analcime one *formation* *. The potash-analcime free from water, and, as leucite, would have an entirely different form if it were in reality crystallized. We cannot expect to find soda-analcime in leavas owing to its fusibility; but potash-analcime can well occur in the relations under which it is at present met with. When soda-analcime is surrounded by fire-proof clay, and strongly heated in the fire, it is changed to soda-leucite.

In the mineral kingdom, several other amorphous bodies besides opal occur, which have been formed in the moist method, or by coagulation, as allophane, psilomelane, uranium-ore *(uranpecherz)*, copper-green, thraulite, &c. all of which contain silica, or rather opal, and might therefore be termed Opalates. To this group we might also perhaps unite gadolinite. Haüy, it is true, thought he observed in that substance external crystalline planes; but its interior is so constituted, that, if we do not imagine we see crystallization every where, we cannot believe that the power of crystallization has been exerted during its formation. The remarkable phenomenon of incandescence which it presents when heated to a certain point, is probably a consequence of its transition from the formless condition to the state when it has a crystalline structure, or, if I may use the expression, of the awakening of the power of crystallization. I believe generally, that the acquiring crystalline structure, and the change of structure (transformation), in bodies, exercise great influence on the phenomena of heat and light in many chemical processes.

Many inorganic bodies having their origin in the organic kingdom, are formless and coagulated, and many of them are quite incapable of crystallization. Such are all mineral-bitumens and mineral-coals, and also many other component parts of organic bodies, as the species of resin and gum, and animal jellies.

* By formation, I understand what is included under organic species, which, retaining the ground-type, pass into one another by the change of vicarious component parts; for example, alum, epidote, garnet, hornblende, augite, grey copper (Fahlerz), &c. There are sometimes larger, sometimes smaller, series of intermediate members, whose extremes represent the pure species, which, as yet, are still partly ideal.

Besides amorphous glassy products, of which we have already spoken, many amorphous coagulated bodies are produced in the moist way in chemical laboratories, especially by precipitation. All slimy and gelatinous precipitates are amorphous substances, and many of them when they become dry are resinous or gum-like masses. Some of them emerge gradually from this state, and pass to that of a crystalline powder, by which process they are drawn together into a much smaller space.

That some of these, by evaporation, and especially by strong heating, become difficultly soluble in solvents otherwise suited to them, may partly be caused by their passing into a crystallized condition under such treatment. In relation to this circumstance, the oxides of chrome, of iron, of tin, and of zirconium, are particularly remarkable. That tin crystallizes when exposed to a high temperature, is rendered more probable, by the circumstance, that, in its chemical relations, it is identical with the natural oxide of tin, the tinstone. It must also possess the same hardness, as, when it is produced in the dry way, it may be employed to advantage in polishing hard bodies. The same may be said of oxide of iron, since, after being heated, it has the same properties as iron-glance. *Mineral kermes*, in regard to whose nature chemists are not yet agreed, is probably nothing else than amorphous sulphuret of antimony, and merely in this respect different from antimony-glance, into which it is converted by fusion.

In respect to the capability of possessing form, or to the power of elevating themselves from the state of amorphism, different bodies exhibit different phenomena. Some conduct themselves, under all circumstances, in such a manner as that one might say that they are altogether unable to acquire form; for example, *Water-glass*, the *Tartarus boraxatus*, &c. and several substances already mentioned.

Other substances lay aside their form only under certain circumstances, and assume it under others, and to this class belong silica, and various bodies capable of vitrification. I might here also name sulphur, which, when heated to a higher temperature than that required for its fusion, and poured into water, immediately forms a soft glass, of a dark hyacinth-red colour; but, after some time, it assumes spontaneously its previous properties. Mineral kermes probably owes its colour to amorphous sulphur.

Many bodies possess such power of crystallization, that they cannot be produced amorphous in a solid condition. The phosphate of lead has been long known and celebrated on this account. It crystallizes immediately when it solidifies, and at the same time emits a strong light, as I remarked many years ago. Bismuth oxide, and several other bodies, present a similar phenomenon. I believe I am not far wrong in stating, that all products of fusion, namely, all substances acted on by the blowpipe, which, previous to their being solidified are transparent, and after it not transparent, or only translucent, crystallize either in whole or in part, and in reality form extremely fine granular crystalline masses, which, as is well known, are never perfectly transparent. It seems to me also not improbable, that glassy arsenic acid loses its transparency by being kept, owing to its being gradually converted into a crystalline mass.

The question now presents itself, Can we regard the passage of a crystalline body to the state where there is no form, as a chemical process? and can we regard as a peculiar and distinct inorganic species, a formless body which has the same material substratum as a crystalline substance, as, for example, opal and quartz; or must we unite one with the other as mere varieties? Since it is not merely the absence of form which distinguishes formless from crystalline bodies, but also the remarkable difference in the compactness (which is usually less considerable in the former than in the latter), in the hardness, in the optical phenomena, and in the chemical relations; I think it is just as proper to consider two such substances as distinct species, as two which have a different fundamental form, but the same chemical composition. But as the want of form is not a positive property, and consequently a character of specific distinction is awanting to amorphous bodies, we cannot place them in the same rank as substances possessing form, and I therefore propose to term them subspecies (*after specien*).

Accordingly, the first question is already answered, and in this way,—that we must consider the conversion of crystalline to uncrystalline bodies as a chemical process; since by it they are specifically or qualitatively altered. In no case can such a change be regarded as a mere mechanical alteration, like, for example, the pulverization of bodies. Quartz, though reduced to the finest powder, is still quartz, and so is opal, and the former cannot be converted into the latter by crushing, even if the powder could be united into a whole without fusion. We should thus obtain a hornstone-like mass, but no opal. In the same manner, we cannot by pulverization convert diamond—crystallized carbon—into lamp-black, or sapphire into aluminous earth, &c. In short, by mechanical processes, we can neither deprive of form nor give form. The one like the other can only happen by an exciting of the internal powers of bodies,—only by a chemical process. The process by which bodies acquire form is called *crystallization*, and that by which they are deprived of form may be termed *deformation*.

Deformation of bodies takes place not only in the cases above cited, but also frequently, though rapidly passing away, under other circumstances, and performs, as I believe, a not unimportant part in the continual change and circle of events in the corporeal world. I cannot forbear making some farther remarks on this subject, although I foresee that they will meet with little approval, as they are in opposition to the prevailing opinions. According to my view, deformation precedes, nay must precede, every chemical synthesis. We shall probably never thoroughly understand this process by which dissimilar bodies are united, so as to form a uniform whole; but we shall at least have gained something by removing an incorrect idea which disturbs the chief part of the investigation, and which leads away from the road to truth. I consider that those are in favour of such an idea who believe that in chemical union the crystalline molecules of one body are applied to those of another, without any further operation taking place, so that the chemical product is in reality nothing else than an extremely fine and intimate mixture. But besides other objections which may be made against this view *, I would mention the following:—That upon such an idea we cannot understand how the crystalline molecules of two bodies

* Upon this subject may be consulted the masterly articles by Karsten in the *Neues Jahrbuch der Chemie und Physik*, vol. v. p. 394, and in the Transactions of the Academy of Sciences of Berlin for the year 1824, published in 1826, p. 1-39.

can be united by juxta-position, to produce a substance whose form is not reconcileable with the forms of these molecules, or how the form of the one can unite with that of the other ; that further, on this supposition, the production of generically distinct forms by the union of the same substances in different quantitative relations is like dimorphism, absolutely incapable of explanation. Accordingly, I cannot support such a view, but, on the contrary, am of opinion that bodies uniting chemically must previously lay aside their form, and then with each other assume the new form to which they have the tendency, or to which they become disposed by the new product of the powers residing in them ; and I am so much the more inclined to believe this, because crystallization like a repulsive force, acts against the chemical union of bodies, and must therefore be removed when the combination begins. *Deformation*, therefore, as already remarked, must precede every chemical union, and only by the substances going through a condition where form is absent, can they give their individuality to the chemical product, and in that product, assume a new form and acquire altogether new properties which partly, as we know, stand in inseparable union with the form.

Every inorganic body must, in my opinion, lay aside its form when it enters the organic kingdom and becomes assimilated to an organic body. Crystallization and Life are absolutely incompatible with each other, and whenever a substance in an organic body becomes crystalline, it at the same moment becomes a member of the inorganic kingdom. The crystal is, as it were, the boundary stone between the organic and the inorganic kingdoms, and we may with propriety term the last, to which many bodies derived from the first belong, the kingdom of crystallization. Accordingly all inorganic substances which are taken up by an organic body and go through it, in so far as they are constituent parts of the same, and are under the dominion of the vital power, must be without form. This is proved to us more particularly by silica, which is one of the best nourishing substances for most plants, and which is often separated and given out from particular plants, viz. from species of Bamboo, as a jelly-like mass—as a true opal—and is called tabashir. It is probable that plants take up more easily the substances of the mineral kingdom which are necessary or beneficial for them, and that they flourish better when the minerals with which they come in contact are amorphous, and probably this is also a concurring cause of silicates being so suited to plants, and of a volcanic soil being generally so fruitful; since by the action of fire many silicates become developed, or, if I may use the expression, from being *quartzate* become *opalate*, and thus become more accessible to plants.

In the same manner as silica passes through vegetable bodies, phosphate and carbonate of lime pass without doubt through animal bodies, and the latter is probably at first given out in the form of a jelly when it forms shells, pearls, corals, &c.

Since at the present time attention is particularly directed to crystals, and since investigators have pursued the subject in its whole depth and breadth, sometimes also entering into points of which nature seems to know nothing, and also being even so bold as to speak of crystallization in organic bodies; I have thought it proper to cast a glance on the *amorphism* of bodies, and to notice it particularly, being of opinion that it is to be regarded as a peculiar and very important condition of aggregation of compact bodies. It has indeed been already slightly touched on by some, but never to my knowledge has any one treated of it distinctly and fully. I know well that there are many points of difficulty connected with it, but I believe that they will afterwards be cleared up. It may perhaps be said that amorphism of bodies admits of no idea being attached to it, that it is a nonentity; we can as little make an abstraction of form as of space, &c.

I must here expressly remark, that by *amorphism* or *formlessness*, I understand nothing else than absence of crystallization; that there are compact bodies which show no trace of it, and altogether are so constituted that we can form no conclusion in regard to them, can hardly be doubted. For crystalline form, something else, something fixed and conformable to nature, must be substituted, which, in relation to the external form of amorphous bodies or aggregates, cannot happen, since that is accidental and may be infinitely varied, but which can happen solely in respect to the smallest portions of aggregation, and such withdraw themselves from observation. Further, this substitute must be the same in all these bodies, since all, as has been said above, have a strong resemblance to one another. But what can this be? According to my conception, nothing but the sphere, which is the form we also assign to all liquids, and which perhaps may not improperly be termed the *mother form* of the corporeal world. Amorphous compact bodies have in fact, apart from their solidity, a strong resemblance to liquids, and I would name them *solid liquids*, if this were not, according to our present notions, a contradictio in adjecto *.

The following additional remarks, by Professor Fuchs, on the subject of Amorphism, are extracted from a recent number of Poggendorff's Annals.

"I have already stated it to be my opinion that flint is a mixture of quartz and opal. In order to ascertain this, several thin fragments were exposed for ten minutes to the action of concentrated solution of potash. They became white and opake, but had not lost more than 1.7 per cent. in weight. Powdered flint, boiled half an hour with diluted solution of potash, lost 7.5 per cent. silica, which was dissolved by the potash. It is thus proved that flint really contains opal, but less than calcedony. It is evident that no constant relation is here to be expected.

"Compact quartz is therefore to be divided into that containing opal, and that which contains no opal. To the former belong flint and calcedony and the substances connected with them, and to the latter cacholong, hornstone, flinty slate, &c. In many sandstones, opal seems to be present as a cementing material."

Remarks on the Nature of the Evidence in support of a Theory of Light. By the Rev. Baden Powell, M. A., F. R. S., Savilian Professor of Geometry, Oxford. Communicated by the Author.

"Omnis enim philosophiæ difficultas in eo vestari videtur, ut a phænomenis *motuum* investigemus vires naturæ: deinde ab his viribus demonstremus phænomena reliqua."—Newton, *Princip. Præf.*

The phenomena of optics, until a very recent period, have been by no means sufficiently extended or matured to offer a legitimate field for the speculations of theory. Theories, how-

* From *Schweigger-Seidel's Neues Jahrbuch der Chemie und Physik*, vol. vii. p. 418.

ever, had been framed long before there was a sufficient accumulation of facts, or even the means of reducing a large portion of those facts which were collected to any regular law. Each of the rival theories,—those of emission and of undulations, was originally framed upon a very scanty stock of phenomena, and devised with no view beyond the explanation of that limited extent of results. Hence it will hardly be a matter of surprise that either hypothesis, in its crude form, should soon have been found to apply very ill to a number of new phenomena as they were successively discovered; nor that, in proportion as the deficiencies of each were manifest to the more sober inquirers after philosophic truth, their respective partisans should become more vehement in upholding them; each charging upon the other defects, which indeed could not be denied, whilst blind to the imperfections of their own hypothesis. Such controversies have not diminished in warmth in the present times. A vast range of new phenomena has been disclosed, which has led to the necessity of more extended and complex theories for their explanation; and, unquestionably, that hypothesis which has attracted most general attention, and on which the most profound mathematical skill has been expended, is the system of undulations propounded by Huygens, and modified and enlarged by the investigations of Young and Fresnel.

Much has been said of late both for and against the claims of the undulatory theory; and, perhaps, much on both sides which has evinced but imperfect conceptions of the real pretensions of that theory, or of the real nature of the evidence on which it has claimed acceptance. Whilst, on the one hand, it has been sometimes held up as possessing all the characteristics of certainty; it has, on the other, been as strongly and unreservedly condemned, because its principles have failed to explain some well established and some alleged facts. On the one hand, the language of its advocates has sometimes represented its explanation of the phenomena as equivalent to demonstration, and the existence and properties of the etherial fluid as physical facts; on the other, certain close comparisons of calculated and observed phenomena, certain difficult cases, for the solution of which the formulas have not been rendered available, certain real or apparent anomalies, and lastly, and principally, the palpable and apparently insurmountable difficulty of the unequal refrangibility of light, have been all urged as amounting to positive refutations of the theory, and as not only *jointly*, but even *singly*, *fatal* to its claims, and calling for its *entire rejection.*

Without here pretending to enter upon the several points of objection in detail, our object will be rather to shew, by a brief reference to *the real nature of the evidence*, that the arguments on both sides have been overstated—that the claims of the theory have been as unduly urged on the one hand as disparaged on the other, and in either case owing principally to a misconception of the *nature* of those claims. We may fully admit, on the one hand, that the proofs are far from being demonstrative, and on the other we may allow the deficiencies to be as numerous, and the objections as strong, as they are represented; and yet, notwithstanding, the theory, *when understood in its correct sense*, may stand *on its proper ground* as firmly as ever.

Its ground of evidence has been compared with that of the system of gravitation. In this system many, doubtless, have speculated on the physical cause of attraction; but the true philosopher, if he ever indulge in such speculations, keeps them carefully distinct from the real investigations of the legitimate theory. Many hypotheses may have been advanced, on the one hand, as to the actual nature of that force which pervades the system of the world; and on the other, the existence of an attracting influence, or real physical connexion, reciprocally uniting the minutest particles of matter in the remotest regions of the universe, has been censured as visionary and absurd; but the credit of the real theory is in no way involved in these speculations. The real philosopher recognises gravitation only as a *name* for the *general fact* of a tendency in matter to approach directly as the mass, and inversely as the square of the distance. The question is, Whether the subsistence of this law, which we know by direct observation in regard to the earth and bodies near it, as a "*vera causa*," will, by the deduction of its various consequences, suffice to explain, and enable us to calculate, all the motions of the remote bodies of our system? That it has been found to do so, not only in the greater and more notable cases, but even in all the most minute and nearly inappreciable results of the vast complication of impulses which are in action throughout the planetary world;—and that it has been found continually to apply with still increasing exactness, in proportion to the advancing precision of observation;—this accumulating species of proof is what constitutes the ground of its claim to be received as the true theory of the world.

Professor Airy has admirably enforced this view of the subject in his paper in the Journal of Science, June 1833, and further adds,—"If at the time of inquiring into the mutual action of bodies on each other, Newton had insisted on including in his general theory (whatever it might be), the effects of what we now call magnetism and capillary attraction, the theory of gravitation would never have been formed. By leaving these as subjects for future investigators, and by reducing to law the preponderating set of phenomena, he was able to form the most complete cosmical theory that has ever appeared. Many years passed before those supplementary laws were reduced to a simple form; yet by the consent of the world, the theory of gravitation, though imperfect as a theory of attraction, though sometimes completely disguised by the forces which Newton left unexplained, was adopted as a true system. That the existing theory of undulations stands in the same relation to the complete theory of light, as Newton's universal gravitation to the complete theory of attraction, I have not the slightest doubt."

In fact, the two cases are throughout strictly parallel. We shall perceive, in the speculations often pursued,—in the distinction to be observed between them and the legitimate theory, —and in the nature of its evidence and its claims to acceptance, the exact counterpart of what we have just referred to in the case of gravitation. All the ordinary facts of optics indicate a motion of translation or propagation in space of something, or of some effect, or influence, whose rectilinear direction constitutes a ray of light. The more obvious facts are consistent with the idea simply of a motion of translation of projected particles. But this is not a *necessary* supposition; and such a motion as these facts require, may equally arise from some combination of other motions whose resulting effect may be propagated in rectilinear directions. When, however, we come to the facts of the interferences, they absolutely require the existence of some of these other kinds of action. That two rays of light, made nearly to coincide with each other in direction, should produce absolute darkness, is a fact utterly contradictory to any conception of light as caused by an impact of material particles. If, indeed, the two interfering rays were always of different natures, as *e. g.* a red and a violet ray, it might be an admissible supposition that they might be capable of neutralizing each other's effects; the production of light being supposed in some sort analogous to electric or chemical action, which might be in different states in different rays. But when we recollect that the interfering rays are absolutely of the same nature, portions indifferently taken from the same original pencil, all such suppositions are at once overthrown The only kind of mechanical actions which it is *possible* to imagine *capable of mutually destroying each other*, are such as belong to *motions* existing and propagated in some medium, and whose *result or effect* in some way constitutes light. That motion of translation, then, which is necessary to be supposed in the radiation of light, must now be understood as a motion of translation of *an effect or result* of other motions, and not as a *simple* translation of matter. And the component or constituent motions, from which these result, must of necessity be such as are capable of composition, and of *destroying each other.* Thus we are compelled by the facts to recognise the idea of some *reciprocating kind of motions* among points distributed in space, whose result or effect propagated in space, constitutes light. By whatever name we call them, and by whatever cause, or in whatever manner, or in whatever sort of medium we suppose them produced, *these reciprocating motions* are a *necessary* consequence from facts. They must be of such a kind as shall be consistent with the established mathematical doctrine, and which is termed the superpositions of small motions, and capable of being expressed by the formulæ which that doctrine supplies. And further, it is a matter of measurement and calculation to determine the *periods* or *intervals* (or by whatever name we designate them) by which these motions are limited. Other classes of facts oblige us to superadd some other characteristics of the sort of motion necessary to be supposed. We frame such systems of these motions as can become subject of calculation. The results are found to accord with a vast number of experimental results. The argument from accumulation has extended itself very widely. Let it be granted that there are certain classes of facts to which these results have not hitherto been rendered applicable:—it yet remains to be seen, whether, by the introduction of some further condition into the primary supposition as to the *sort* of reciprocating motion, they may not be made so. There are other facts which are *at variance* with the results of the first principles, in the form in which they are commonly assumed. The only question is, May not those principles be somehow differently assumed so as to include the cases referred to? "Cases may arise" (as is observed in the paper before quoted), "which require a supplementary theory; and our only care with optical theories at present must be, that our present assumptions may admit of such a supplement at some future time." The investigation of the theory is comparatively recent; but even now, those first principles have been reduced into such a form as to render them applicable to an immense range of results, for which nothing approaching to an explanation has been offered on any other hypothesis. And every new research evinces its powers more completely. The accumulative argument is, therefore, rapidly advancing in strength.

We assume only what is a necessary consequence from facts and observations; but this is quite distinct from any proof of the existence or physical properties of an etherial fluid. When, therefore, we speak of the theory of undulations, or of an ether, let us divest ourselves of all ideas derived from physical hypotheses, and fix our attention solely on those *mathematical motions* (so to speak) *which are necessary to be supposed in accordance with the possibility of two rays destroying each other's effect;* and which can alone be some of the various kinds of *reciprocating motion*, or oscillation, of which mathematical analysis enables us to trace the laws. It has indeed been said, and the authority of great names has been referred to in support of the idea, that it is possible to reconcile the fact of the interferences with the theory of emission. In what particular way this may be done, has not been made to appear; but one thing is certain, that, in order to accomplish it, the emission theory must be so framed and modelled, as to include the production of some of those *reciprocating motions* before referred to, a problem which is fairly open to the skill of philosophers to attempt, and which, however difficult to imagine, it is impossible to say may not be accomplished. All we contend for is, that the condition just mentioned must essentially be fulfilled, in order to render any solution sufficient.

Guided by these considerations, we shall readily acknowledge, that neither, on the one hand, is it necessary to ascribe a demonstrative character to the evidence of etherial impulses for the support of the undulations as a legitimate theory; nor, on the other, will the real or alleged exceptions in which the theory does not apply, diminish the satisfactory nature of those explanations which it does afford, or impair the certainty of the existence of *some kind* of vibratory motion for the production of light. Nor, again, will such deficiencies in its completeness of application even be *real exceptions*, until it has been demonstrated that the fundamental principles are absolutely incapable of such modification as to include them. The course to be pursued, in such cases, is only to investigate more closely the originally assumed principles, so as to ascertain to what modifications they may be subjected, without injuring their application to the cases they already explain, and whether by such modifications they can be made to include the cases in question also.

The theory of undulations is then applicable to the phenomena of light, simply in this way, that waves propagated under certain conditions, and consistent with *the principle of* " *the superposition of small motions*," will explain with the greatest exactness extensive classes of facts which optical experiment has exhibited; but of the physical character or conditions by which the actual motions constituting the waves are determined, very little need be assumed. A variety of such suppositions may be made, by which all that is wanted for the actual representation of the simpler phenomena will be equally well supplied.

In the earlier steps of optical inquiry, undulations produced by vibrations of any kind would suffice. When the consideration of polarised light, and the characteristic phenomena dependent on it, were introduced, then that more restricted view of undulations which involved the transverse vibration of Fresnel, was rendered necessary; and such vibrations of equal periods, by the principle of superposition, afforded the results of circular or elliptic motion of the molecules.

Still, in the primary assumption as to the particular mode in which the vibrations may be occasioned, or the circumstances of the medium on which they may depend, there was great latitude of choice. Amid these primary assumptions, then, might it not be possible to find some, which, leaving all the formerly established conclusions unaffected, might involve consequences which should include the explanation of other points to which the theory had not yet been applied? Such seems to have been the inquiry which occurred to M. Cauchy, and he appears to have been perfectly successful in the answer he has elicited.

In fact, nothing can give any physical hypothesis a higher character as a truly philosophical theory, than this capacity of accommodating itself to new phenomena,—of adaptation to them, that is, without any sacrifice of what has been already attained, and without any capricious alteration of the first principles originally assumed; but merely from the circumstance that those principles were in the first instance so cautiously or so happily selected, and of so comprehensive a character, as really to include more than they were supposed capable of doing.

The idea possibly presented itself to its first inventor under one very simple and limited aspect; but it was in itself much more extensive. He regarded it perhaps only with reference to a single application, while it was in reality far more fertile than he imagined.

Such is, in fact, precisely the view in which the undulatory theory of light presents itself to us, when we compare it in its ordinary form, and in that which M. Cauchy has given it in his profound "Mémoire sur la Dispersion de la Lumiére," Paris 1830. He assumes a medium in which waves are propagated, whose motions will accord with those of the common theory. He supposes two molecules slightly disturbed by any cause (either agitation produced by the peculiar action of the luminous body, or source of light, or the attraction of neighbouring particles depending on *their* previous disturbance), whence he investigates expressions for the forces thus brought into action, and then, by the integration of a differential equation, finds the motions. But the fundamental suppositions on which he proceeds are more comprehensive: they lead to the conception of *vibrations* slightly different from those of Fresnel, but as nearly the same as in no way to affect the nature of the resulting *waves:* yet they include the germs, as it were, of other consequences afterwards deduced, among which is contained the relation on which the explanation of unequal refrangibility depends.

This characteristic property of the primary and component rays, it has been justly remarked, has hitherto presented great difficulties to any theory. These difficulties are by no means *peculiar* to the undulatory theory: the hypothesis of emission has not been at all more successful in affording any satisfactory explanation. The dispersion has been allowed to be almost the only real objection against the former theory, at least as commonly propounded. *On the ordinary suppositions* of the vibrations, the *equal* refrangibility of rays having waves of all lengths is a necessary consequence.

The degree in which a ray is deviated, depends solely on the diminished velocity of propagation of the waves within the refracting medium, in which we suppose the ether to exist in a state of greater condensation. If, then, for waves of different lengths, the velocity be the same for the same medium, it follows that the amount of their refractions will in all be exactly equal. In order to explain why rays having waves of different lengths should undergo different degrees of refraction, that is, be propagated with different velocities within the medium, it would be necessary for theory to assign a mathematical relation between the length of a wave and the velocity of its transmission. This the theory, as ordinarily conceived, fails to do; at least it may safely be asserted that no mathematician has *as yet* exhibited any such deduction from it in a precise and definite form.

By that modification of the first principles which constitute the basis of M. Cauchy's investigations, he is enabled to deduce the *general* result that A RELATION *subsists between the length of a wave and the velocity of its transmission, or the time of the vibration of a molecule of ether.* Thus, as far as *general* explanation is concerned, this formidable obstacle is satisfactorily overcome. But the more *precise* representation of the facts by the principles of theory would require *the specific nature of the relation* to be more closely examined. This is what I have endeavoured to do in some investigations in which I have been recently engaged. In the London and Edinburgh Journal of Science, No. 31, and continued in No. 32, 33, and 34, I have given an abstract of M. Cauchy's views, to which is annexed the deduction of that *more specific* relation. I have also adverted to the necessity of an exact comparison of the results of experiment with the formula thus derived from theory. The test of *numerical* comparison is that by which alone any theory can, in the present state of science, be substantiated. Such a comparison I have carried on to a very considerable extent, and with results eminently favourable to the theory: they will shortly be laid before the public *.

OXFORD, *Feb.* 17. 1835.

* The following extracts will illustrate the views above taken:—

"Supposing," says Dr Hartley, "the existence of the ether to be destitute of all direct evidence, still if it serves to explain and account for a variety of phenomena, it will, by this means, have an indirect argument in its favour. Thus we admit the key of a cypher to be a true one when it explains the cypher completely: and the decypherer judges himself to approach to the true key in proportion as he advances in the explanation of the cypher; and this without any *direct* evidence at all."—(Observ. on Man, vol. i. p. 15, 4th ed.)

Again, "Philosophy is the art of *decyphering* the mysteries of nature: and every thing which can explain all the phenomena has the same evidence in its favour, that it is possible the key of a cypher can have from its explaining the cypher."—(Ibid. p. 350.)

Le Sage (Opuscules relatifs à la Methode) has supported the same view of the subject, and Gravesande, in his Introductio ad Philosophiam, to a chapter on the use of hypotheses, joins another on *decyphering.*

Mr Dugald Stewart makes some judicious remarks on the subject (Phil. of Human Mind, vol. ii. p. 444, &c.) The analogy of the cypher, he observes, supposes that we have *all* the facts before us. "In our physical researches, on the other hand, we are admitted to use only a few detached sentences extracted from a volume, of the size of which we are entirely ignorant. No hypothesis, therefore, how numerous soever the facts may be with which it tallies, can completely exclude the possibility of exceptions or limitations hitherto undiscovered."

Again, he observes, there are few, if any, physical hypotheses which afford the *only* way of explaining the phenomena to which they are applied, and therefore, admitting them to be perfectly consistent with all the known facts, they leave us in the same state of uncertainty in which the decypherer would

Views in Ethnography, the Classification of Languages, the Progress of Civilization, and the Natural History of Man. By CHARLES T. BEKE, Esq., F. S. A. Communicated by the Author *.

IN the remarks which will be offered in the present paper, it is not intended to enter upon the question, which has so often and so ably been discussed by physiologists and natural historians, as to whether the numerous and strongly marked diversities in the human race have proceeded from distinct stocks, or whether they are derived from a common origin, and are consequently to be regarded as forming merely varieties of one and the same species: it is sufficient to state, that, for the purposes of this disquisition, the latter hypothesis is adopted, as being that which appears to be the more in accordance with reason, and to have on its side the greater weight of authority.

It is also scarcely necessary to do more than allude to the opinion generally entertained by physiologists, historians, jurists, political economists, and others, who have investigated and treated of the subject of the primitive condition of man, and the rise and progress of society, that, in the first ages, the human race existed in the lowest state of civilization; namely, that of the mere consumer of the spontaneous productions of nature; and that mankind thence progressively advanced through the

find himself, if he should discover *a variety of keys* to the same cypher.—(Ibid p. 447.)

To complete this analogy, as referring to the case before us, I should say, that, in point of fact, we have *not* here a *variety* of keys; at the *utmost* we have but *two*, and of these one applies satisfactorily to a vastly larger portion of the cypher than the other. And further, this key is not of a fixed unalterable nature, but as it was in the first instance framed upon trial, and as the first supposition was *successively modified* till found to supply a tolerable clew to a large part of the difficulties, we have still only to pursue this process, and have a fair prospect of success in doing so, from what we have already witnessed of its capabilities.

* This paper was to have been read at the meeting of the British Association, at Edinburgh, last September, but did not reach the Secretary in time.

several conditions of the hunter, the herdsman, and the agriculturist; or through states nearly corresponding with them;—until, in this last state, an absolute property having been acquired in the land, which was then first subjected to cultivation, the residences of mankind became fixed and permanent; whilst, by the same progressive advancement, societies were formed, which at first were simply patriarchal, but which, from their subsequent increase and union, required the institution of laws for their government and mutual protection; whence ultimately resulted the establishment of the various forms and conditions of civil rule.

This opinion of the gradual progress of civilization, whatever ground it may have gained, is, at the best, purely hypothetical. So far, indeed, is it from being borne out by facts, that it is actually at variance with the evidence of all history and experience; for in the early historical remains, whether real or fabulous, of all nations,—with the remarkable exception of those of the progenitors of the Israelites,—we find that instruction and improvement are considered to have been introduced from an extrinsic source, by individuals possessed of a higher degree of culture; whilst among those savage people with whom civilization may be said not to exist, there is not manifested even the remotest tendency towards progressive improvement, from the exercise of that unaided reason, which, as the characteristic of the human race, has been deemed to be entirely sufficient for that purpose.

It is to be considered, then, whether the direct converse of the hypothesis here adverted to ought not rather to be maintained; and whether, in fact, it will not be more in accordance with the truth to assert, that the savage and uncultivated condition of mankind, which has usually been designated *the state of nature*, is, in reality, nothing else than a degeneration from a previous social state, in which a high degree of culture and of artificial attainments were possessed; and that, consequently, this latter condition (and not the former,) ought to be regarded as the primitive condition of the present human race.

However paradoxical such an hypothesis may at first sight appear, there is, in reality, nothing unreasonable in it. If we consider the history of the European settlements in the New

World, and especially in North America, we find the fact to be, that some of the members of a previous social state, which had existed in a highly civilized condition during several ages, arrived in that continent; where their descendants, and especially those who spread themselves most widely over the newly settled countries, speedily degenerated from the cultivation of the parent stock. Could it so have happened, that all further communication with the Old World had ceased, the deterioration which had commenced would unquestionably have proceeded still farther; but this process has been checked by the continual arrivals of fresh settlers from the mother country, and the constant communications between the two continents, which have, in a great measure, maintained an equality between their respective inhabitants. But let it be supposed that these European settlers in North America had been the only remains of a former race of mankind: it is evident that, whatever in the course of ages might be the character and condition of their descendants,—even if some of them in the extreme western provinces of America, or in other countries into which they might have spread, had become so debased and brutalized as not to be recognised as belonging to the same race,—still, in the consideration of their history, and in the endeavour to trace to their pristine state, their laws, their customs, and their religion, however altered, however perverted or corrupted they might become, it would be utterly inconsistent that reference should (in the first instance at least,) be made to any other stock than the European colonists from whom they had sprung, or to any other condition of society than that previous *artificial* one of which those Europeans themselves had been members.

May not, then, the history of the whole human race be considered in a similar point of view to that in which the history of the North American colonists has thus hypothetically been regarded? If we look to the histories, traditions, and fables, of all nations, we find that they all coincide in expressly recording or in alluding to a cataclysm,—the particulars of which are the most fully and circumstantially detailed in the Sacred Writings of the Israelitish nation,—which overwhelmed the whole of mankind, with the exception of a few favoured individuals, who became the founders of the subsequent human race: and if, therefore, we only admit the fact of the occurrence of such an event, we can at once understand how the condition of the first ancestors of the present race of mankind was not a natural but an artificial one, derived from the previous social state of the antediluvian world. Hence we can have no difficulty in conceiving how the social condition of man may have fallen from the culture of that artificial primitive state to the condition of the uncultivated savage, through all those intermediate stages of civilization which, according to the contrary hypothesis, have been regarded as the steps by which man has progressed upwards.

The process of this declension in civilization may be thus briefly stated. When mankind first began to separate, and to be "scattered abroad upon the face of all the earth," it is manifest that the amount of knowledge in every department of pursuit must have diminished at every step that was taken from the centre, unless each tribe could have ensured to itself (which would have scarcely been possible) the possession of individuals imbued with the *aggregate* of the acquirements of the parent society. Knowledge can in no case remain perfectly stationary: it must either advance or recede: and the latter must universally have been the case in the first instance, and must have continued to be so, until the numbers of mankind had sufficiently increased to allow them again to begin to accumulate—each nation in its own particular sphere of acquirements—the knowledge which had been retained by direct transmission from the common centre, or which had subsequently been derived from the circumstances in which they had respectively been placed.

Subsequently to the dispersion of mankind from Shinar, the pressure of population would doubtless have been the primary cause of the general distribution of the human race over the earth, and of their consequent descent in the scale of civilization. To this, however, are to be added disputes among neighbouring people, too often ending in warfare; the dislike of some races to the countries in which they had voluntarily settled, or into which they had been compelled to migrate; and the desire, or probably the necessity, of obtaining possessions more suited to their inclinations or their requirements. As the social tie gradually became weaker, the growth of erratic habits, and the consequent rapid declension in civilization which universally attends the settling of new lands, would operate; leading at length to a confirmed nomadic state. In any of these intermediate stages of degradation, however, further deterioration may have been prevented, and an impulse may indeed have been given to a progressive state of improvement, by any causes, whether natural or artificial, which would prevent the further disintegration of society, and bring its members into more intimate connexion, so as to preserve the means for the mutual importation of knowledge. Thus, in maritime countries, where the further progress and dispersion of mankind has been stopped by the ocean;—in islands;—in cities, where men have been congregated together for the purposes of commerce;—and even in rich alluvial countries, of which, by means of agricultural knowledge, the products have afforded subsistence to a dense population;—civilization, so far from remaining stationary, has generally continued to advance: whilst in champaign, barren, and desert countries, on the contrary, where nomadic habits have been induced, the people have descended in the scale of civilization in an equal ratio to the quality of the country, and its means of affording subsistence, operating conjointly with its extent, and the consequent absence of the necessity for its inhabitants to adopt any means of support, beyond those which have spontaneously presented themselves, and which have thence become congenial to them; such as the pasturing of their flocks in countries sufficiently fertile for that purpose, and the hunting of wild animals, where the physical condition of the country has not been adapted to the support of tame ones.

From this last state,—in which, owing to the loss of the knowledge of accumulating capital, whether in the form of money or of merchandize, and ultimately even in that of cattle, a large tract of country would become necessary for the support of a much smaller number of persons; and in which also, from the disintegration of society, the traditive knowledge of each successive generation would become less and less,—the progress to the condition of the mere savage, or man in the lowest state of cultivation, is easy to be traced. In cold and inhospitable countries, however, where the uncivilized races inhabiting them would be compelled to use every exertion in order to procure a scanty and precarious subsistence, the lowest mechanical arts would still be retained, until the inclemencies and privations to which those races were subjected had caused their extinction (a result which there is good reason to believe has in many instances taken place); whilst in more genial climates, where the spontaneous productions of nature were sufficient for the support of mankind, the absence of motives for exertion would lead to the total declension of their debased inhabitants, so that at length they would become almost assimilated with the brute creation.

The hypothesis which is thus advocated removes very many of the difficulties which, under the opposite one, have attended the consideration of primeval history; and it more especially accounts for the existence, in the earliest ages, of nations whose civilization and power, even allowing to them the utmost precocity, were always incompatible with what was conceived to have been at the same periods the state of society generally.

A still more important result is, that we have afforded to us a satisfactory means of explaining the existence of the various diversities in the human species; which diversities, so far from being referrible to any permanent distinctive characters, or even to the action of climate and other physical causes alone, must principally be derived from the operation of changes in the moral and intellectual state of the various races. Indeed, it must never be lost sight of, that man is a reasonable being, and not a mere animal; and that consequently it is absolutely necessary, in all investigations of his natural history, to consider him not *physically* only, but also *psychologically.*

Upon the hypothesis, then, that the origin of the numerous and widely differing races of man, is to be referred to a single parent stock possessed of a high degree of cultivation, the following principle presents itself, namely, That (allowing for circúmstances by which the progress of deterioration may have been accelerated or retarded, or otherwise modified,) the culture or the degradation of an aboriginal race * will be in proportion to the geographical distance of its residence from the common centre of dispersion. For example, if we take the primitive residence of the post-diluvian race to have been in the north-western portion of Mesopotamia—the reasons for which location

* By the term "aboriginal race" is simply meant the people who were the earliest inhabitants of any country.

are given at length in the work,* of which this paper is designed to make known the principal conclusions with respect to philology, ethnography, and the natural history of man,—it will be seen that the countries more immediately surrounding that central point, namely, Assyria, Chaldea, Egypt, Phœnicia, and Asia Minor, are those whose inhabitants were in the earliest ages possessed of the highest degree of culture; whilst, on the other hand, at the points most distant from the same centre, the Papuans, the Hottentots, the Esquimaux, and other savage races, have degenerated almost to the lowest state compatible with the retention of rational endowments.

A second principle resulting from the same hypothesis is, that (except where invasions have introduced foreign tribes, as in the case of the Hindoos in India,) the more degenerate races whose positions are considerably removed from the centre, must have derived their origin from that centre through the medium of the more civilized people geographically situate between it and them, and must consequently have received from them their languages, their religion, and their customs; although, in consequence of the recession from the centre of these more degenerate races, and their gradual corruption and debasement, the changes in all those particulars, as well as in their physical structure and appearance, may have become such as to render it a task of the utmost difficulty to trace the resemblance and the connexion between them and their more civilized ancestors. Thus the primitive inhabitants of the whole of Southern and Eastern Asia must have sprung from ancestors who originally occupied the countries situate to the northward of the Persian Gulf; so the aborigines of Africa must be descended from the earliest settlers of Arabia, Ethiopia, and Egypt; whilst the tribes who peopled the islands and continent of Europe, and who from thence also spread themselves eastward into the northern portions of Asia, must have had their origin in Asia Minor.

It is also to be inferred, that, where different races have, in their corresponding removal from the centre, undergone a corresponding degradation, at the same time that they have been subjected to the operation of similar physical conditions, the results will be analogous in those races, both with respect to

* Origines Biblicæ, or Researches in Primeval History, vol. i. London, 1834.

their physical conformation, and as regards their moral and intellectual character. This is remarkably exemplified in the separate existence of the Hottentots of the south of Africa, and of the Papuans or Asiatic Negroes; which two races—in spite even of the authority of Cuvier himself—cannot, without violating the most obvious principles of science and of history, be referred to the same class, but must be regarded as "deviations from the type of the species by different routes, in *parallel* extreme states of degradation."

I will now attempt briefly to trace the outline of a classification of the various races of mankind, in accordance with the principles which have thus been enunciated. In doing so, I shall avail myself of the aid afforded by the numerous additions which, during the last few years, have been made to our philological knowledge, arising principally and more especially from the improvements which have taken place in the science of philology itself. It may indeed be asserted, that, in the present condition of physiology and of the natural history of man, the affinities of languages, if they be not the sole guides which we possess for enabling us to arrange the varieties of the human species in an order at all approximating to the truth, must at least be regarded as the only one upon which any real dependence is to be placed.*

With the assistance, then, of this guide, we may divide the races of mankind into the following principal classes. The first is that which is composed of the nations to whom belong the various languages of cognate origin, distinguished by the common designation of Indo-Germanic, or Indo-European. These consist of the Sanscrit, the Zend or ancient Persic, the Phrygian, the Lydian, the Greek, the Latin and its derivations, the lan-

* The importance of this guide has recently been most ably exemplified by two distinguished ethnographers, namely, Dr Prichard and M. A. W. de Schlegel: by the former in a "Comparative Review of Philological and Physical Researches, as applied to the History of the Human Species," read before the British Association for the Advancement of Science, at the meeting at Oxford in 1832, an abstract of which is printed in the Report of the First and Second Meetings of the Association, pp. 529–544; and by the latter in a paper entitled, "De l'Origine des Hindous," read before the Royal Society of Literature on the 20th November 1833, and published in the Transactions of that Society, vol. ii. pp. 405–446.

guages of the great Germanic family, the Celtic, and the Slavonian.

Of these, the various languages of Europe and Asia-Minor may be regarded as aboriginal; that is to say, as having been spoken by the people who were the first inhabitants of those portions of the globe. On the other hand, the Sanscrit is admitted to be the language, not of the aborigines, but of a race of conquerors, who entered the Indian peninsula from the north-west, and extirpated or drove southward before them the native races. In like manner must it be considered that the Zend (the intimate connexion of which language with the Sanscrit is well established,) was not the primitive language of Persia, but was introduced into that country also by the same exotic race, whose original seat must be looked for in the mountainous country to the *west* of the Caspian.

To this class of languages, and to the people among whom the various dialects of them are spoken,—which people are, in the present day, spread not only over Europe and a considerable portion of Asia, but, by means of European settlements and conquests, over the vast continent of America also, and who have likewise taken root in what may be regarded as a fifth quarter of the globe, namely, Australia,—the designation of Japetic or Japhthitish may, with the strictest propriety, be applied.

The next grand division of mankind is composed (in part) of the nations to whom belong the so-called Semitic or Aramean languages; namely, the Hebrew, the Arabic, the Chaldee, and the Syriac.

The reason of this nomenclature is, that the Hebrew and the Arabic are the languages spoken by the people who are regarded as the descendants of Abraham; whilst the Chaldee and Syriac are considered to have been vernacular in Mesopotamia and Syria among the descendants of Aram; both those patriarchs being of the posterity of Shem, the eldest son of Noah. Philologists have already discovered, however, that affinities exist between these so-called Semitic tongues and other languages, such as the Phœnician, the Coptic, the Geez, and the Amharic (?) of Abyssinia, and the Berber of Northern Africa, to which the same designation cannot, with any correctness of nomenclature, be applied, and which are, in reality, entitled to the appellation of *Hamitish* alone.

Since then the languages spoken by the descendants of Isaac and of Ishmael, the sons of Abraham,—namely, the Hebrew and the Arabic,—are thus found to be cognate with those which are so widely spread among the descendants of Ham, it would seem most reasonable to imagine that the former languages, instead of being the representatives of the Shemitish tongue which was spoken by Abraham either in Chaldea or Aram, are the Hamitish languages which were vernacular in the countries in which that patriarch and his descendants took up their residence, and were, in fact, acquired by them during their residence therein, to the exclusion of their paternal tongue. This hypothesis has been advocated at length in the *Origines Biblicæ*. In the same work it has also been attempted to be shewn that the so-called Chaldee is merely a corruption of the Hebrew spoken by the Jews during their captivity in Babylon, and not the native language which at that epoch was vernacular in Babylon itself; which language, from the few proper names met with in the Hebrew Scriptures, and the remains of it preserved in the cuneiform characters (if rightly interpreted), was of Japhthitish origin, and closely related to, if not identical with, the Zend. In like manner is the Syriac to be regarded as only a further degradation and corruption of the Hebrew. Under no circumstances, indeed, can it claim to be the primitive native tongue of the countries in which it was spoken about the period of the commencement of the Christian era; for, subjected as they had been to repeated and continued foreign invasion and occupation, it is impossible that any native language should, during more than twenty centuries, have continued to exist without very considerable alterations, if, indeed, it must not have been altogether extirpated.

The appellation of Semitic or Shemitish, as applied to these languages, must therefore be superseded by that of Hamitish; under which designation will have to be comprised not only the Canaanitish, Arabian, and African languages which have been enumerated, but also the whole of the native dialects spoken throughout the continent of Africa; all the inhabitants of which continent must, agreeably to the hypothesis advocated in this paper, have derived their origin from the centre, through the medium of the more civilized countries of Arabia and Egypt. To the same source is probably to be referred the Basque language, which may readily be conceived to have been introduced into Spain by an aboriginal people, from the northern coast of Africa; and should any other dialects, spoken along the western shores of Europe, be found to be cognate with the Basque, to them also must the like origin be attributed.

The remaining class of mankind which will here be mentioned, is that of which the Chinese, and the various Indo-Chinese nations, may in the present day be regarded as the principal representatives.

In tracing back these people to their common origin with the rest of mankind, in accordance with the foregoing hypothesis, it is manifest that their progenitors must, in the earliest ages, have occupied the more western portions of Asia, and that they were, in fact, of like origin with the aborigines of the Peninsula of India, of whom traces are yet left, in the Bheels and other savage races scattered over various portions of that peninsula, and in the people found in greater numbers towards its southern extremity; whose languages, of a totally distinct character from the Sanscrit and its derivative dialects, plainly point to the separate origin of those people from that of the Japhthitish Hindoos.

It is to this division of mankind that I conceive the designation of Semitic or Shemitish ought properly to be applied; and within this division must also be comprised the whole of the aboriginal inhabitants of the Indian Archipelago, of Polynesia, and likewise of America, excepting probably the tribes who inhabit the extreme north of that continent; but upon the subject of these people I will refrain from enlarging, as the grounds upon which the classification of the varieties of the human species has been attempted in this paper are intended to be essentially philological, and that department of knowledge does not (as far as I am acquainted with it,) afford sufficient data upon which the proposed classification should be thus far extended.*

* I am happy in meeting with a remarkable confirmation of my views respecting the connection between the languages of Eastern Asia and America,

When, however, our philological knowledge shall become yet further enlarged, it will be seen whether or not all the languages of the earth, and the people speaking them, are referrible to the three distinct divisions which have thus been enumerated; and it will also be definitely ascertained, whether these divisions of languages are, like the distinct races of mankind to whom they belong, reducible to one common source. With respect to the former of these questions, there is good reason to believe that, sooner or later, it will be determined in the affirmative; but, with regard to the latter of them, the opinion of philologists is already very decidedly in the negative. Speaking of the so-called Semitic (Hamitish) languages, M. de Schlegel remarks, "Elles sont àpart de la famille Indo-Germanique. Aucun tour de force étymologique ne peut les ramener à une origine commune; les vains efforts des Hellénistes Hébraïsans sont condamnés pour toujours."* If the truth of this representation be established, we shall be compelled to have recourse to an original formation of more than one primitive tongue; an hypothesis which, in reality, is attended with no greater difficulty than that of the original formation of a single language.

London, 30*th August* 1834.

Report by MM. Geoffroy St Hilaire and De Blainville on the Zoological Results of the Travels of M. Alcide d'Orbigny in South America, from 1826–1833.

The remarkable and splendid augmentations which our national collections of natural history have for a long time received, have been chiefly the result of voyages of circumnavigation, or at least of maritime expeditions, sent for the purpose of exploring the Southern Seas; and they consequently consist, for the most part, of the productions of the Indian ocean, of Australasia, and of the Pacific. In these circumstances, the Directors of the

(and also upon many other important subjects,) in Dr Lang's *View of the Origin and Migrations of the Polynesian Nation*, which work was published almost simultaneously with my *Origines Biblicæ*. February 19. 1835.

* "De l'Origine des Hindous," *ut supra*.

Museum of Natural History conceived that it was necessary to employ the funds at their disposal (unfortunately somewhat limited in amount) for the purpose of obtaining a scientific examination of certain portions of the Asiatic and American Continents. The very important results that were obtained, many years before, from the mission of Lalande, a preparer of zoological specimens, to the Cape of Good Hope, induced them again to have recourse to a similar appointment. Indeed, there are few travels which have proved equally productive, in so short a time, and at so little expense, to our zoological and zootomical collections; but it must be admitted that they were not equally so in scientific observations. The managers of the Museum were therefore desirous that the expeditions which they were about to send out, should be in a condition to advance the interests of science, not only by collecting new objects, but also by making requisite observations on the places visited. With this view, two journeys were projected at the same time; one of them to explore the northern parts of India, penetrating as far as possible into the valleys and defiles of the Himalaya; the other, to collect and make observations on the productions of South America, traversing that continent from the shores of the Atlantic to those of the Pacific, and thus comprising Patagonia, Paraguay, and Bolivia, or higher Peru, and a portion of the Andes. The Directors could not, however, conceal from themselves the difficulties attending these two enterprises, as they were unable, from the want of sufficient funds, especially at that particular period, to permit the travellers to be suitably accompanied. Indeed, the examination of the interior of a country has many inconveniences not felt by those who explore it by sea. In the latter case, the naturalist has usually one or two associates, and is besides almost always more or less assisted by the officers and others attached to the expedition, whenever the service permits, which is always the case when any halt is made, or the party goes on shore. Along with this aid, the traveller finds an easy transport for the objects which he collects, as he has it in his power to embark them at pleasure. He possesses, either on ship-board or on shore, and in a suitable place, the necessary means for conveniently preparing and preserving specimens. Spirits of wine, or some other preservative liquor, jars, barrels, boxes, cases, together with aid of every kind from one or more assistants, are almost always ready for him, and can never be wholly awanting, while he continues in health ; and should he happen to become unwell, such advantages are increased in value. But it is unhappily very different with the continental traveller. Usually alone, in consequence of the inability of the Directors of the Museum to make a more liberal appointment, he can expect no assistance while he continues well, nor even if he should happen to fall into bad health. He can obtain neither advice nor assistance among a people with whose very language he is wholly unacquainted. The means of transporting his baggage are not only very expensive, since it can be done only by hiring men and beasts of burden ; but another great difficulty is experienced by the roads, in countries but little advanced in civilization, being either entirely wanting, or of the most imperfect description. The means of preserving what he is always obliged to carry along with him, thus become greatly limited. The collections which he has the good fortune to make, gradually becoming more bulky, and consequently more embarrassing, as he proceeds, occasion a continual increase of trouble and expense, until he has it in his power, after a longer or shorter time, to transmit them to some sea-port, where they may be shipped for Europe whenever a favourable opportunity occurs. In these circumstances, it would be a matter of the greatest importance to continental travellers, first, for their own safety, and secondly, for that of the collections, which are always made with great trouble, that travels for illustrating natural history should be so arranged, that the naturalist who is chiefly to be employed as an observer, should have along with him an intelligent assistant, who might collect and prepare the objects, and at the same time increase the security of the collections in circumstances of unforeseen difficulty.

These preliminary reflections have been naturally suggested by the unfortunate situation in which the two naturalists were placed, who were selected by the Directors of the Museum to execute the plan which they conceived useful to the progress of science. Although both young and vigorous, one of them, M. Jacquemont, who was sent to India, sunk just at the moment of his return, and in the midst of his rich collections, the greater part of which were already embarked for Europe. The other, M. d'Orbigny, whose destination was South America, kept us for two years in the greatest uneasiness, both for his own fate and that of his collections; and we have learned since his return, that without the assistance of every kind which he received, in the most noble and generous manner, from the Government and President of the Republic of Bolivia, his mission would have proved nearly a failure. Let us rejoice, however, that it has not been so, for he has arrived with seventeen cases well replenished, besides those which he had previously sent, and such as are yet to come. After having laid these before the Directors of the Museum, who have already appreciated their value, he submits to the judgment of the Academy the scientific results that flow from them.

Reports on the Phytological, Geological, and Geographical portions, will be laid before you by the other members of the Commission; that which M. Isidore Geoffroy Saint-Hilaire and myself have the honour to submit to you, treats of the Zoology, and touches, though unequally, on all the points of the animal series. We have scarcely need, I presume, to premise, that among so many facts that have been ascertained, and new animals collected, our time will not permit us to do more than indicate summarily the most curious and interesting points, following the MSS. of M. d'Orbigny, and drawings made on the spot, while the animals were alive, or recently dead,—an advantage not so often enjoyed as is to be wished.

M. d'Orbigny's manuscripts on the molluscous animals—a branch of the subject to which he is particularly attached—are already completed, and ready for publication. In the other departments they are less copious; but the catalogues are complete, and carefully prepared, with numbers corresponding to those on the objects themselves; so that each can be recognised in relation to its locality and the circumstances of its discovery. Often, too, there is a coloured figure of the whole animal, or having only such parts coloured as change after death.

The drawings, in general, are carefully finished, particularly those of the animals which M. d'Orbigny was unable to bring with him, or which are liable to become distorted or discoloured by the action of the liquor employed to preserve them.

Before drawing the attention of the Academy to the most interesting animals of each tribe, we may be permitted to say a few words respecting the route of the traveller.

Leaving France in June 1826, he did not return till 1834; his journey has therefore lasted for eight years.

He embarked at Brest for Rio-Janeiro, passed from thence to Monte-Video, and then to the mouth of the La Plata, at which point his observations commenced.

In 1827, he traversed and examined the countries on the southern bank of that river, on his way to Buenos-Ayres. From thence he repaired to the banks of the Parana, where he embarked for the frontiers of Paraguay; visiting the provinces of Corrientes, Missions, Entrerios, and Santa-Fé, and making observations as he advanced on the geological structure of the basin of the Pampas, and, at the same time, on the fishes and molluscous animals in the rivers.

Not being able to penetrate into Chili and Peru, for the civil wars which then desolated these unhappy countries, he determined to explore Patagonia, a country then little known, and which afforded interesting objects of research. But the natives having risen against the settlers, M. d'Orbigny was obliged to shew his courage, by taking up arms in favour of the inhabitants.

He traversed Patagonia from the 39° to the 40° of south latitude, and at last, after eight or nine months' stay in that province, returned with much difficulty to Buenos-Ayres.

In the mean while, he did not forget the purpose of his mission; for, as he could not reach Chili or Peru by land, he embarked and sailed round Cape Horn, in order to reach them by sea. He arrived in Chili in 1830; but as the civil war continued at its height, he could not run the risk of entering the country. He therefore took advantage of an opportunity that occurred for visiting the State of Bolivia, and, with this view, embarked for Peru.

He visited, during his route, the western declivity of the Cordilleras, a country so arid, that it is destitute of all interest to the zoologist; and mounted to the summit of the Andes, which presents an immense plain, and where the air is very highly rarified, and the dryness extreme.

It is on this plateau, however, about twenty geographical miles from the sea, that the most populous portions of the Republic of Bolivia, or higher Peru, are to be found; and that on account of the great number of Lamas and Alpacas which occur on it. He visited the natives who live in the interior of the country, advancing towards the east, in the province of Chiquitos. He then rejoined the banks of the Paraguay, and pushed forward to Malto-grosso, belonging to Brazil.

After having visited the numerous nations of Paraguay, and the province of Mojos, he reascended the river Piray, in order to reach Santa-Cruz with his collections. After having again mounted to the most elevated parts of the Cordillera, where the rarefaction of the air had nearly deprived him of life,—observed the lake of Titicaca, and employed three years in exploring all the regions of Upper Peru,—he again crossed the Cordillera of the Andes, descended on the side of Peru, and embarked on the 25th July 1833 for Europe, where he arrived on the 4th of March 1834.

In the seven years during which this journey has continued, M. d'Orbigny has repeatedly crossed the Andes, and traversed the continent of South America from the 11th to the 43d degree of south latitude; he may thus be considered as having traversed 14,780 leagues, both by land and sea, including, it is true, his two passages from the one continent to the other.

Having enjoyed the opportunity of residing for so long a time in the countries he visited, M. d'Orbigny devoted his special attention to the study of the nations among whom he sojourned, and which were scarcely or not at all known even by the very descendants of their conquerors. He has studied the different degrees of civilization among the native tribes, from the Guichuas, whose average stature does not exceed 4 feet 9 inches (French measure), to the Patagonians, so long regarded as giants, whose medium height is 5 feet 5 inches. In general, it appeared to M. d'Orbigny that the human race follow the same law as plants, that is to say, that they decrease in size as we ascend from the plains to the summits of the Andes.

M. d'Orbigny has likewise directed his inquiries to the idioms in use among the native tribes, and he assures us that his observations on this subject have extended to more than thirty different nations.

He has also brought with him two skulls, found in the tombs of the ancient Peruvians, and which are very remarkable in two respects; first, in themselves, by the general narrowness of the cranium, and the flattening of the forehead; and, secondly, by the great resemblance which they bear to the crania of the ancient inhabitants of Avares, discovered some years since in Austria. On the supposition that this extraordinary formation of the cranium is artificial, as is certainly the case in regard to those of the ancient Caribees, it must necessarily be admitted that the extraordinary custom of flattening the foreheads of infants at a very early age existed also in Europe,—in the old as well as in the new continent; or that a migration had taken place from one country to the other, an occurrence still more improbable. However this may be, besides the additional confirmation which M. d'Orbigny's observations have given of this singularity in the crania of the ancient Peruvians, he has put us in possession of the skulls themselves, of which previously we had only models.

In the class of Mammifera, science as well as our own collections owes important additions to M. d'Orbigny's travels, and that in every order except the Pachydermata.

Thus, in the order Quadrumana, we have observed a new species of monkey, allied to *Saimiri* (*Callithrix Boliviensis*, d'Orb.), distinguished by its long tail, the black colour of its head, and the yellow tinge of its arms: a beautiful series of the howling monkey, which will enable us to complete the history of that remarkable species: a new species of *douroucouli*, a genus so incompletely established by Humboldt, that Illiger thought he might give it the distinctive name of *Aotus*, that is, without ears, although it is one of its characters to have these organs larger than the other monkeys: and a fine species of *ouistiti* without rings on the tail.

As our traveller had an opportunity of seeing for a long time a great number of different species of monkeys, he has been enabled to rectify some mistakes in their natural history; thus he affirms that the species never intermingle, and that all the individuals of the same species live exclusively together. He could also assign the exact limits of their distribution in South

America. He never met with them beyond the 27th degree of south latitude, and he observed that the number, both of individuals and species, is greater in the plains than in the mountains, and that it diminishes with the temperature.

Among the carnivorous animals, M. d'Orbigny particularly studied the bats, especially those named vampires; and his observations confirm the habit ascribed to them of sucking the blood of animals, and even of man, as was experienced both in relation to the people and mules belonging to his caravan. Such is the avidity of these creatures for blood, that the natives are obliged to pass the night protected by nets, in order to avoid them, and carefully to shut up their fowls and other domestic animals. The vampire generally fixes on the nape of the neck or back of its victim, that the latter may have greater difficulty in getting free, which, however, it sometimes accomplishes by rolling on its back.

Having often met with the mephitis or skunk, a small carnivorous animal allied to our polecats, he has not only been able to rectify what is exaggerated in the number of admitted species, but has discovered another very distinct, peculiar to the southern parts of America. He has also examined with care the substance which has procured for them the name of *mephitis*, and which is sufficiently strong and infectious to be felt at two leagues distance at sea, and which compels even the jaguar himself to abandon his prey, when a mephitis happens to approach. The substance which diffuses this odour is not, as has been so long supposed, the urine of the animal, but a liquid matter of a yellowish-white colour, secreted by the anal glands, as in many other carnivorous animals. He has also rectified what has so long been said about the slowness and sluggish habits of the animal; and has assured himself that the habit attributed to it of letting itself fall from a tree, when wishing to descend, is not practised by it, but is rather to be ascribed to the *coati*. He has, in like manner, observed the manners of the *kinkajou*, a nocturnal and frugivorous animal.

M. d'Orbigny's mammalogical collections contain, besides, a fine example of the red wolf, first brought into this country by Humboldt: also an animal which frequents extensive plains, and feeds chiefly on partridges,—a new species of fox, much dreaded by the natives of Patagonia,—and a beautiful specimen of that species of bear named *Ursus ornatus* by M. F. Cuvier, of which the museum contains only a single example, in a bad state of preservation.

In the family of seals, our collections are indebted to him for a magnificent skeleton of the eared seal, and for the cranium of a kind of seal (*phoque à trompe*), upwards of twenty feet long, forming no doubt a new species.

The edentated land animals, and particularly the armadillos, have been the subject of M. d'Orbigny's observations; he has, in fact, collected many species either new or wanting to our collections, although described upwards of fifty years since by D'Azara. By attending to their manners, he has ascertained that many of them are of sufficiently carnivorous propensities to disinter carcasses, while others feed exclusively on fruits. But in all, the flesh is equally white and agreeable to the taste, as he had often occasion to judge from experience.

The family of edentated aquatic animals, or cetaceæ, has likewise been augmented by many new species. Of these the principal one belongs to the division Delphinorhynchi, and inhabits rivers even more exclusively than that of the Ganges, certainly never leaving them, since M. d'Orbigny found it 800 leagues from the sea, in the Mamore. It is, besides, remarkable in retaining at all ages the short hairs or moustaches on the muzzle.*

But it is in the tribe of gnawers that M. d'Orbigny has made the greatest number of discoveries, not only in species, but even in genera and subgenera. Besides many squirrels from the Cordilleras, we have remarked a new species of Ctenomys,—a very interesting collection of Viscaches and of Chinchillas, with skeletons,—many species of rats or of campagnols, and a new species of rabbit which does not burrow,—a species, likewise new, of Agouti, with two fingers only on the hinder legs,—two or three species of cobay, or Guinea-pig, which inhabit the most elevated regions of Patagonia,—and, lastly, two other gnawers

* This new species is figured and described by M. d'Orbigny under the name of *Inia Boliviensis*, in the third volume of the Nouvelles Annales du Museum d'Histoire Naturelle.

from Chili, which one of us, M. I. Geoffroy St Hilaire, regard as the types of new genera.

M. d'Orbigny conceives that we must cancel the two species of Coëndon, admitted by some mammalogists, as their differences depend merely on the changes of their covering in summer and in winter.

Among the ungulated animals, it is deserving of being remarked, that our traveller met with only one species of tapir; and that of the small humpless camels of America, there are at least four distinct species, viz. the lama and the alpaca, which are domesticated; and the guanaco and the vigogna, which have never been reduced to that state, and which refuse to couple with the two others.

The genus Cervus has supplied him with five species; one of which (*Cervus Antisensis*, d'Orb.), from the eastern declivity of the Cordillera, is entirely new, and remarkable for having hair that can be broken like that of the musk-deer: also the elk, which belongs to the division of deer properly so called; besides some others wanting to our collections, although long since described by D'Azara.

With regard to the bovine tribe, using this word in its most comprehensive sense, and extending it to all the ruminating animals with horns, it is worthy of remark, that M. d'Orbigny met with no species unknown to previous travellers. The genus Bos, therefore, which is so rich in the Old World, and particularly in Africa, is represented in America by three or four species which do not range beyond the Gulf of Mexico. Our domestic ox, and also the horse, having been transported to South America shortly after its conquest, have propagated every where in an astonishing manner, and constitute one of the sources of the commercial wealth of the country.

Finally, in the subclass of Didelphis, M. d'Orbigny has likewise collected some new species of opossum, from which it appears that this genus is found in all parts of the American continent.

Upon the whole, one of the commissioners, M. J. Geoffroy St Hilaire, who, from his situation, is most familiar with the mammiferous animals, believes that he may estimate the number of new species of mammiferæ discovered by M. d'Orbigny at forty-six,—a number which must be admitted to be very considerable, when we remember that the total amount of these animals, according to the most complete catalogues, does not exceed 1200. But it is in the class of birds that science and our collections are still more indebted to M. d'Orbigny's expedition: the number even of new species is much too great for us to be able to enter into such details of them as we have done with the mammalia.

The family of parakeets will be augmented by many beautiful species of parakeets properly so called, as well as the subgenera Ara and Perrucha.

Among the birds of prey, besides magnificent examples of the condor, or great vulture of the Andes, we have noticed some beautiful species of eagles.

The tribe of climbers comprises two individuals of that superb species of aracari which we described for the first time in the report made to the Academy on the expedition of M. Eydoux, as well as many new woodpeckers, and a couroucou, remarkable for the beauty and richness of its plumage.

But it is in the almost innumerable order of passerine birds that the greater portion of M. d'Orbigny's ornithological riches are to be placed, since his catalogue contains at least 500 species. Among these, M. Geoffroy regards as most deserving of notice, two new species of thrush with large claws (Megalonyx); a great number of fly-catchers, some of which are very remarkable; the beautiful *coq de roche* of Peru, with red wings and a black tail, the female dull brownish red, but unfortunately without any part of the skeleton; some very beautiful procnæ; new species of manakin, and of tangaras, one of them the size of a crow, with a crest of three feathers, and of great brilliancy in its colours; a new species of phytotoma; many rare species of magpie, one of them altogether new; lastly, about fifty species of humming-birds, nearly a dozen of which were previously unknown, and five or six very rare in collections. Besides these, M. G. St Hilaire is of opinion that each of the following ought to form new genera:—A bird referable to the genus *Ampelis* of Linnæus, remarkable for its beautiful and uniform green colour and red bill; another allied to the starling; a third approaching *certhia*, but remarkable for its singular hook-shaped bill; lastly, three or four others from Patagonia and the Andes, which could not properly be placed in any of the genera already constituted.

The pigeon tribe will likewise be increased by the addition of many new species.

The gallinaceous tribe will receive many important additions; among others, the genera tinamou and tinochorus, established by M. Eschscholtz on a species of bird sent by our traveller to the museum; besides two new species with tridactylated feet, one from Patagonia, the other from the higher regions of the Andes, and which seem to admit of being formed into two genera, which have accordingly been established by M. I. Geoffroy, under the name of Eudromia. Unfortunately, M. d'Orbigny, not being aware of the importance of possessing the skeleton, or, at least, the sternal apparatus of those birds intermediate between the pigeons and the gallinaceæ, has preserved nothing but their skins. This has likewise been the case with the hoazins and penelopes that he met with, so that their place in the series may yet be regarded as doubtful.

The cursores appear to have furnished a less abundant harvest. We may mention, however, a complete series at all ages of nandou, a species of ostrich with three toes, illustrated by a beautiful skeleton; a fine example of the humphed kamichi; as well as a new species of agami, of phenicoptera or flamingo, of foulque, and of phalarope.

Of the palmipedes, M. d'Orbigny has collected in his travels twenty-five species of the extensive genus *Anas* L. the greater part of which are unknown to naturalists.

In general, the ornithological aspect of the unexplored countries of South America, presents nothing very peculiar. Only one or two species have been remarked which could be regarded as identical with the birds of Europe. It may also be noticed, that M. d'Obigny figured and coloured, with great care, while the specimens were yet fresh, the eyes and beaks of all the birds that he collected, as well as their eggs, and that he neglected no opportunity of observing their habits and periodical migrations. Among other facts, he remarked that the *Ani* is not the only bird which makes a nest common to many females, as he found a species of cuckoo, and a parakeet, which follow the same practice. He also noticed that many birds build nests all the year; for example, gulls and goatsuckers.

The class of reptiles appears not to have offered to M. d'Orbigny nearly so many subjects of observation as that of birds. Every where indeed it is much more restricted both in species and individuals. His catalogues do not extend beyond 119.

From the inspection we have made of them, we perceive that his collection contains several emydes or fresh-water tortoises, one of which seems to be quite new: also several land tortoises, of which the *T. carbonaria* of Spix was a desideratum to our collections. But there is no example of trionyx, or soft tortoise, none of which seem to exist in the great rivers of South America. M. d'Orbigny has, however, often met with the crocodile with bony eyelids.

In the division of Saurian reptiles, he has observed many kinds of ameiva; a species allied to the tropidolepis, or lizard with spiny scales; a second species of the genera *doryphora* and *oplurus;* a new chalcidis, which, on account of the ease with which its tail can be broken, the natives name *acerilla*, or steel serpent, and which they regard, no doubt erroneously, as very dangerous; and, lastly, two distinct species, which may form a generic group allied to Ecphimotes.

In the division of Ophidians, some new species may likewise be remarked, but of this it is more difficult to speak with assurance. M. d'Orbigny has never met with aquatic serpents, which are so common in the Indian Seas; but he has met with a species of Crotalus or rattle-snake, as far as the 27th degree south, becoming more common in the north, and some true vipers. Of the fifty-two species of serpents which he has collected, five or six only are poisonous.

The class of Amphibia, judging from what M. d'Orbigny has seen of it, is much poorer in those parts of America which he has examined, than that of reptiles. Indeed he has met with no examples, except an enormous toad, about a foot long, some new species of frog, and of hyla; but no terrestrial or aquatic salamander, no siren, or other allied genera, which are so generally distributed over North America. Neither did he observe any kind of pipa, or coccilido.

But he has been more fortunate in the class of Fishes, particularly fresh-water fishes, which were to be collected from all the tributaries of the La Plata, and from that river itself. He observed, however, but one species of Cyprinus, which affords so many in northern Europe. This genus seems to be replaced in South America by that of the Siluri, only one of which, on the other hand, exists in Europe. Thus M. d'Orbigny enumerates eighteen or twenty species in his catalogues, very variable in form, and consequently exemplifying many of the genera recently constructed. Some of them are of gigantic size, measuring two or three metres in length. The salmon are likewise numerous both in individuals and species, and many of them are no doubt new. The same may be said of a kind of mullet, of perch, lucio-perch, and blenny, which we have seen figured in his atlas. He nowhere observed any species of eel, which appear to be replaced by the Synbranchiæ. He speaks of Clupeæ and Atherinæ found in the Plata, at 100 leagues from its mouth ; of Plaice, in the Parana, at the distance of upwards of 150 leagues from the sea ; and of a kind of Sole, 390 leagues distant from the sea, on the frontiers of Paraguay.

He observed a kind of Pastenagua, or armed fresh-water ray, and also a lamprey, in the rivers of Patagonia, but no sturgeon.

Thus with the exception of salmon, which are pretty common in the South American rivers, the ichthyological physiognomy of these countries may be said to be more peculiar than that of the birds.

The molluscous articulated animals which presented themselves to M. d'Orbigny's observation, are not numerous ; the few genera which constitute that subtype being all pelagic or littoral, and our traveller, according to his instructions, exploring chiefly, or almost exclusively, the interior of the country.

But his investigations have been carefully directed to such of the mollusca as inhabit fresh-water. Not that he has neglected to observe, describe, and what is still better, to figure, the poulpes, the seches, the calmars, and marine shells which he met with in his passage from Europe to America,—from the eastern side of the latter country to the western,—and finally, in his return to Europe. Indeed we have noticed a considerable number of pteropodes, firoles, and of doris; a cancellarious animal, remarkable for the absence of the respiratory tube, a fact well indicated by the shell ; many natices, and cryptostomæ, &c. But it is chiefly in the order Pulmo-branchiæ, in the class of Cephalidii, and in the family Submytillaceæ, and likewise in the class of Acephalidii, that M. d'Orbigny has collected shells, and made observations and drawings from the living subject, highly deserving of attention. We now know that the genera Unio and Anodonta, both of them so rich in varied and remarkably formed shells in the lakes and rivers of North America, are likewise very numerous in the tributaries of La Plata, which flow down the eastern side of the Cordilleras in Paraguay. Among the most interesting, we have remarked a species of Anodonta, the shell of which is formed like a lithodome muscle, or of a pholas, and which lives placed perpendicularly in a hole, rising and descending by a peculiar kind of mechanism in the structure of the foot; several true unios, provided with a respiratory tube still more developed than in the iridinia of the Nile; lastly, certain species in which the hinge demonstrates, better than any specimen previously in conchyliological collections, the passage of the genus Castalia of Lamarck to the unios.

When crossing the ocean, M. d'Orbigny neglected no opportunity that occurred to him of examining the biphores, diphyes, and beröes. While studying these, drawing and colouring them from living examples, he doubtless will have observed some new facts, or his observations will serve to complete what was imperfectly known; and it is more than probable that he has found some new species which had escaped the researches of MM. de Chamisso, Eschscholtz, Quoy, and Gaymard, to whom the science owes so many interesting facts.

The same observations may be made respecting the medusæ or types of the radiated animals, which, as being pelagic, were necessarily more frequently presented to M. d'Orbigny's observations, than the echinidæ, madrepores, polypiariæ, and zoophytariæ, of which he has brought home but a small number, as these animals are more or less littoral, being usually found fixed to rocks. Indeed we have noticed a considerable number of medusæ belonging to the genera Equorea, Geronya, Aurelia, Chrysaoris, and Rhysostoma, drawn and coloured with sufficient care to admit of being employed, in the absence of the animals themselves, which are so difficult to preserve, in illustrating a work which may benefit the science.

In fine, when we know that M. d'Orbigny has observed 6960 species of animals, the amount of those contained in his catalogues, which are prepared with a degree of care deserving of all confidence, it seems just to conclude, that having visited, not in a cursory manner, but residing for a longer or shorter period in each, countries till then imperfectly or altogether unknown, the number of new species he has obtained must be very considerable, especially among the mammiferæ, birds, and hexapod insects, as well as among fishes and fresh-water shells.

Before hearing the Report on Geology, which will be read by M. Cordier, we may add, that M. d'Orbigny did not neglect fossil organic bodies. Thus we have seen, with much interest, unquestionable examples of melaniæ from very old water deposits, as well as trilobites. We have noticed among the collections only one ammonite, but no belemnite; but in the tertiary and quaternary deposits, he found the remains of carnivorous and gnawing animals, which he supposes, perhaps rather hastily, to be different from those now existing. He has shewn us a coloured drawing of the half of an under jaw, still retaining the teeth, of a great species of Mastodon; and he had previously sent, some years before his return, a tibia and the molar teeth of that gigantic animal (Megatherium), which has been erroneously conjectured to be a species of sloth, but which, in reality, is a true species of armadillo, about the size of a small elephant. The occurrence of these remains, it may be remarked, overturns the hypothesis of Buffon, that America had never supported animals of larger size than the tapir *.

Description of Drawing of Machinery for Registering the Variations of the Tide and Wind †. By Charles Atherton, Civil Engineer; Resident Engineer, Dean Bridge Works, Edinburgh. With a Plate.

Upon the occurrence of extraordinary circumstances that occasionally attend the flow of the tide, causing it so far to depart from the ordinary course of nature, as to engage the particular attention of scientific observers, it is generally a subject of deep

* Nouvelles Annales des Museum d'Histoire Naturelle, t. iii. p. 84.

† Read before the Society of Arts 19th January 1831.

regret that satisfactory evidence cannot be obtained of the peculiar combination and changes of circumstances which preceded and gave rise to such remarkable events.

It is peculiar to such events, that, not being subject to periodical recurrence, they cannot possibly be foreseen ; and, similar to the progress of a disease, its approach is only known subsequent to the period at which the creating causes commenced their operation, whereby the vigilance of practical observers is rendered abortive, the result of their labour being merely a minute historical record of facts, conveying such an insufficient account of the circumstances from which those facts resulted, as to give but little aid to the genuine advancement of science.

The mode usually adopted of registering natural phenomena, consists of noting down the state of things at particular periods of the day, best suiting the general convenience of the observer. Were the changes of natural phenomena subject to periodical occurrence, this system, diligently attended to, may be sufficiently satisfactory ; but, in the existing state of nature, numerous circumstances, deeply involved in the production of subsequent remarkable events, pass unheeded.

For instance ; the wind is frequently known to blow from all points of the compass in the space of a few hours. This must necessarily create strange atmospherical disturbances in some shape or other ; and yet, should it happen during the night, or if the attention of a recorder of atmospherical changes be otherwise demanded for a few hours, the event would not appear upon his record, which omission would probably lead to false conclusions as to the origin of a subsequent matter of investigation. Thus the laborious researches and happy conclusions of theoretical speculators may frequently be condemned as useless, upon the fallacious testimony of pretended practical observations.

Natural phenomena are so constantly in action, and subject to such incessant fluctuations, that the most persevering diligence of man is scarcely competent to furnish data sufficiently complete to form the basis for a standard rule, or test the truth or fallacy of theoretical deductions.

The numerous difficulties attending the present system of record, and the objections to which it is liable, are too evident to require further remarks in order to shew the comparative advan-

Edinr New Phil. Jour. Vol XVIII p 313

MACHINERY for Registering the Gradual Variations of WIND and TIDE

tages that would result from the constant operation of a self-acting machine, so constructed as to furnish the data required in that interesting branch of science connected with the motions of the tide.

I now proceed to describe the mechanism represented in the accompanying drawing.

The general principle of the machine is such, that a circular dial being fixed to the axle of a clock, revolves with a uniform motion once in twenty-four hours; a pencil is also moved vertically up and down by the rise and fall of the tide; which combined motions of the dial and pencil trace a curve upon the face of the dial, whereby the height of the tide, at any particular period of time, may be ascertained, also the time of high and low water, and the variable rate of ascent and descent.

The direction of the wind is indicated by a circular dial fixed horizontally to the vertical axis of a wind-vane. And, by means of the clock, a pencil is made to move uniformly, at a given rate, from the centre of the dial towards the circumference, so that if the wind remain stationary upon any point of the compass, the mark traced by the pencil will be a straight line, radiating from the centre of the dial; but if the wind be changing, the dial will revolve, and the combined motions of the dial and pencil will trace out a curve by which the direction of the wind at any particular period of time will be indicated.

Fig. 1. Pl. III. represents the general elevation of the machine. It need not necessarily be formed as here represented, it being merely required that the weather-vane be properly elevated to be freely acted upon by all winds.

Fig. 2. represents the interior construction of the machine. A is a case inclosing a strong clock, which causes the dial-plate BC, fixed to its shaft, to revolve once in twenty-four hours. D is a large air-tight vessel, which, floating on the surface of the water, ascends and descends agreeably to the rise and fall of the tide, and thereby causes the wheel EF to revolve. G is a small pinion fixed to the axle of the wheel, and working into the rack HK, to which the pencil L is fixed. By this construction the pencil will be moved vertically up and down agreeably to the rise and fall of the tide, and as the circular dial-plate, fixed to the shaft of the clock is turned round, the pencil will trace out

a curve line upon the face of the dial. M represents the shaft of the wind-vane, to which the wind-dial NO is fixed. A screw is cut upon the shaft of the clock, which is supposed to turn round once in twenty-four hours, and the pencil P being carried by an arm projecting from the nut Q, nicely fitted to the screw and shaft of the clock, it follows that, in the course of twenty-four hours, the pencil is moved through a space equal to the distance between two threads of the screw, and therefore constantly moves at a uniform rate from the centre of the wind-dial N O towards the circumference; whilst, at the same time, the variation of the wind causes the dial to revolve, by which combined motions a curve-line will be traced upon the face of the wind-dial.

In order to make the wind-vane point steadily to the true direction of the wind, and not subject to the constant vibrations, and occasional pirouettes to which vanes, wanting some regulating contrivance, are generally subject, a finely pitched wheel R S, is fixed to the vane-shaft, which wheel, working into the pinion T V, causes fans to revolve in the close-box W, filled with fluid. The resistance thus opposed to any sudden and violent motion of the fans, will cause the vane to move steadily. But the resistance to the fans, when moving in the fluid with a slow steady motion, will be so small as not to affect, in any sensible degree, the truth with which the vane would indicate the direction of the wind.

Fig. 3. is a view of the face of the machine, the pannel being removed. The letters on fig. 3 are placed agreeably to fig. 2.

Fig. 4. represents the face of the tide-dial, with a supposed tidal curve traced upon it, in half a lunation, or in the interval between the new and full moon. In practice, the dial is supposed to be 3 feet in diameter, and the rise of an ordinary spring-tide from low to high water mark 20 feet, which lineal motion, being reduced by the wheel and pinion turned by the float, is here arranged so as to move the pencil through the space of 10 inches. Therefore, as the tide rises or falls 1 foot, the pencil would ascend or descend $\frac{1}{2}$ inch. At each time of tide, the curve will form a vertex. If we wish to determine the time of high or low water for any particular tide, we have to draw a straight line from the centre of the dial, through the correspond-

ing vertex of the tidal curve, and produce the line to the hour-circle; the point at which it cuts the hour-circle will indicate the time required. The state of tide at any particular time of a given day, is determined by drawing a line from the centre of the dial, to the point in the hour-circle corresponding to the given time, and measuring at what distance from the centre it cuts the tidal curve for that day.

The ordinary course of nature will produce uniformity in the contour of the curves described, but any extraordinary occurrence will be strikingly indicated by a corresponding distortion. For instance, suppose the face represented in Fig. 4. to have been fixed to the dial-plate on the 1st day of a particular month, we observe, that during nine days the curve follows a general law, shewing that nothing extraordinary happened; but we find that, on the 10th day of the month, the tide rose 4 feet 6 inches higher than was to be expected from the ordinary course of nature, attained high water at 33 minutes past eight in the evening, remained 57 minutes at its highest elevation, and then descended 8 feet in the course of 20 minutes; the subsequent low tide appears to have taken place at 2 minutes past three in the morning of the 11th, and fell 1 foot 9 inches below what was to be expected; and similarly, other extraordinary circumstances would be indicated by a corresponding extraordinary feature in the contour of the tidal curve.

Fig. 5. represents a face supposed to be taken from the wind-dial. To determine the direction of the wind at any particular period, take a distance upon the scale (measuring from the centre) corresponding to the given time, and with that distance, as a radius, describe a circle about the centre of the face. The intersection of the circle with the wind-curve, will indicate the point of the compass from which the wind blew at the given time. As long as the wind blows steadily with a gentle breeze, the fans placed in the box W will effectually prevent any violent agitation from affecting the vane, and consequently the pencil will describe a clear line. But it is intended, that if the wind blow with regularity and considerable force, the vane may be slightly agitated, in order that violent winds may be indicated by some remarkable feature upon the wind dial-face, shewing us, after considerable experience and observation of the action of

the machine, under what appellation the wind that blew at any particular period may be classed, together with the point of the compass from which it blew. Thus, for instance, supposing the wind dial-face, represented in Fig. 5, to have been applied on the 1st day of a particular month, we find that during the 1st, 2d, and until midday of the 3d, the wind gradually veered from N. to N.E. by E., when it commenced a strong breeze, which continued till about six o'clock in the evening of the 7th. The wind then rapidly turned to the N., from which quarter it blew furiously until about six o'clock P. M. of the 10th. It then subsided, and gradually veered by the W. to the S. and S.E., and about midnight on the 14th, blew hard from the S., and so continued till midday on the 16th, and so on. Thus, the direction of the wind, at any particuliar period, would be indicated with precision, and it is expected that the appearances on the face would enable us, after having experienced the action of the machine, to form a tolerably correct idea of the simultaneous state of the wind.

In the construction of the machine, various particulars must be well attended to. For instance, the float will require to act upon a surface of water undisturbed by the waves of the sea, to secure which, the space for the float's action should be enclosed, the water having ingress and egress through a small aperture; the aperture will be amply large, if its area be one square inch for each superficial foot of water surface that the enclosed space contains. The dial-faces may be formed of thick white paper, made for the purpose, and kept with the required figures and divisions of the circle ready printed upon them fit for use. A fresh face may be placed upon each dial plate once per month, or at such other regular periods as from experience may be found more convenient. The date should always be marked upon a new face upon its being fixed to the dial-plate, and the old faces carefully preserved. On the tide dial-faces, midday is denoted by the letter M, to distinguish it from midnight.

The small tubes which contain the markers, are so contrived, that a small slip of prepared black lead is forced with a gentle pressure against the face of the dial, by a slight wire spiral spring enclosed in the tube, whereby a constant point is kept up. Experience of the practical operation of the machine, would doubtless suggest numerous improvements in the detail, especially as concerns the size of the dials and the motion of the pencils, which particulars will depend upon the nature of the investigations we may desire to make. It is, however, hoped, that the foregoing drawings will make the nature and construction of the machine perfectly intelligible.

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*Description and Drawings of an Improved Method of Making Screw Taps and Dies.** By John Robison, Esq. Sec. R. S. E. and M. S. A. In a Letter to the Secretary.

Dear Sir,—In reply to your inquiries regarding the method of making Screw Taps and Dies, which I mentioned at a meeting of the Society of Arts about two years ago, I now beg leave to offer the following detailed description of them.

1*st*, Of the Tap.—I propose that this should be made half round, as it will be found that a tap formed in this way will cut a full clear thread, (even if it may be of a sharp pitch,) without making up any part of it by the burr, as is almost universally the case, when blunt-edged or grooved taps are used.

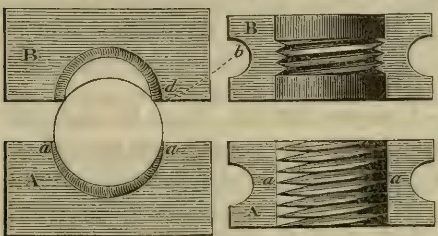
It has sometimes been objected to me by persons who had not seen half-round taps in use, that, from their containing less substance than the common forms do, they must be very liable to be broken by the strain required to turn them in the work. It is proved, however, by experience, that the strain in their case is so much smaller than usual, that there is even less chance of breaking them than the stouter ones. Workmen are aware that a half-round opening bit makes a better hole, and cuts faster than a five-sided one, and yet that it requires less force to use it.

The method I recommend for constructing such taps, is to begin by making the screwed part cylindric, or of equal diameter up to the point; then to turn off five or six turns of the thread from the point, leaving just a faint trace of the bottom of the thread. This portion of the tap then serves as a gauge for the size of the hole to be tapped, and as a guide for entering the

* Read before the Society of Arts, 14th November 1829.

tap fairly into the work. The rest of the thread, from this bare portion to within a few threads of the upper end of the tap, should have the angle turned off, beginning by removing nearly the whole of it, and taking less and less as the other end is approached, where five or six turns of the thread should be left entire. When this has been done, then one side of the tap should be filed or ground away, giving nearly the form of a half-round opening bit.

2d, Of the Dies.—It appears to me, that these should be made so as to have only one or two cutting points, instead of the multiplicity presented in the constructions usually adopted. With this view, I form one of the dies so as to act merely as a guide, and the other die to cut by one or two threads only. The figure



is a representation of dies made in this way. The die A has the thread filed away at *a a*, so as to admit the bolt which is to be screwed, to apply itself solidity to the cavity; while in the die B, so much of the thread is cut out as to leave only about two turns. The die *b* may be whetted when its cutting edge becomes blunt, by being ground in the direction of the dotted line *d*; and as the tap is likewise susceptible of being kept in a sharp cutting state, it must be the fault of the workmen if as clean threads be not produced by these means, as can be made by the chasing tool in the turning lathe, and with the advantage of not being liable to be irregular in pitch or diameter.

As few operations recur more frequently in practical mechanics, than the making of screws, any thing which facilitates this operation, or which enables workmen to produce better work at the same expense of time and trouble, is deserving of examination. I hope, therefore, that such members of the Society of Arts as may have the means of testing the accuracy of what I have stated above, will think it right to do so, and to communicate to the Society the result of their trials. In all the cases which have come within my own knowledge, the trial has been very successful. I have had a most favourable report from the persons concerned in erecting the beautiful printing machinery used in the Bank of Ireland, and in this city the plan has been found useful in making up gas-fittings, and even in such heavy work as screwing the shoulders and the nuts of the axles of carriages.

On finding the Dew-point, &c., from the Cold induced by the Evaporation of Water. By H. Meikle, Esq. Communicated by the Author.

I might have felt a little flattered by the approbation which the ingenious author of the article Vol. xvii. page 330, of this Journal, has bestowed on my scheme for finding the dew-point, had he not coupled it with a weighty charge of error. To render this "apparent," he brings forward an "example" in which air at the high temperature of 114° is to be "absolutely dry," and the dew-point "infinitely low;" though the slightest reflection might have satisfied him that neither this far-fetched example, nor any thing at all approaching to it, can ever occur. I have always maintained, and that gentleman admits, that confined air can never be absolutely dry if the vessel at same time contain the bulb of a thermometer having a wet covering. Unconfined air again is never found absolutely dry, and more especially at a temperature so very high as 114°; for, in such a case, I should think it rare for the dew-point to go even so low as 60°, in place of descending infinitely low. Indeed, I do not recollect of a case of any sort being recorded, in which the external air in a state of free circulation did not contain more than a fourth of the whole moisture required for complete saturation at the actual temperature. It is therefore no disparagement to the graphic scheme that it does not embrace an extreme and imaginary case with air absolutely dry. Should it fortunately turn out to have no other fault, it will fully answer my expectation; for, in proposing that method, I distinctly went on the supposition that it might require some amendment, and I therefore accompanied it with suggestions for remedies, should such be found necessary. These, our author might have seen, were capable of modifying the results very considerably.

My design in bringing forward the hyperbola was not to give a geometrical construction for finding the dew-point, but professedly to shew the probability of a combination of lines being found which should serve for the construction of a convenient practical scale; and from delineating two pretty large hyperbolas, I find that, by making the distances of the parallels for degrees of temperature to decrease a little in the lower part of the figure, the results everywhere come very near those of the table, except in a few cases which, like the above example, can never occur. I have also found that straight lines might be used in place of the hyperbolas, by making the divisions for degrees of temperature to decrease both ways from the 54th degree; and that by putting a curve, which would need to be one of double curvature, in place of the asymptote, straight lines with almost equal divisions might be got to answer in place of hyperbolas. But perhaps a medium between these different constructions would be the preferable one; namely, to curve slightly all the lines but the parallels of temperature, and to use intervals somewhat unequal between the latter. It is evident that if any sort of curves were substituted for these parallels, a straight line or ruler would not be sufficient to lay across this scheme; but where a ruler is not at hand, its place may be very well supplied by stretching a fine thread.

The author of the article above quoted seems to have laid hold of very apocryphal authorities for the specific heat of air varying as the square root of the pressure. As for the experiments of Desormes and Clement, to which he alludes, I do not see how they warrant any thing of the sort. These distinguished chemists having inclosed air in a glass globe, placed it in an empty trough, which they next filled with hot water, and assumed that the specific heat of the air was exactly proportional to the time which it and the globe took to acquire the same temperature with the water; whereas, for aught that is known to the contrary, the specific heat might follow some other power or root, or some very complex function of the time. Nor do they make any allowance for the share which the mass or matter of this globe, which far exceeded that of the included air, had in protracting the time; or for the different mobilities, and consequently different conducting powers of different gases, or of the same gas at different pressures. Thus, when the globe was filled with hydrogen, it was probably from the extreme mobility, and consequently great conducting power, of that gas, that the time of its attaining the temperature of the hot water was scarcely two-thirds of that in the case of air; and it is as natural to think that, when filled with carbonic acid, it was the more sluggish motions of that gas which rendered the time one-half longer than in the case of air; for the experiments of Mr Haycraft, which are free from all such objections, shew that, under equal volumes and pressures, the specific heats of the different gases are equal. If, therefore, the experiments of Desormes and Clement are so very erroneous for comparing the specific heats of different gases, why should we put any confidence in them for that of the same gas under different pressures, especially when the effect of so bad a conductor as the mass of the glass globe is totally overlooked? and as for their "corroborating the law theoretically deduced by Laplace," it may be sufficient to observe, that Laplace himself, shortly after framing this law, virtually repealed it by enacting a very different one in its stead, which may be seen in the *Mecanique Celeste*, livre xii. chap. 3. Both are remarkable for being quite incompatible with the principles from which they profess to be deduced, and are therefore to be regarded rather as laws prescribed to nature than deduced from it.

Our author is quite mistaken in his attempt to clear Dr Lardner from teaching that the sun aids in cooling a moist body; because in his Treatise on Heat, page 241, it is distinctly stated, along with a most learned rationale of the phenomenon, that while the wet thermometer exposed to the sun is falling rapidly, another thermometer placed near it in the shade is stationary. But though this had not been mentioned, the precisely parallel case of cooling wine in the sun for want of ice, as described on page 245, shews clearly that such cold was intended to be real and not relative to a dry thermometer *heated* in the sun, as the other gentleman supposes; for surely no one would seriously consider wine *cooled* by having its temperature actually *raised* from 66° to 74°, as this other gentleman says he found his wet thermometer to be when exposed in the sun. I cannot therefore conceive how any other meaning can be attached to such passages, than that the sun aids in the production of the cold, otherwise, of what use was it to recognise the sun at all in the affair, any more than the moon or the pleiades? But when I wrote the note, page 107, vol. xvii. of this Journal, I did so from memory, not having the Treatise on Heat by me at the time. It will, however, be seen that I have not misrepresented the matter, though it is not stated precisely in Dr Lardner's own words.

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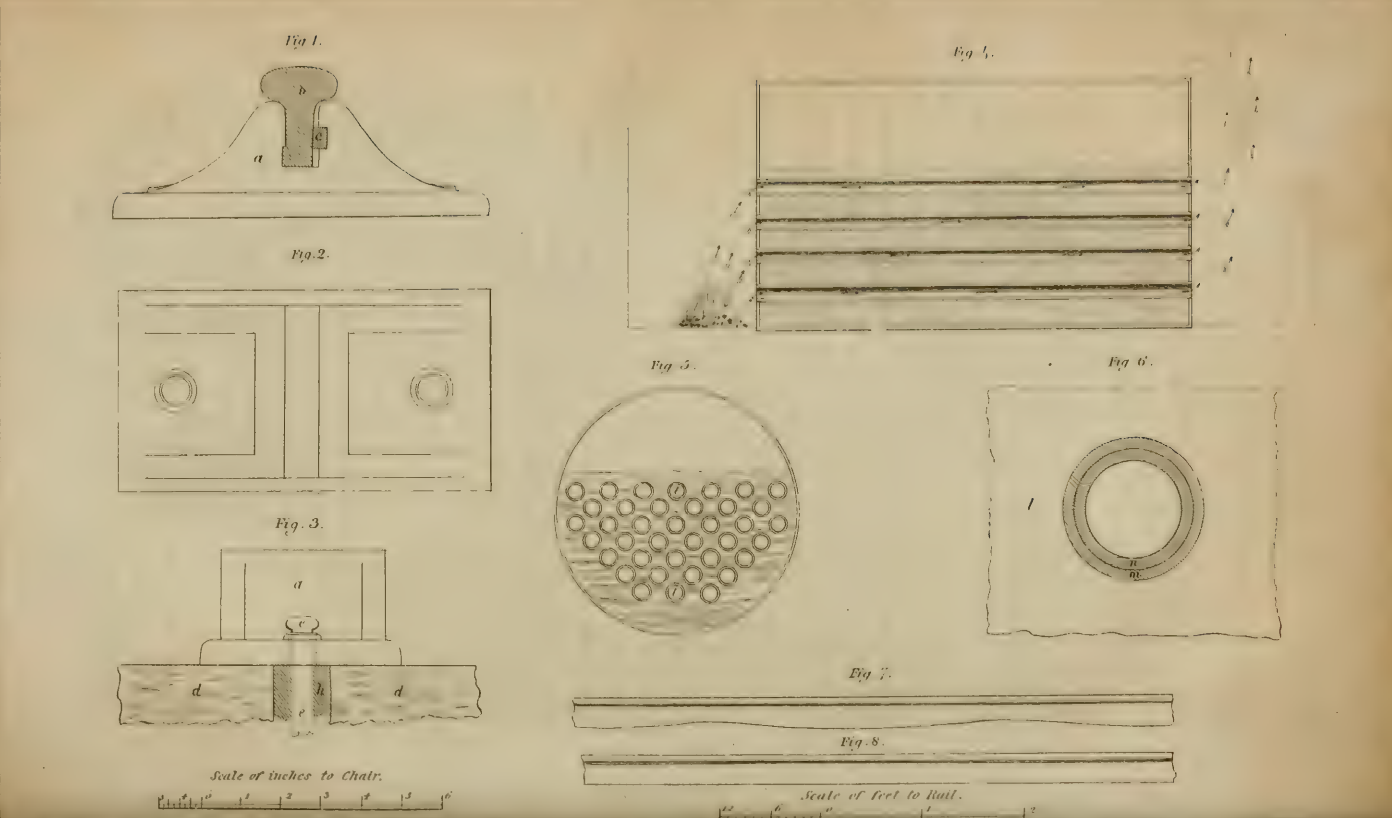
*Observations on the Liverpool and Manchester Railway.** By Mr David Stevenson, Edinburgh. With two Plates. Communicated by the Author.

The improvement of Railway communication is now a subject of so much importance, that any observations relative to the construction of railways, or the best mode of conducting traffic on them, especially such as are elicited in the course of practical trials, will generally meet with some share of public attention. I, therefore, venture to address to this Society a few observations upon the Liverpool and Manchester Railway, the most remarkable work of the kind hitherto executed, both as regards the railway itself, and the means of traffic employed on it. These observations occurred to me during a late professional engagement on that work under Mr Mackenzie of Liverpool; and though I do not think it necessary to give a lengthened account of the railway, I trust some of the facts which I have collected will be found sufficiently interesting to excuse me for having brought them under the notice of the Society.

The Liverpool and Manchester Railway was opened on the 15th of September 1830. Its formation and construction, including the erection of lodges, depôts, and offices, is said to have cost about one million Sterling, or at the rate of L. 33,300 per mile; but as much of the work was not done by contract, this railway cannot be taken as a criterion of the expense of operations of this nature, which now are executed at a much lower rate.

The whole length of the main line is thirty miles. It forms a double way composed of four single tracks of rails, having several branches to towns and collieries on either side. These branches, in most instances, consist of only a single way, with passing places. Connected with the main line, there are many works of importance and interest, including three tunnels, sixty-three

* Read before the Society of Arts for Scotland, 25th February 1835.



David Stevenson, Delt — E. Mitchell, Sculpt bridges, and several cuttings and embankments of great extent. The drainage of Chatt Moss, and the conveyance of the Railway over that bleak and uncultivated tract of country, are also particularly worthy of notice; but as accounts of these works have already been made public, I shall not farther notice them.

Excepting at Whiston and Sutton Inclined-planes, where the inclination is at the rate of one foot perpendicular to ninety-six horizontal, there is no part of the Liverpool and Manchester Railway, more than one in 880; and the curves in no instance deviate from the straight line more than four inches in the chain, or 66 feet. The inclination of one in 880 is hardly felt by the locomotive engines, and the curves are so gentle as to affect their progress very little. But the inclines of one in 96 on the main line, and several of the curves on the branch lines, prove formidable impediments, by diminishing the speed of the engines, and occasionally causing them to stop. The distance between the rails forming the tracks is 4 feet 8½ inches, and the distance between the two railroads or ways is the same. The rails, as shewn in Plate IV. fig. 7, are of that form technically called *fish-bellied* edge rails; they are made of malleable iron, in lengths of 15 feet, and weigh at the rate of 35 lb. to the yard. They measure 2 inches in breadth at the top, 2½ inches in depth at the chair, and 3½ inches in the middle. It is worthy of remark, that, when these rails break, the fracture is generally a few inches from the part resting in the chair, and never in the thick part of the rail, between the points of support, which has led to the adoption of the parallel rail shewn in Fig. 8, in all cases of repair. This rail weighs at the rate of 40 lb. to the lineal yard. At every three feet the rails rest in a cast-iron chair, which, including keys and spikes, weighs about 16 lb. The chairs rest upon stone blocks in the cuttings where the ground is solid, and upon wooden *sleepers* on the embankments, as shewn in Plate V. The resting blocks contain 4 cubic feet of stone; two holes, 6 inches in depth and 1½ inches in diameter, are drilled in them, and into these, oak treenails are driven, to which the chairs are spiked. The manner of fixing the chair will be best understood by a reference to Plate IV. Fig. 1 is an elevation, in which *a* is the chair, *b* the rail, and *c* the steel wedge or key with which it is fixed. The lateral motion of the rail is prevented by this wedge, while the recess in the chair, and corresponding *feather* in the rail, obviate any tendency it may have to rise from its seat. Fig. 2 is a plan of the chair in which the rail is not shewn. Fig. 3 is an end view, in which *a* represents the chair, *c* the spike for fixing it to the treenail, *b* the treenail itself, and *d* part of the stone block. The sleepers are of oak or larch, and contain about 1½ cubic foot of timber; they measure from 9 to 10 feet in length, and being laid across the road, each sleeper gives support to both rails. When sleepers are used, a seat is cut in them for the chair, which is simply spiked down to them. A piece of cloth or *felt* dipped in pitch is generally interposed between the chair and the stone blocks to make the seat more solid. The blocks occasionally split when the treenails are not driven home with care, but the sleepers are most frequently in want of repair and renewal.

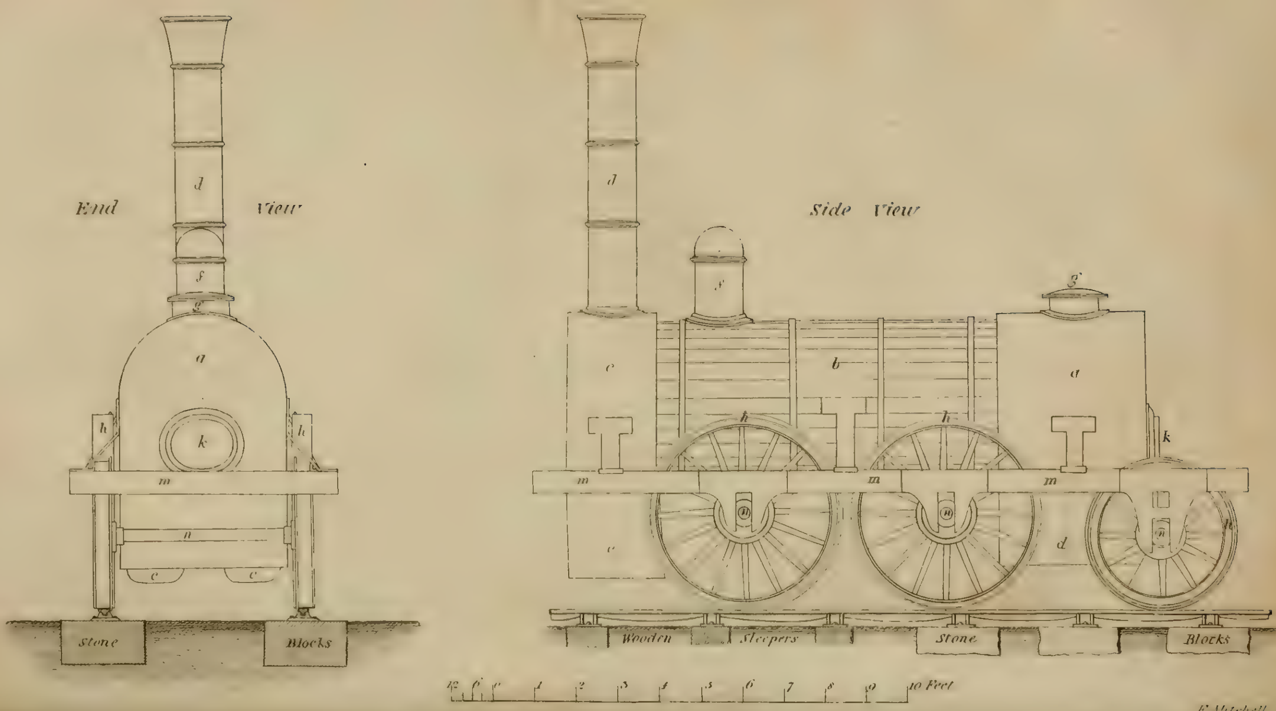
The repair and keeping of the way was this year (1834) let by contract for L. 6000, being at the rate of L. 200 per mile. The contractor furnishes labour, chairs, keys, and spikes, while the Railway Company furnish rails, blocks, and sleepers. They calculate upon having to renew one chair per mile per day, and L. 120 per annum is taken as the outlay for keys and spikes. The workmen employed in repairing the rails, and keeping the road in order, are called *plate-layers*, and the tear and wear is so great, that there is constant employment found for three men on every mile of the railway. The *ballasting*, in which the blocks and sleepers are embedded, consists of sand and broken stone, and forms a stratum of two feet in thickness.

The Railway Company have had thirty-two locomotive carriages made, five or six of which are now out of use, and many of those at present on the road have been almost totally renewed. These carriages are all numbered and named. No. 1 is called the "Rocket." This engine was made by Messrs Stephenson the engineers, and is that which did them so much honour in carrying off the prize of L. 500, given by the Directors of the Liverpool and Manchester Railway for the best locomotive carriage.* It has been little used, and is still in good repair.

* The persons who competed for this prize were,—

	Tons.	Cwt.	Qrs.
Braithwaite and Ericsson, of London, whose carriage the "Novelty" weighed - -	2	15	0
T. Hackworth, Darlington, "Sans Pareil," -	4	8	2
R. Stephenson, Newcastle, "Rocket," - -	4	3	0
T. Burstall, Edinburgh, "Perseverance," -	2	17	0

LOCOMOTIVE CARRIAGE.



The locomotive carriages used at present on the railway are of three kinds, and are called *train*, *luggage*, and *bank* engines. The train engines average about thirty horses' power. They weigh about eight tons, and cost about L. 900. The luggage engines are in general thirty-five horses' power, and weigh about nine tons. They cost about L. 1000. There are only two bank engines, the "Goliah" and the "Samson," which are used for assisting the trains with passengers and luggage up the inclined planes at Whiston and Sutton. They are about fifty horses' power, weigh about twelve tons, and cost about L. 1100. The cylinders of these different engines measure from eleven to fourteen inches in diameter, and the length of stroke varies from sixteen to twenty inches. The carriages used for conveying water and fuel for the engines are called *tenders;* they have four wheels, and are yoked behind the engines. They average when loaded about four tons weight, and cost about L. 150 each.

The technical names applied to the different parts of these engines, will be understood by referring to the letters in Plate V., which is a view of one of Messrs Stephenson's patent locomotive engines of forty horses' power. In this Plate, letter *a* is the *fire-box*, *b* the *boiler*, *c* the *smoke-box*, *d* the *funnel*, *f* the *cap*, which is made of copper, and contains the end of the steam-tube communicating with the cylinders, *g* the *man-hole*, *k* the *fire-door*, *m* the *framing*, *h* the *wheels*, and *n* the *axles*. Figs. 4 and 5 of Plate IV. shew the principle on which the boilers are constructed, which is simple, and at the same time very efficient. For this invention, it is believed the Railway Company are indebted to their treasurer Mr Booth. The shell or outside coating of these boilers consists of sheet-iron, half an inch in thickness. Brass tubes, one-eighth of an inch in thickness, and from one to three inches in diameter, are rivetted or fixed into the end plates of the boiler, and being open at both extremities, allow the fire to pass freely through them, as represented by the arrows in Fig. 4, which is a longitudinal section. By this means a great surface of the water contained in the boiler and surrounding the tubes is exposed to the heat, and the steam is more quickly generated than in the common boilers. Fig. 5 is a cross section of the boiler, shewing the brass tubes at letter *i*. Fig. 6 is an enlarged view, shewing the method of rivetting or fixing the tubes. In this view, letter *l* represents the end plate of the boiler, *m* the end of one of the brass tubes, and *n* is a steel ring, about one-eighth of an inch in thickness, one inch in breadth, and slightly tapered. This ring is driven into the brass tube, after it is fitted into the boiler plate, by which means the tube is wedged against the plate, and thereby rendered water and steam tight. The tubes are proved by means of a water pressure of 50 lb. on the square inch, and, notwithstanding this, they frequently burst. When this accident happens, the engineer stops both ends of the broken tube with wooden plugs. The mechanics connected with the railway prefer the large tubes of three inches bore to the small ones, which are more apt to get choked with soot and ashes. The boilers are generally seven feet long, and four feet in diameter, and contain about seventy or eighty of the small-sized tubes. Round the boiler there is a *lagging* or casing of one half inch deal timber, fixed with iron hoops, as shewn in Plate V., which being a non-conductor, prevents the radiation of heat, and greatly facilitates the generation of steam, especially in frost, or in a damp state of the atmosphere. The time required for getting up the steam, even in the most improved boilers, is generally above an hour, when every thing is in a cold state.* The Act of Parliament, in consequence of the smoke raised by pit *coal*, enforces the exclusive use of *coke*, which increases the expense of fuel about 40 per cent.

The cylinders are horizontal in all the locomotive carriages, with the exception of two, in which they are vertical, and these are not found to answer so well, and require more repair; the cause of which may be satisfactorily explained in the following manner:—When the cylinders are vertical, the machinery cannot yield to the up-and-down motion of the piston rod, and has consequently to bear the whole shock; while, on the other hand, when the cylinders are placed horizontally, the motion of the piston tends to impel the carriage along the rails, by which the shock is deadened, and has not so injurious an effect upon the

* A member of the Society having mentioned, that on the Glasgow and Garnkirk Railway, the steam is raised in twenty minutes, I think it necessary to remark, that the time stated in the text is dated from the first application of heat to the fuel, and is the result of many observations made by me while at Liverpool.

machinery. The objection to horizontal cylinders, founded upon the more rapid abrasion of the lower side of the piston by the effect of gravity, is not found to have much force in practice. In some carriages the piston rods are connected to the outside of the two fore-wheels, but in the improved engines they are connected to cranks on the axle of the carriage, in which case the cylinders are placed below the boiler, and are quite hid from view, as in Plate V. On these engines also the wheels themselves are connected by rods, by which means the moving power is applied to four wheels instead of two, which doubles the adhesion of the carriage to the rails. The *cross-head* at the end of the piston rod, working in a slide, produces the parallel motion. I may add, that some experiments were made on the Liverpool and Manchester Railway with Lord Dundonald's rotatory engine, which were of so favourable a nature, as to induce the Railway Company to construct a locomotive carriage on that principle. I have not, however, heard whether their efforts to introduce the rotatory system have proved successful.

The *fire-box*, as in Plate V. letter *a*, consists of a double casing of metal, with an intervening space of about 4 inches. This space is filled with water, and has a free communication with the boiler, of which it may be said to form a part. It has a grated or ribbed bottom for holding the fuel, about nine square feet in surface. The *smoke-box* at letter *c* and the *funnel* at *d* are made of iron, and are indispensable for catching the dust and embers blown through the tubes, carrying off the smoke and steam, and causing a draught for the combustion of the fuel. In the improved engines, the waste steam is ingeniously blown into the tender, and heats the water for the supply of the boiler.

The framing in some instances is made of cast-iron, but more generally of wood. It rests upon the axles, and supports all the machinery, together with the boiler and its accompaniments. Connected with it also are the springs for rendering the motion as smooth as possible for the machinery. The carriages have generally four wheels; the "Atlas," however, and some others have six. In some carriages all the wheels are of the same size, and about five feet in diameter, while others have one smaller pair of wheels about four feet in diameter. The naves and rims are of cast-iron, and the spokes and tires of malleable iron. Sometimes, however, the greater part of the wheels, like the framing, is made of wood.

It was lately suggested, as an improvement on locomotive carriages, to work the engines more slowly, and to produce the same or a greater speed by increasing the size of the wheels. Wheels of six feet in diameter were accordingly applied to one of the engines, but were found to produce an unsteady motion, and so greatly to increase the liability of the carriage to start off the rails or break down, that they were immediately discontinued. The Railway Company at present allow no wheels more than five feet in diameter to be used on the line. The greatest speed which the engines have been able to attain on a level, is sixty miles per hour, without a load. The Planet engine with her tender went from Liverpool to Manchester in forty-five minutes! being at the astonishing rate of forty miles per hour, including time lost in stoppages and ascending the inclined plane.

During wet weather the engine wheels are found to adhere better to the rails than in dry weather, but if the rails are only damp or *greasy*, the wheels have a tendency to slide instead of rolling, and the carriages then have considerable difficulty in dragging along their loads. According to Mr Booth's experiments, the adhesion of the wheels, in the most unfavourable state of the rails, is equal to one-twentieth of the weight supported by them. During frost, a loaded waggon is generally placed before the engine to rub off any ice or hoarfrost that may adhere to the rails. After the steam is thrown off, and the *break* or *drag* applied, in order to stop the trains, the time that elapses before they cease to move, is generally from 40 to 60 seconds, but this depends entirely on the state of the rails, and the rate at which the carriages are moving.

There are generally eight or ten engines at work on the line, each of which makes four trips a-day between Liverpool and Manchester, and on coming in at night the steam is blown off, and the machinery is thoroughly cleaned. At each end of the line the company have a depôt, consisting of sheds, where the engines are repaired at the sight of an overseer or manager, and it is not a little remarkable that 200 men are employed in keeping these engines in good order. The carriages are daily in want of some small repair, but they generally run about eighteen months before receiving a renewal, or thorough repair. The "Vulcan," a train engine, ran no less than 47,000 miles before it required to be taken into the shed for repairs, and the "Fire-fly" ran 50,000 miles. I have never seen any correct account of the work done by the several engines, or the repairs made on them. According, however, to the Railway Company's reports, the expenditure connected with locomotive power, exclusively of outlay for new engines, amounts to the extraordinary sum of about L. 28,000 per annum. On visiting the Stockton and Darlington Railway in the month of November last, I learned, through the kindness of Messrs Pease, the promoters of this undertaking, that the engines running on that railway very seldom required repair; although in their construction, and the workmanship employed on them, they fall greatly short of those in use on the Liverpool and Manchester line. But at Darlington the rate of travelling is only eight miles per hour, while at Liverpool twenty-five miles per hour is the usual speed; and hence we are fully warranted in supposing that the great tear and wear on the Liverpool and Manchester Railway may be chiefly attributed to the speed at which the engines are worked. Notwithstanding the smooth surface on which the carriages run, and the judicious use and application of springs, the tremor or shaking of the engines is very considerable, and is much increased with the speed. When moving at the rate of twenty-five or thirty miles per hour, the tremulous motion of the engine becomes quite alarming to those unaccustomed to it.

The luggage-engines perform a great deal of work, and generally bring in twenty loaded waggons, averaging $3\frac{1}{2}$ tons each. With this load they move easily at the rate of twenty miles per hour on every part of the railway, excepting at Whiston and Sutton inclined planes, where the effect of gravity reduces their power two-thirds, and forces them to bring their load to the summit at two, and sometimes three trips, although assisted by the bank engines. They nevertheless make the journey between Liverpool and Manchester in about two hours. Upon one occasion I saw the "Fury" engine with twelve loaded waggons, averaging $3\frac{1}{2}$ tons each, ascend the Whiston inclined plane without the aid of the bank engine; its speed on the level was about thirty miles per hour, and when it reached the top of the incline, the velocity was diminished to about two or two and a half miles per hour. This inclined plane is a mile and a half in length, and its rise is at the rate of one in 96.

Some idea may be formed of the load these engines are capable of taking, and of the rate of charges and expense of fuel, from the fact, that, during my stay in Liverpool, the "Atlas" engine brought in forty-seven waggons, being a load of 160 tons, for which the company's charge would be L. 70 Sterling, or at the rate of L. 1, 10s. per waggon. It is, I believe, calculated that the combustion of half a pound of coke will produce steam sufficient to carry one ton one mile, at the rate of travelling adopted on this railway, so that the conveyance of one ton from Liverpool to Manchester requires about 15 lb. of coke, the cost of which is about 2d. The expense, therefore, of fuel for bringing 160 tons from Manchester to Liverpool, according to this calculation, may be taken at L. 1, 10s., while the company's charge for carriage is L. 70; so that the chief expenditure, after the interest of the first cost of the railway, is in keeping the engines and railway in repair.

The second class train makes the journey in two hours, and has generally eight or ten carriages, which are open, and each seated for twenty-four persons. There are nineteen stations on the line where this train regularly stops, for the accommodation of passengers; and at each station there is a watchman, who makes signals if he sees cause for stopping the train. The signals are made during the day by red flags, and by lights after sunset.

The first class train makes only one stoppage, at Newton, to take in fuel and water, and performs the journey of thirty miles in an hour and a half. The coaches in this train are framed and covered like handsome road-carriages, and are seated for eighteen passengers, with the exception of the railway mail coach, which goes at the end of the first class train, and is seated for twelve persons. The charge for passengers from Liverpool to Manchester by the first class train in the mail is 6s. 6d., and in the other carriages 5s. 6d. In the second class train, the fare by the closed carriages is 5s. 6d., and by the open ones 4s. The weight of luggage allowed to each passenger is 60 lb., beyond which a charge is made at the rate of 3s. per cwt. The charge for conveying a four-wheeled road carriage is 20s., and a two wheeled carriage 15s. One horse is charged 10s., two horses 18s., and three horses 22s. About 1020 passengers and 640 tons of goods are daily transported along the railway.

Each engine carries two men, an engineer and a fireman, who have respectively 5s. and 2s. 6d. per day. As a check upon their regularity, a fine of 2s. 6d. is imposed on the engineer for every fifteen minutes he arrives *before* his time. There is a *breaksman* with the luggage train, and the trains for passengers carry two guards.

The occurrence of accident is not so frequent as might be imagined, as the great weight of the carriages prevents them from easily starting off the rails; and so great is the momentum acquired by these heavy loads moving with such rapidity, that they easily pass over considerable obstacles. Even in those melancholy accidents where loss of life has been sustained, the bodies of the unfortunate sufferers, though run over by the wheels, have caused little irregularity in the motion, and the passengers in the carriages have not been sensible that any impediment has been encountered on the road. For the prevention of accident, some arrangements have been adopted, by which the north rails are exclusively allotted for engines going towards Manchester, the south being for those going towards Liverpool.

The railway business is conducted by twelve directors, who give a half-yearly report on the income and expenditure; and a dividend of nine per cent. per annum has been declared for payment. At present, the railway is in use only during the day; but by conveying goods during the night, provision may be made for a great increase of traffic, without incurring expense in the execution of new works.

Edinburgh, 21*st February* 1835.

On the Pitch-Lake of Trinidad.

There is nothing more extraordinary in the structure of the whole island of Trinidad than the extensive pitch formations it contains. The part of the island in which the pitch-grounds, as they are called, are found, is about twenty-four miles from Port Spain, at a place called Point Breea. There it is said that they are fifteen hundred acres in extent. On landing at Point Brcea, which is done on a sandy beach, a person is naturally surprised to see large black rocks of pitch towering above the sand, and pieces of them rolled smooth and plentifully about the beach like pebbles. Every step he takes is on pitch-ground. Extensive masses of it are also found presenting a broad and smooth surface. In some places the road has been entirely made over them; sometimes passing between large pieces, rising some feet above the surface. In some parts it seems as if a barrel of pitch had been upset, and left to mix with the soil. The pitch in general is merely a superficial coating on the surface of the ground; and nothing but strict examination would allow one to believe that the fertile scene around is situated on pitch-grounds. But it is so; cottages and gardens are implanted on it, and on it vegetation thrives most luxuriantly. The pitch-ground is not one continued mass of this substance, but is a series of broken and irregular patches of it, the soil intervening for considerable spaces. After walking up a gentle ascent of a mile and a quarter from the sea, over the pitch-ground, the visitor reaches an elevated basin, which is called the pitch-lake. This is a vast mass of pitch naturally collected in the form of a lake. The surface of it, moreover, assumes the appearance of one, and it is completely surrounded by a wood. The length of this lake is about half a mile, and its greatest breadth about half a furlong. Numerous pools of water abound on the surface, and the deep cracks and fissures in the pitch are filled with it, in which little fish and frogs sport about. The water is perfectly fresh and good. The pitch appears to be in some parts of great depth, if such an opinion may be justified from the cracks and fissures. It is hard enough to sustain the weight of a person walking on it, but becomes a little softened by the heat of the sun; so that persons at a little distance from each other sometimes disappear by sinking gradually into the hollows formed by their own weight. On the confines of the lake, vegetation is abundant and vigorous; and pine-apples grown on the pitch-grounds are said to be remarkably good. Many plants also grow in the pitch itself, without a vestige of earth for their roots; but they are stated to have been more barren formerly than at the present time. The name of pitch-lake can only with propriety be given to this small spot, for by considering the whole as a lake, a person naturally expects to find one very large lake of pitch, which is not the case. The question naturally arises whether the lake is to be considered as the basin or origin of the whole, from which the sides of the hills and the adjacent country have been overflowed. I think appearances are against such a conclusion. A little to the northward of the pitch is a well, or fount of liquid tar. But the pitch itself is not confined to the lake, for there are submarine beds of it. Midway between Point Naparina and Point Breea is a very extensive pitch-bank, with no more than ten or twelve feet water on it, the approach to which may be generally known by a strong unpleasant smell, and by the water having a pellicle of tar on its surface. Sometimes, at low-water, ships have grounded on this bank; and should they come to an anchor, the anchor and cable are found covered with pitch. The water about the pitch-bank abounds with fish, and fish-pots are generally set on it. At the Serpent's Mouth there are some reefs, formed of pitch, which occasionally increase and again disappear, and are supposed to be connected with the mud-volcano. The pitch itself is a dull, black, solid substance, breaking with an even fracture, easily scratched by a knife; it emits a peculiar nauseous smell, like coal-tar; it sinks rapidly in salt water, and marks paper a dull brown. At about 310° Fahrenheit, it fuses imperfectly into a soft mass, more like the softening of coal than the melting of pitch, for it does not run into a flaccid mass. Spirits of wine, nitric acid, strong alkali, had no effect on it whatever. It differs, therefore, in chemical composition from pitch, and is incapable of being used for the same purposes. It is used in mending and repairing the roads at Trinidad, and for cementing and binding stones under water. It has also been employed to obtain gas. Some years ago, when speculation soared with prying eye over the surface of the globe for treasures, the pitch-lake came into notice, but was soon disregarded. Whatever speculations may be indulged in about the origin of this substance, its affinity to coal cannot be doubted; and, notwithstanding the authority of the names in favour of the theory respecting the vegetable origin of coal, it is by a remote analogy only; and philosophers have never yet made one atom of coal by their processes. It is a very vague inference, because hard woods become charred by submersion, to say that coal is formed by it. In respect to the circumstance of finding the remains of the vegetable kingdom in the coal strata, we may observe on this pitch lake and ground a remarkable coincidence. The remains of the coal-field exhibit the vegetation of a hot climate and a moist situation: the vegetation of a country abounding in ferns, arundinaceous plants, as the bamboo and palms. About the pitch-lake all these abound in a remarkable degree; they are, in fact, growing on it, and with them a palm called the pitch-lake palm, from the peculiarity of its thriving there. Supposing therefore, that coal was of similar origin, it may have been similarly situated with respect to vegetation; and we have no difficulty whatever in discerning how it is that vegetables become so abundant in it. If the pitch-grounds at Trinidad were now to be covered or buried beneath other rocks, the vegetables already collected in them, or about them, would hereafter occasionally be found. We have seen that there are pitch-beds in the sea in a soft state sufficient to receive the anchor of a ship, and therefore shells of marine origin may be found in this substance. In the deep fissures of the pitch-lake are pools of fresh water containing fish; and at a very short distance from them the marine beds may also receive salt-water fish. Besides this, a river may run over the pitch-grounds, and then we shall have every variety. Hence some very puzzling and opposite appearances may be found in juxta-position. The coal formations of our own country may probably have been originally in the same state as now are the pitch-grounds of Trinidad, which would tend considerably to explain some of the present anomalous appearances. The pitch-grounds, in my opinion, are primordials, and do not result from the conversion of vegetable matter. The botany of the pitch grounds would tend to elucidate the subject of organic remains found in the coal strata; and I am satisfied that a very surprising conformity would be discovered between them. No one dreams of the pitch-lake being formed from the surrounding vegetation.—*Webster's Voyage made in the years* 1829–31, *by order of the Lords Commissioners of the Admiralty*, vol. ii.

On the Structure of some Fossil Woods found in the Island of Mull, Northern Africa, and on the Karoo Ground to the North-East of the Cape of Good Hope. By WILLIAM NICOL, Esq. Communicated by the Author.*

AT a late meeting of the Wernerian Society, Professor Jameson requested me to examine the structure of some fossil woods which had been found by Mr Cunningham in the island of Mull, and also of some specimens from Egypt, Nubia, and Southern Africa. Having finished the examination, I shall now, in a very few words, lay the result before the Society.

I. *Fossil Dicotyledonous Wood found in the Island of Mull by Mr R. H. CUNNINGHAM.*

Mr Cunningham, in his account of the Geology of Mull, read before this Society, states that the fossil woods from that island were found on the beach, about two miles to the westward of Tobermory, and that they had proceeded from the trap-rock, which occupies a considerable extent of coast. The specimens, from the whitening of their surfaces, would seem to have long been exposed to the action of the weather, but they shew no great signs of having been worn by attrition. Some of the masses were six or eight inches in diameter. They were of a greyish colour on the surface, but when recently broken, the fracture surface is greyish black. The cross fracture is in some parts conchoidal, in other parts uneven, and the longitudinal fracture in some parts presents an obscure fibrous structure. All the specimens afford sparks with steel, and are traversed by veins of quartz, which in drusy cavities is crystallized in the usual forms. Each of the masses has a very contorted appearance, and when broken up, it seldom happens that any of the fragments display the slightest trace of a ligneous structure. Some of the fragments, however, split in such a manner as to shew the longitudinal direction, and from some of these I have obtained cross sections, which leave no doubt as to the vegetable origin, the structure resembling that of recent dicotyledons.

The medullary rays are very similar in number, breadth, and

* Read before the Wernerian Society, on Saturday, 7th March 1835.

extent, to those in some of the recent species of Acer. The vessels are numerous, and in general very much compressed, owing to the derangement the wood has undergone, either before or during the petrifactive process; but in some parts they bear the usual circular or elliptical form of most dicotyledonous woods. The cellular structure, which must have constituted but a very small part of the whole, on account of the number and contiguity of the vessels, is so much obscured, as not to be seen. All the sections where the vascular structure is seen, present well defined annual layers, varying in breadth from a tenth to an eighth of an inch.

All these fossil woods of Mull, collected by Mr Cunningham, belong to the same species, and are the only specimens I have hitherto seen of the dicotyledonous series from rocks of the secondary class.

II. *Fossil Woods found in Egypt and Nubia by the Rev. Vere Monro.*

The Egyptian and Nubian specimens which have been put into my hands, are seven in number. They are all of the siliceous kind. Two of them can merely be inferred to have had a vegetable origin from their external appearance, for internally they are formed of yellow jasper, without organic structure. A third specimen may have been wood, but it presents nothing but a congeries of fibrous substances, so slightly cohering, that it is impossible to decypher it by slicing it in the usual way. The remaining four are undoubtedly of vegetable origin. One of these is a conifera, the others are dicotyledons. The mass containing the conifera is an aggregate, consisting of fragments of the fossil wood, and grains of quartz, united by a cement, consisting chiefly of carbonate of lime, with a little iron and clay. The fragments of wood are of an elongated form, and of various dimensions, the largest being little more than an inch in length. They are lying in different positions intermixed with the grains of quartz, and the aggregate is in some part cavernous. Externally, the woody portions are of a greyish-black, but internally, the colour at least of one of the specimens was hair-brown. By reflected light, the hair brown-fragment shews no appearance of organization even when polished; but when a transverse section of it was reduced to the proper thickness, it shewed distinctly the reticulated texture of the recent coniferæ. From the faintness of the partitions it is not likely that the longitudinal sections would exhibit discs so as to enable us to determine whether the fossil belongs to the Pine or Araucarian division of coniferæ, and I have accordingly not attempted to make a longitudinal section.

The remaining three specimens of Egyptian wood are most obviously dicotyledons. The form and arrangement of the vessels, together with the septa enclosing the vessels, are so well preserved, that they may be distinctly seen in a cross fracture, even without such a fracture being polished. A thin transverse section of one of the specimens, shews, though faintly, even the cellular texture. All the three specimens are so much alike, that they may fairly be referred to one species. What that species was, I do not pretend to determine, but I may mention, that the form and arrangement of the vessels, as well as the cellular texture, bear a considerable resemblance to what may be seen in some kinds of mahogany.

Mr Jameson Torrie adds the following notice in regard to these Egyptian woods.

" The specimens described in the second section of this paper, form part of an interesting series of rocks collected in Egypt and Nubia by the Rev. Vere Monro. The breccia, containing fragments of a conifera, is from the neighbourhood of Aboosambal or Ipsambul, in Nubia. The rocks of that district are sandstones and conglomerates, which form hills presenting very remarkable conical and pyramidal shapes. Many of the specimens of sandstone are highly ferruginous and much indurated, and some of them seem to have been taken from masses which, from their hardness, offer much greater resistance to the action of the air than the other portions of the strata. The colour of these fragments is brown internally, but brownish-black externally, and the external shapes rendered apparent by the decomposition of the softer sandstone, are singular, being frequently stalactitic, botryoidal, perforated, vesicular, &c. The physical features of the surface of the country, combined with the peculiarities of the rocks just alluded to, have induced a recent traveller to assert the existence of an extensive volcanic district in Nubia, but none of the specimens we have seen in any degree warrant such an opinion. The wood breccia is from a bed at the edge of a large chasm, which traverses for a considerable distance sandstone strata, to the south-east of the ruined town and castle of Kalat Addé, and about a league and a half from Ipsambul. The specimens of Egyptian fossil wood are from Gebel Ataka, and Wadi el Tiheh, three leagues south-east of Cairo; and in regard to the fossil trees of that district, Mr St John, in his lately published Travels, remarks, that "several of the trunks measured three feet in diameter, and from forty to fifty-two feet in length," and that the tops of the hills, the beds of the torrents, the hollows, the glens, and ravines, are profusely covered with these petrifactions."

III. *Fossil Coniferous Woods found in the Karoo Ground, upwards of* 400 *miles North-east from the Cape of Good Hope, by Mr* J*ames* S*cott of Greenock.*

The fossil woods from southern Africa are of the siliceous kind, and, from a peculiar glaze on their surfaces, would appear to have been long exposed to the action of the weather, although they shew no signs of having been worn by attrition. The external appearance of these fossils clearly indicates a vegetable origin, and from the natural polish of the ends of each, an experienced eye, aided by a common pocket lens, would find no difficulty in determining them to be coniferæ. A thin transverse section shews in both most distinctly the coniferous reticulation. In one of the specimens, the rows of vessels are very much compressed in the direction of the radial partitions, and the annual layers, which are well defined, present an unusual disparity in their relative breadths. A longitudinal section of one of the specimens parallel to the radial partitions, displays, though faintly, discs similar to those in the recent araucarias. A transverse section of another specimen, in some places shews the coniferous reticulation very distinctly, but by far the greatest part of it is twisted and contorted in such a manner as nearly to obliterate the original structure.

These specimens were found by Mr Scott in one of the Karoo Plains, north-east from the Cape of Good Hope. He informs Professor Jameson, that the Karoo was covered with this fossil wood for upwards of twenty miles.

Ampere's Theory of the Formation of the Globe, and of the Phenomena of Volcanoes.

In a former number of our Journal, we communicated to our readers those important observations respecting the increasing heat of mines and wells in proportion to their depth, which seemed to demonstrate the existence of a temperature in the interior of the earth surpassing that which prevails on its surface, and which have thus disposed the minds of many distinguished philosophers of the present day to adopt the notion of a central heat, as supplying a ready explanation of the phenomena of volcanoes, hot springs, &c.

This hypothesis, however, though sanctioned by such high authority, can by no means be said to have commanded universal assent. Von Buch, for example, in many of his memoirs, speaks of volcanic action as a process of *oxidation*; and we have ourselves inserted, in a former number of this Journal, an article by Professor Daubeny of Oxford, on Thermal Waters and their connection with Volcanoes, in which it is contended, that the known phenomena cannot be reconciled with the principles assumed by Cordier, and must rather be referred to processes of a chemical nature, kept up by the access of water and atmospheric air to bodies capable of absorbing oxygen from both *.

* In an article on Volcanoes, published in the 40th Part of the Encyclopædia Metropolitana, which has just appeared, Professor Daubeny has developed his theory somewhat more at length, and has endeavoured to shew the fallacy of some of the objections which have from time to time been alleged against it. Thus he has proved, 1st, That a mass of matter composed of the bases of the alkalies, earths, and metallic oxides, which exist in ordinary lava, and in similar proportions, would possess a higher specific gravity than the lava itself is found to have.

2dly, That the basis of silica, and also that of alumina, combined either with hydrogen or with an alkali, would enter into combustion at a red heat, and therefore take a part in the chemical action which is manifested in volcanoes.

3dly, That we might infer from the long continuance of the process, that the substances which maintain the combustion are principally such as would form with oxygen a fixed product, and disengage from water an inflammable principle, both of which accord with the conditions of the theory.

The rest of the article we need not insert, as its substance will be found in the memoir already published in our Journal, and referred to above.

We now propose to lay before our readers some extracts from an article by the pen of Monsieur Roulin, contained in a French periodical, which professes to give an abstract of the views of that original and almost universal genius, Monsieur Ampere, on the subject of the Formation of the Globe.

M. Ampere sets out by adopting the hypothesis of Herschell, who imagined the matter composing the planets to have been deposited from a nebulous condition, having existed in the first place in a gaseous state, and gradually concreting into a solid.

Herschell had observed, that amongst the *nebulæ* some display only a diffused and homogeneous light, analogous to that exhibited by the tails of comets; whilst others exhibit in this light brilliant points, which seem to shew that the particles of gas have begun to unite into liquid or solid nuclei.

He had moreover remarked, that the brilliancy of these points augmented in proportion as the diffused light diminished in intensity; and hence he naturally concluded, that these differences of appearance corresponded with the different phases through which a world passes during the progress of its formation.

As a naturalist, in order to give the history of an oak, need not follow any individual tree through the long period of its existence, but is satisfied with surveying a forest, in order to observe oaks at one time in all the conditions through which they successively pass, from the first development of their cotyledons up to the period of their decrepitude and death; so the astronomer, finding in the heavens *nebulæ* representing all the different stages of the formation of a planet, may fairly deduce from them the successive steps by which each must have passed, or is destined to pass, in order to arrive at the condition of a world similar to our own.

Granting such to have been the state of things, that is, admitting that all bodies, whether simple or compound, that have contributed towards the formation of our planetary system, and in particular of the earth, were originally in a gaseous condition, it will follow that their temperature at this period was more exalted than that at which the least volatile of all these bodies would remain in a liquid state.

Now, the first deposit produced would probably consist of only one substance, either simple or compound; for it is not likely that two distinct substances should pass into the state of a liquid at exactly the same temperature. Upon being deposited in a mass, it would, by virtue of the mutual attraction of its parts, assume the form of a sphere, and this sphere, if it were thrown into a state of rotation, would naturally become in time flattened at its poles.

As the temperature of the nebulous atmosphere surrounding it continued to cool, another substance would become liquid, and be deposited in a concentric bed around the former, and so the process would continue until the most volatile alone of the constituents of the nebulæ remained in an elastic condition.

We have hitherto overlooked the chemical actions which the substances successively deposited might exert one upon the other, and, leaving this out of the account, it would seem that all these deposits having been the results of a slow and gradual cooling, would be ranged round the central nucleus precisely in the order of the temperatures at which they pass into a gaseous condition.

This, however, is not the mode in which the globe we inhabit is constituted, and, in order to account for its actual structure, we must next consider how this regular order would be interfered with by the chemical affinities exerted amongst the constituents of the several strata.

Immediately upon the deposition of a new substance upon one already formed, the chemical actions taking place at the line of junction between the two may be presumed to give rise to new combinations, and to occasion explosions, rendings asunder, and heavings up of the strata, an elevation of temperature as a consequence of the intense chemical action excited, and a formation of solid matter, whenever the new compounds resulting should require a temperature more elevated than that of the previously existing constituents, for continuing in a liquid condition. It may therefore easily happen, that the internal beds already solidified will return to a state of liquidity, and, where the mass is considerable, a long period might elapse before the centre, then less heated than the surface, is restored to an equilibrium of temperature with it.

At the time when any one of these combinations was going on, the maximum of temperature would neither be at the centre nor yet at the surface of the mass, but at the precise point where the uppermost bed reposes on the one subjacent, since it is there that the chemical action, according to our hypothesis, ought to be developed.

It would only be after many convulsions had taken place, and after large portions of the earth's crust, which were already solidified, had been reconverted into a gaseous condition, that, by virtue of a further cooling, a continuous crust would be formed of a sufficient consistency to oppose an obstacle to fresh chemical combinations.

When, however, the temperature had sunk low enough to admit of a new substance being deposited upon this solid substratum, calculated to act chemically upon it, we should have the same phenomena which had previously occurred, reproduced upon the contiguous surfaces of the two deposits. On the other hand, supposing the bed immediately subjacent not liable to be acted upon, but to have underneath it a bed of matter, a certain period might elapse without any action occurring between the first and third, until the liquid last deposited reached the surface of the latter through fissures in the intermediate bed, fissures produced by preceding convulsions, or occasioned by a contraction which resulted from a cooling of the materials subsequently to their becoming solid.

The first effect of this would be that of producing explosions, which must widen the fractures in the bed interposed, and thus increase the lines of communication between the two bodies which possess a mutual affinity. Hence would result fresh convulsions, the effects of which would be the more considerable, in proportion to their slowness in beginning, and to the obstacles they had to overcome in order to burst through the intervening substances.

It is thus we may conceive the successive revolutions which the terrestrial globe has undergone to have been brought about, and may account for the fractures and the varieties of inclination belonging to beds, which we should imagine to have been at first deposited in a linear series.

It is also conceivable that the surface of the earth, instead of having cooled in a gradual manner, may have experienced, from time to time, very considerable and very sudden augmentations of temperature, whenever the chemical actions alluded to were produced.

During the first stages of the formation of a planet, the liquid substances, which upon their deposition exerted chemical action, might have been many and various, but now that the only one which has continued in a liquid state is water, this alone can, by its penetration into the interior, be supposed to bring about similar convulsions to those which we have imagined to have taken place antecedently.

But experiment shews us that there are bodies in nature, upon which water does produce a chemical action, capable, if proceeding on a sufficiently large scale, to bring about very considerable changes.

M. Ampere illustrates this by observing, that, by pouring water in very minute drops on a mass of potassium, a good imitation of a volcano may be produced, the hydrogen liberated, causing a little crater-shaped cavity in the centre, whilst the oxide of potassium resulting will accumulate round its borders into a little hillock.

On the other hand, if water is made to fall in rather larger quantities upon the same mass, its whole surface will be split and rent asunder, so as to represent, on a minute scale, the great valleys and chains of mountains with which the earth is channelled.

Moreover, says M. Ampere, there remains an evidence of the convulsions brought about by the decomposition of bodies deprived of their oxygen by these metallic bases, in the enormous quantity of azote which forms the larger proportion of our atmosphere

It seems most natural to suppose that this azote was once in a state of combination with some substance or other, most probably with oxygen, existing perhaps in the form of nitric or nitrous acid.

This compound would have required eight or ten times as much oxygen as the quantity existing in the atmosphere at present. The disappearance of all this oxygen may be accounted for by the oxidation of substances, at one time metallic, which are now converted into silex, alumine, lime, oxide of iron, manganese, &c.; whilst that which the atmosphere at present contains may be only the portion left after all these processes had been completed, or which has been expelled from bodies already oxidized by means of chlorine, or other analogous principles.

We will not follow M. Ampere in his remarks respecting the manner in which this acid liquid would act upon and modify the contents of the solid strata; it is sufficient to observe, that in proportion as these events were repeated, the increasing thickness of the substratum of oxide would render the communication between the surface and the interior more and more difficult, and consequently bring about cataclysms which, though rarer than heretofore, would, when they did occur, prove more violent. In the mean time, the strata of the earth would become fissured more and more by the heavings up of its crust, and inclined in all directions; from the irregularities in its surface would result basins, into which the liquid, which the next stage of cooling caused to be precipitated, would find its way; so that first would emerge a few islands from the midst of an expanse of liquid matter, no longer as before universally covering the surface, and afterwards more extended tracts of land would make their appearance.

The earth, at this period, might begin to be surrounded by an atmosphere similar in nature to our present one, but in which probably the constituents bore to each other a very different relation as to quantity.

It seems to follow, indeed, from the ingenious researches of M. Adolphe Brongniart, that at this period the atmosphere contained a much larger proportion of carbonic acid than it does at present, a circumstance which, whilst it unfitted it for animal, was highly favourable to the development of vegetable life.

On the occurrence, however, of every new cataclysm, the sudden and great elevation of the earth's temperature, which would occur from the chemical action that occasioned it, would put an end for the time to all kinds of organization, and hence we observe in the earth, beds without a vestige of organic remains succeeding others richly fraught with such evidences of existing life.

M. Ampere then proceeds to show the consistency of these views with the relation given of the creation in the Book of Genesis, and particularly with the order in which the several classes of beings are there represented to have been successively formed.

Since the creation of man, he observes, the only catastrophe which the globe has undergone is that which corresponds with the Mosaic Deluge, to which perhaps may have been owing the elevation of Himalaya and the Andes. At present the crust of oxide which separates us from the non-oxidized nucleus is so thick, that convulsions are become very rare, and the resistance opposed by it is so great, that when a fissure does take place, by which a communication with the interior is brought about, the explosion is only local, and its effects are not extended, as heretofore, over the entire globe; so that, although the shock may at times be propagated over a great extent, yet no actual fracture of the solid covering, or ejection of melted matters over its surface, will take place, except over a comparatively limited area.

This hypothesis of an unoxidized nucleus, concludes our author, an idea at one time pronounced by Davy to be the only admissible one, affords a ready explanation of the phenomena of volcanoes, without rendering it necessary for us to suppose the earth to possess an enormous heat derived from the state of fusion in which its internal nucleus is by some imagined to be retained. This very unoxidized mass, indeed, is in itself an inexhaustible chemical source of heat, which will be developed each time that another body enters into union with it with sufficient energy; so that an active volcano may be regarded as nothing more than a permanent fissure in the globe, a constant channel of communication between its unoxidized nucleus and the liquids which lie above its oxidized crust.

Every time these liquids penetrate to the unoxidized nucleus, an elevation of the crust must take place from the mere increase of volume, which a metallic substance experiences upon uniting with oxygen.

The heat resulting from the chemical action would have its maximum of intensity at the point at which the union takes place, *i. e.* along the line of contact between the oxidized portion and the metallic nucleus, and must be propagated from thence, not only towards the exterior of the globe, but likewise towards its interior.

In proportion, therefore, as the oxidation of the crust advances, the seat of the chemical actions, and consequently the *focus* of the subterranean heat, will approach nearer and nearer to the centre.

What has been just remarked, says M. Ampere, may seem at first sight at variance with certain observed facts. It has been noticed, that from the surface down to a certain depth the earth's temperature is progressive, and we are hence disposed to conclude, that this same increase continues even to the centre, or at least down to the point at which the contents would exist in a state of fusion.

The observations themselves are good, but the conclusion drawn from them may well admit of objection.

Let us, in the first place, suggest, that this increase of temperature from the surface to a certain depth furnishes no ground for setting aside our hypothesis, inasmuch as, even upon our own assumption, it is a necessary consequence, seeing that the most intense heat ought to exist at the line of contact between the metallic nucleus of the oxidized bed above it, and consequently far below the greatest depth that has ever been reached by man.

Let us add, that man has as yet sunk scarcely a league into the interior of the earth, so that he is acquainted by actual observation only with what takes place over $\frac{1}{1400}$th part of the diameter of the globe. To infer from what has been remarked in this small portion of the diameter, the nature of what is taking place throughout the whole extent of the globe, seems very precipitate, for it is an established rule in physics, that we have no right to regard a fact observed as indicating a general law, until it has been found to hold good with respect to the larger portion of the scale over which it is extended.

Those who maintain, that the internal nucleus of the globe is in a liquid state, do not appear to have reflected upon the action which the moon would exercise on this enormous fluid mass: an action, from which would result tides analogous to those of our seas, but infinitely more terrible in their effects, both on account of the extent and the density of the liquid. It is difficult to conceive, how the casing of the earth could offer resistance to the continued shocks of a sort of hydraulic lever 1400 leagues in length *.

Heretofore certain objections might be brought against this theory, in so far as related to the formation of muriatic acid from the union of hydrogen with chlorine. It was not admitted by chemists, that water was able to decompose a metallic chloride. Berzelius, however, has recently proved by direct experiment, that water does decompose the chloride of silicium (and also that of aluminium. Tr.)

The heat emanates, as we have said, from the line of contact between the non-oxidized nucleus of the globe, and its oxidized crust, and is attributable, in a great degree, to the chemical action which takes place in that region.

We must add, however, that there exists a secondary cause for its production, in the electric currents which result from the contact of two beds composed of heterogeneous materials. Similar currents exist even on the earth's surface, as is shown by their influencing the magnetic needle; but they are less energetic, on account of the slighter conducting power of these oxides.

Similar effects, we cannot doubt, are taking place equally in the interior, whilst the direction which the currents affect may be suspected to be determined by the action of the sun, which, heating successively different meridians, diminishes in this manner for the time the conductibility of the corresponding portions of the more superficial beds of the earth's crust.

* Mr Lyell, in the last edition of his Principles of Geology, vol. ii. p. 284, has combated the doctrine of a central heat upon principles similar to these.—"Granting for a moment," says he, "that the tides in this internal matter can have become so feeble, as to be incapable of lifting up every six hours the fissured shell of the earth, may we not ask, whether during eruptions, jets of lava ought not to be thrown out from the craters of volcanoes, when the tides arise, and whether the same phenomenon would not be more conspicuous in Stromboli, where there is always lava boiling in the crater? Ought not the fluid, if connected with the interior ocean, to disappear entirely on the ebbing of its tides?"

The same author suggests an ingenious mode of reconciling the theory of volcanoes which has been advocated above, with his own fundamental principle, that the changes going on in the earth are calculated so to counterbalance each other, as to produce an endless repetition of the same phenomena. He suggests, that the hydrogen resulting from the water decomposed by the alkaline and earthy bases, may react upon the oxides, and by reducing them to their metallic state, fit them for the same purposes again and again."

Instructions for the Expedition into Central Africa from the Cape of Good Hope, 23d June 1834.

The "Instructions" drawn up for the guidance of Dr Smith, the chief of the exploratory expedition, at present in the interior of Africa, were sanctioned by Sir William Herschell, and others distinguished individuals at the Cape of Good Hope, interested in the success of the enterprise. The following pages from the "Instructions" will be read with advantage by those who may embark in similar journeys.

"At primary stations the Committee recommend the assiduous application of every instrumental means for the determination of the three elements of latitude, longitude, and elevation above the level of the sea, and especially at such stations as many series of lunar distances as possible should be procured, in addition to the usual sights for time (or observations of the altitudes of heavenly bodies near the prime vertical) which, together with meridian observations for the latitude, they would recommend to be practised daily as a matter of regular duty, at every station, as well primary as secondary. At primary stations also the barometer and thermometer should be observed at regular intervals, and the magnetic variation ascertained *by taking the sun's azimuth immediately before and after the observation for time* (*noting the exact moments, and thus obtaining data for interpolating to the time of observation*). At such stations likewise a careful investigation of the Index errors of Sextants should be made, the zero points or index corrections of the Sympiesometer should be determined by leisurely comparison with the mountain Barometer (giving time for the instruments to attain the same temperature), and the difference noted in the observation-books. The necessity of frequent comparisons of these instruments will be apparent, if it be considered that in the event of fracture of the barometer tube, no other means will exist by which the zero point of a new one can be determined. Occultations of stars by the moon, and, if possible, eclipses of the satellites of Jupiter, should be observed whenever an opportunity may occur. The former especially, affording the best known method of ascertaining the longitude by a single observation, should be constantly borne in mind, and the Almanac consulted several days in advance, so that no occultation of a large star certainly identifiable, should be allowed to escape through inadvertence.

"The Committee especially recommend that every observation made should be registered in a book devoted to that purpose, and preserved *in the exact terms of the readings off of the instruments and chronometers,* and kept rigorously separate in its statement from any calculation thereon grounded, and that the observed or presumed index or zero corrections, whether of Chronometer, Sextant, Barometer, or other instrument, should be stated separately in every case, and on no account incorporated with observed quantities; and, moreover, that the observations upon which such index errors have been concluded, should also be preserved. Since, however, the guidance of the expedition will necessitate the calculation of many observations on the spot, the results of such calculations should be entered (as such) beside the observations from which they have been concluded.

"The Committee farther recommend, that the Chronometers with which the expedition has been provided by the liberality of his Majesty's Government, should on no account be corrected by moving the hands, however great their errors may become, not even in the extreme case of one or both of them having been allowed to run down. In case of such a misfortune (which should be most carefully guarded against by making it the daily duty of more than one person to remind their bearers to wind them at a stated hour) it will be most convenient in place of setting them, to defer winding them until the hours and minutes come round, at which they may respectively have stopped as near as may be ascertained from one to the other or from both, to other watches of the party; and such event, should it take place, should be conspicuously noted in the observation-book; and, as a further and useful precaution, it is recommended to keep some of the best going watches belonging to individuals of the expedition, to mean Greenwich time, by frequent comparison with one of the chronometers. In every case where time is observed, express mention should be made of the chronometer or other watch employed, designating it by the maker's name and number, so that no uncertainty may ever arise as to the proper application of the correction for error and rate.

"The rates of the chronometers should be examined at any station where the expedition may rest two or more consecutive nights, either by equal altitudes of a star, or more simply by noticing the disappearance of any large fixed star from the same point of view, behind the edge of a board fixed at some considerable distance in the horizon, and having its edge adjusted to a vertical position by a plumb-line; the interval between the two such disappearances being an exact sideral day, or 23 h. 56 m. 4 sec. mean time. Under the head of secondary observing stations may be classed those in which no lunar distances can be got, and when the sights for time and meridian altitude can only be superficially and imperfectly taken, or one without the other. With a view to the connection of these with the primary station, and to the sketching out a chart of the country passed through, at every primary station a series of angles should be taken with the sextant between remarkable and well-defined points in the horizon, dividing the horizon into convenient portions, and carrying the angles all round the circle, back to the point of departure; and in the selection of such points, two ends should be kept in view, first, the precise indentification of the point of observation, in case of its being desirable to find it again; and, secondly, the determination from it of geographical points. The first of these purposes will require angles to be taken between *near*, the second between *distant* objects. For the latter, of course, remarkable mountain peaks will, if possible, be chosen. Of such, when once observed, the appearances from the place of observation should be projected by the *Camera lucida*, and their changes of aspect and form as the expedition advances, should be well and carefully noticed, to avoid mistakes. The approximate distance of any remarkable object may be had by pacing or otherwise measuring more exactly, a base line of a few hundred paces, in a direction perpendicular to that in which it appears, erecting a staff at each end, and from each staff measuring the angle between the object and the other staff.

"In this manner the neighbourhood of any station may be mapped down so as to be available for many useful purposes. In all such cases the compass bearings of the most important object in the horizon should be taken, and in the absence of the sextant angles, azimuth compass readings of each point may be substituted, though of course with less precision.

"Indications of the progress of the expedition should be left at various points in its course, by making marks on rocks or stones, &c. and by burying documents in bottles. In regard to the latter, it will be necessary to deposit them one foot deep at some known distance, say 15 feet from a conspicuous surface of stone, on which there is painted a circle containing the distance and bearing by compass of the bottle, from its centre, and that the situation of such places of deposit should also be ascertained by exact compass bearings of several remarkable points in the horizon, both near and distant, as well as by angles between them, carefully determined with a sextant, and noted down in the journals of the expedition for their own reference or that of future travellers.

"In surveying the basin of a river, or in proceeding along the prevailing slope of a country, it is very desirable to determine as many points as possible on the same level, and form thus as it were a parallel of elevation to the level of the sea. A line of this kind traced at the altitude of, say 1000 feet, would determine, in a considerable degree, the physical condition of extensive spaces on the map on both sides of it. The stations of most interest will be found at the extremities of transverse arms of the ridge, or in the central and most retiring points of the intervening spaces. Let the general slope of the country on both sides of such stations, be noted as to its rate and direction; and in regard to the valleys which intersect the slope, let their width, direction, and general rate of declivity, and the section and velocity of their streams, be ascertained, and the probable course of the rivers, as far as it can be determined by the appearance of the country and the reports of the natives, giving them the aboriginal names when they can be discovered. The altitude and acclivity of remarkable peaks or ridges should also be investigated, along with the nature of their climate and of the clouds formed upon them. It will be requisite also to mark with care the nature of the winds and sky, as well as the temperature at stations in the neighbourhood, and to note the influence which changes of that description have upon the barometer, and observe also the temperature of deep pools or lakes and copious springs.

"The geological structure of the country is especially worthy of minute and extended observation, and will require that notes be kept of all such appearances as indicate or accompany changes of structure in the formation, or of components in the soil and surface, especially such fossil remains of plants or animals as may occur, and metallic ores, and that proper specimens accompany these notes, ticketed on the spot with precise localities.

"The botanical researches of the expedition will extend to the preservation of specimens of plants not found in the colony, and especially of transportable roots and the seeds of all such as may be found in a ripened state, noting localities and the varieties of aspect which vegetation puts on in different situations. In regard to other branches of natural history, as it is obvious that after a short experience of research under your direction, almost every one will be able to recognise and preserve what is rare or novel, no further instruction needs to be given, except the general expression of the desire of the Committee that all shall endeavour to secure for the Expedition whatever in any department they esteem valuable, it being expressly understood that every article collected by each individual belongs in property to the subscribers to the expedition collectively.

"In regard to the inhabitants themselves, it is a paramount interest to gain an exact portrait of their life, as respects their condition, arts, and policy, their language, their external appearance, population, origin, and relation to other tribes, or in general whatever tends to elucidate their disposition or resources as sharers or agents in commerce, or their preparation to receive Christianity.

"It will be proper to ascertain their religious traditions or practices if they have any, distinguishing what is indigenous from the glimmering apprehension of great religious truths which necessarily spreads in advance of the scenes of missionary labour.

"Examine also the state of their intellect generally, as exemplified in their social and political arrangements, and common traditions, songs, or amusements, and particularly in regard to their knowledge of nature, and their notions of its vast and varied proceedings, as thunder, rain, wind, &c.

"Inquiries respecting commerce and the prospect of its extension are to be viewed as of no small importance in this undertaking. Every means must be used to ascertain its present nature, channels, and extent, and to determine the existing demand for foreign commodities, and the return which may be expected for them. Proper inquiries may also lead to some satisfactory views of its future condition, as indicated by the wants of the native population, or the objects of most importance to improve their condition, and the corresponding resources for exchange which may arise from a more beneficial employment of their industry.

"Lastly, we may notice the propriety of making inquiries or gathering information with respect to similar enterprises, as whether the natives have traditions of movements of their own, or of the arrival of strangers among them. All that can be gathered respecting Dr Cowan's expedition will be acceptable in the highest degree. The elucidation also of an isolated effort to struggle through the difficulties of African travelling should also be kept in view; it was made by a missionary of the name of Martin, who has not been heard of since he crossed the Colonial boundary in December 1831. He is consequently supposed to have perished in the Gariep, or to have been destroyed on its banks, though, as it was his intention to avoid the establishments of Europeans or their lines of communications, there is a lingering possibility of his still surviving.

" The articles fitted for carrying on commerce with the natives have three distinct objects :—First, by keeping up a constant appearance of traffic, to present in their eyes an appreciable motive for this visit to their territory. Second, to conciliate favour, or to procure provisions for the purpose of husbanding the resources of the expedition. And third, for the purpose of procuring any profitable articles to carry on to the other districts for the ends above mentioned, or to sell in the colony at the termination of the enterprise. In regard to these the Committee has to remark, that attention to the two first mentioned objects is indispensable, from its necessary connection with the safety and efficiency of the expedition, and that the third is to be contingent on the acquisitions of the party in regard to its main object of collecting information as to the country, and securing what illustrates its natural history and resources, and on the state of its means of transport. The Committee therefore recommend that this third object be attended to only in case that it be necessary to send waggons back for supplies, or in case that in the homeward progress of the party, there be room for such articles without incommoding it in its other operations.

(Signed " Thomas Wade, Chairman, J. Herschell, A. Oliphant, James Adamson, D. D., T. M'Lear, A. J. Cloete, C. F. von Ludwig, F. S. Watermeyer, John Centilivres Chase, Hon. Secretary."

June 23. 1834.

CAPE EXPEDITION TO EXPLORE AFRICA *

" *Report of the Committee of Management of the Cape of Good Hope Association for Exploring Central Africa.*

" The Committee has much pleasure in announcing to the subscribers the receipt of despatches from Dr A. Smith, dated the 23d September 1834, at Caledon River.

" From these documents it appears that the journey from Graaff Reinet to the frontier of the colony, was attended with much hinderance and trouble, owing to the severe drought which has long been experienced in that part of the country, and it is understood has extended very far beyond the colonial boundary.

" Upon the arrival of the exploratory party at Philipolis, a missionary station belonging to the London Society, and the assumed capital of the Griqua Chief Adam Kok, situated about twenty-five miles to the north of the Nu-Gariep or Black (Orange) River, Dr Smith, from the information he there obtained, decided upon taking an easterly route, as the only one at that period practicable, the drought preventing a safe access with ox waggons to the Bechuana town of Latakoo, on the Kuruman River, which it had been proposed to make the starting point of the expedition.

" Had, however, this difficulty not intervened, Dr Smith considers that it

* We are indebted to the Director-General Sir James MacGrigor for the above document in regard to Dr Smith's expedition.

is highly probable he should have decided to adopt his present intended route, inasmuch as it is extremely desirable that the district between the two principal branches of the Orange River should be investigated, not only from its contiguity to the colony, but from the promise it holds out of very considerable and interesting additions to our scientific knowledge.

"The party, therefore, thirty in number, were to cross the Caledon River on the day subsequent to the date of the despatches, for the purpose of tracing up, in the first place, the country situated between the Caledon and Stockenstrom Rivers to their respective sources, thence to explore the origin of the Mapoota River, which it is believed takes its rise eastwardly of the same highlands, and falls into De La Goa Bay; and having completed that survey, to stretch across the country westward to the Ky-Gariep or Yellow (Orange) River, following it down to its confluence with the Hart or Malalareen, somewhere about Lat. 28° 10′, Long. 24° 35′, and where they would arrive and communicate with the colony *via* Philipolis, in the month of December. At this point it was intended to ascertain from the Rev. Mr Moffatt, the intelligent missionary at Lattakoo, the state of the country northward, and the prospect of the expedition; to bring together the stores laid up in reserve at Philipolis, and there finally to arrange the route of the party for its northerly destination, which it was expected would then be open in consequence of the periodical fall of rains, which would render the country traversable by oxen.

"In the prosecution of the preparatory excursion eastward, Dr Smith anticipated much interest and gratification. By native testimony he was assured that the wide Caledon issued at once a perfect river, from an enormous spring, on the side of a high mountain, where it was nearly as large as at the place where he was then encamped; the probability of which singular circumstance may be credited from the fact, that the river at New Lattakoo, the Kuruman, gushes in the like manner from its rocky fount, a noble stream, and is at no part of its subsequent course of greater size. His route lay at first to Massus, King of the Basuta tribe of Bechuanas; thence to the once formidable but now subdued Mantatees; and after that to the kraal of a large but little known tribe, where twenty-five chiefs were reported to reside. He was in the immediate vicinity of the Agate Hills, which supply the Orange River with those well known and beautiful gems, and he had reason to believe that he would be able to investigate the porphyritic formations at its sources, of which so many and splendid specimens strew the course of that stream. There was also considerable prospect of a large supply of ivory obtainable in this route, as a return for the trading part of this expedition.

"The following memoranda of the acquirements of the expedition are attached to the despatch:—

"About 350 specimens of birds, quadrupeds, &c. have been preserved.

"Fifty drawings have been completed.

"The history of three Bechuana tribes, viz. Batlapee, Barralong, and Baclarou have been minutely investigated.

"A map of the route from Philipolis to the Caledon River has been constructed.

"The latitude and longitude of eleven stations have been ascertained (as per enclosure).

"The geological characters of the country between Graaff-Reinet and this station have been minutely investigated, and numerous specimens of rocks have been collected. The heights of many of the mountains and hills, both within and beyond the colony, amongst others the Compass Berg, have been taken."

(FROM A CORRESPONDENT.)*

"27*th December.*

"From letters addressed to Mr Chase, extracts of which he handed to us, we were enabled in last Saturday's paper to give an account of the unprovoked attack made by the Zulo chieftain Matsellikatz on a small Colonial party headed by that indefatigable and undaunted traveller, Mr A. G. Bain, of Graaf Reinet, between the rivers Seechecoolie and Meeritsaanie, in about Lat. 25° 30′ and Long. 26° 30′, who were out for the purpose of collecting wild animals for an American menagerie. We now insert, from the same source, extracts of a letter from Dr Smith, which give some account of the progress of the central expedition.

"Lat. 28° 30′, Long. 28° 30′.—*Nov.* 6. 1834.

"All goes on well, and every day supplies much of interest. The Bamtu and Backlogue are the two most powerful and interesting tribes which we have met with; all the individuals of both these hordes reside on the tops of mountains, part fortified by nature, and part by art, and are so secure in their retreats, that they have set at defiance both the forces of Dingaan and Masalacatzie. The latter, it is understood, has left the country towards Latakoo, and has taken up his position on the higher branches of the Vaal River, where he is plundering and murdering in every direction, and from various occurrences which have lately come to our notice, it would not be justifiable for us to approach him. We, therefore, intend to leave him to work his utter ruin, which, in all probability, is close at hand. He has, from fear of John Bloem and the Corannas, fled back to the country of Dingaan, who will now, having him within a moderate distance, eventually overthrow him.

"A party of Bastards were on a hunting expedition, about three weeks ago, along the banks of the Vaal River, and whilst occupied in cutting up some sea-cows which they had killed, were attacked by one of his commandoes without any provocation, and lost all their waggons, and two or three of their people. They shot a number of Caffres, and the chief of them informs me that had not part of his fled, they would have been able to have beaten them off. This act has excited the indignation of all the well-disposed people in this direction, and they are actively engaged in assembling a force to revenge it; if they manage matters well, they will certainly destroy him—if not, he will be more troublesome than ever.

"To-morrow morning we proceed with the view of advancing a little farther to the eastward, in order to get some idea of the character of the country to-

* From a Cape of Good Hope newspaper, sent to us by Sir James MacGrigor.

wards the sources of the Vaal River, and to examine the high mountain range which extends to N.E., distant about twenty miles from us, after which I intend turning back, and travelling along the high ground, which extends nearly east and west, between the Caledon and Vaal Rivers, towards Philippolis, where I expect we will arrive about the end of December. The Caledon River extends much farther to the eastward than would be inferred from any of our maps, and rises out of the same mountains with the Black River, or the Stockenstrom River of the maps. We are at present within a short distance of its sources, but despair of being able to visit them, as the mountains are so high and rugged. A few days, however, will decide the point.

"N.B.—Some time ago I happened to get hold of some Graham's Town papers, and was astonished to see such a statement about the Compass Berg. The figures are all wrong, and the remark about the want of a detached thermometer is incorrect."

Castle Toward, west coast of Scotland, Daily Meteorological Register, from 1*st October to* 31*st December* 1834.

Date.	9 o'clock A. M.			6 o'clock P. M.			OBSERVATIONS.
	Bar.	Ther.	Wind.	Bar.	Ther.	Wind.	RAIN FALLEN IN OCTOBER, 5 Inches 5 Hundreds.
Oct. 1	30.21	55	S.	30.12	54½	S.	Most beautiful day.
2	30.2	56	SE.	30.2	57	S.	Beautiful day, blowy P. M.
3	30.21	54	NW.	30.20	53	S.	Most beautiful day.
4	30.11	57½	S.	30.5	58	S.	Blowy and cloudy, rain in the evening.
5	30.20	55	NW.	30.25	51	NW.	Cloudy A. M., beautiful P. M.
6	30.22	52	E.	30.11	55	SW.	Stormy and showery.
7	30.2	56¼	SW.	29.90	58¼	WSW.	Cloudy morning, very wet rough day.
8	29.84	58	SW.	29.80	56	SW.	Very wet and rough.
9	29.79	54½	SW.	29.75	48½	NW.	Gloomy, showery A. M., fine till 5 P. M., showery even.
10	29.95	50	SW.	30.7	48	NW.	Stormy, showers of rain and hail.
11	30.10	50	S.	30.12	52	S.	Beautiful day, gloomy afternoon.
12	30.	53½	S.	29.90	55	SW.	Stormy, with heavy showers.
13	29.89	58½	SW.	29.70	57	S.	Gloomy A. M., very wet P. M.
14	29.76	49	N.	29.76	48½	SW.	Showery.
15	29.62	49½	S.	29.75	45½	N.	Very wet A. M., fine P. M.
16	29.22	54	SW.	28.92	51	W.	Very stormy, with heavy showers.
17	29.33	45	NW.	29.43	44½	NW.	Stormy and wet.
18	29.59	43	NW.	29.90	45	NW.	Showery A. M., windy P. M.
19	29.80	46	S.	29.51	53	S.	Frosty morning, blowy showery day.
20	29.50	53	W.	29.62	48	E.	Very stormy and showery.
21	30.27	41½	N.	30.11	46	NW.	Rough and showery A. M., very blowy P. M.
22	29.78	50	WNW.	29.73	47½	NW.	Beautiful day, frost A. M.
23	29.58	47	N.	30.11	46	N.	Beautiful day, frost A. M.
24	30.15	37	N.	30.20	38	N.	Beautiful A. M., cloudy, few drops of rain P. M.
25	30.33	41	N.	30.40	41	N.	Beautiful day, cloudy blowy evening.
26	30.50	48½	N.	30.52	48	NW.	Most beautiful day.
27	30.54	53	NW.	30.54	52	NW.	Cloudy, rain in the evening.
28	30.60	47	NW.	30.67	46½	S.	Most beautiful day.
29	30.69	47½	NW.	30.59	48½	SW.	Cloudy rain in the evening.
30	30.22	50½	SW.	30.10	52½	W.	Very blowy and wet.
31	29.92	52	SW.	29.90	47½	W.	Very stormy and wet.

Date.	9 o'clock A. M.			6 o'clock P. M.			Observations.
	Bar.	Ther.	Wind.	Bar.	Ther.	Wind.	Rain fallen in November, 4 Inches 80 Hundr. Do. December, 3 do. 90 do.
Nov. 1	29.91	52	W.	29.90	53	W.	Stormy and showery.
2	29.81	51½	W.	29.90	47	W.	Very stormy and wet A. M., calm but wet P. M.
3	29.91	45	E.	29.69	52½	S.	Very gloomy, slight rain A. M., very stormy evening.
4	29.70	49	S.	29.49	53	S.	Showery and stormy A. M., very stormy and wet P. M.
5	29.15	47	SW.	29.5	45¼	SW.	Very blowy and showery.
6	29.38	43½	NW.	29.68	43¼	NW.	Very stormy and showery A. M., beautiful P. M.
7	29.55	41	NE.	29.9	43½	E.	Very, very stormy and very wet.
8	29.10	46½	N.	29.43	42	N.	Fine day.
9	29.81	41	N.	30.2	39½	N.	Beautiful day, slight frost A. M
10	30.25	39	N.	30.32	38½	N.	Beautiful day, hard frost.
11	30.44	39	NE.	30.45	40¼	E.	Fine but gloomy, frost A. M.
12	30.48	42	E.	30.47	41½	SE.	Fine day.
13	30.40	43	W.	30.53	41½	NW.	Showery A. M., beautiful P. M.
14	30.62	43	NW.	30.60	46	NW.	Frosty A. M., cloudy and wet P. M.
15	30.54	48	NW.	30.54	47	NW.	Fine but cloudy.
16	30.45	50	W.	30.40	49	W.	Fine A. M., showery P. M.
17	30.19	49½	W.	30.18	48	N.	Showery A. M., fine P. M.
18	30.27	49½	W.	30.25	49	N.	Very showery A. M., beautiful P. M.
19	30.33	49½	E.	30.25	49	N.	Cloudy and misty.
20	30.32	47½	SE.	30.22	46	E.	Very fine day.
21	30.1	44	E.	30.	43	E.	Showery A. M., fine P. M.
22	30.3	41½	E.	30.10	40	N.	Most beautiful day.
23	30.29	38½	N.	30.30	37½	N.	Most beautifnl day, hard frost.
24	30.28	38½	N.	30.20	41½	N.	Very misty.
25	30.1	41¼	SE.	29.90	42	SE.	Very gloomy, slight rain in the evening.
26	29.81	47	SW.	29.80	49½	SW.	Blowy and showery.
27	29.80	49½	SW.	29.70	49	SW.	Very showery, smart breeze.
28	29.39	49	S.	29.10	47	SW.	Very rough and wet A. M., blowy P. M.
29	28.82	45½	SW.	29.	48	W.	Very rough and wet.
30	29.60	42	N.	29.68	42	N.	Beautiful day, gloomy evening.
Dec. 1	28.81	46	W.	28.92	46	W.	Very rough and wet A. M., showery and windy P. M.
2	29.52	47	NW.	29.81	47	NW.	Blowy A. M., fine but gloomy P. M.
3	29.99	50	W.	30.1	50	S.	Showery day.
4	29.98	50	S.	29.91	50½	S.	Blowy and showery.
5	29.95	51½	SE.	29.91	53	SE.	Blowy and cloudy.
6	29.92	52½	SE.	29.82	53½	S.	Rough and gloomy A. M., very rough P. M.
7	29.87	45½	E.	29.53	50	S.	Rough and showery A. M., very rough P. M.
8	29.99	42	NW.	30.34	45	NW.	Very stormy, heavy showers of rain and hail.
9	30.40	47	SW.	30.20	46	S.	Stormy and cloudy.
10	30.40	41½	S.	30.40	41½	SW.	Fine day, slight showers A. M,
11	30.59	42	S.	30.56	43½	N.	Very fine day, slight frost A. M.
12	30.60	43	W.	30.59	44	N.	Most beautiful day.
13	30.60	42	N.	30.61	41½	N.	Very gloomy and misty, frost A. M.
14	30.78	46½	.	30.79	46	E.	Cloudy, few drops of rain.
15	30.83	45½	NE.	30.83	44	NE.	Very fine day.
16	30.77	48	NW.	30.63	47	NW.	Very fine day, blowy P. M.
17	30.72	44	NW.	30.58	40	N.	Most beautiful day.
18	30.62	34	NW.	30.68	37	N.	Most beautiful day, hard frost.
19	30.63	38	W.	30.60	35½	N.	Cloudy, with hard frost A. M., beautiful P. M.
20	30.50	42	W.	30.43	44	W.	Cloudy, slight showers all day.
21	30.39	47	W.	30.50	40	NW.	Showery day.
22	30.62	38	NW.	30.62	41	NW.	Showery, frost A. M.
23	30.63	39½	NW.	30.61	42	NW.	Fine, with frost A. M., showery P. M.
24	30.49	47	W.	30.47	46	W.	Showery day.
25	30.52	47	N.	30.60	44	N.	Most beautiful day.
26	30.68	42½	N.	30.68	43½	N.	Very fine day.
27	30.61	41	SE.	30.50	41	SE.	Very fine day, smart breeze.
28	30.34	40	SE.	30.22	42	SE.	Fine A. M., gloomy P. M.
29	30.	45	S.	29.81	45	SE.	Stormy, with heavy showers A. M., fair P. M.
30	29.61	51	S.	29.49	57	S.	Very wet and rough.
31	29.42	53	S.	29.71	40	E.	Stormy wet morning, showery day.

Meteorological Table, extracted from the Register kept at Kinfauns Castle, on the east side of Scotland, Lat. 56° 23′ 30″. *Above the level of the sea* 150 *feet.* By the Right Hon. Lord GRAY.

1834.	Morning, ½ past 9. *Mean height of*		Evening, ½ past 8. *Mean height of*		Mean Temperature by Six's Therm.	Depth of Rain in Garden.	Number of days.	
	Barom.	Therm.	Barom.	Therm.			Rain or Snow.	Fair.
January, ...	29.286	43.032	29.315	40.677	41.000	4.30	21	10
February, .	29.751	41.000	29.721	39.750	40.357	1.50	15	13
March, ...	29.844	43.387	29.858	41.677	43.064	1.40	11	20
April, ...	30.051	47.833	30.044	43.767	46.000	.90	6	24
May, ...	29.799	55.290	29.793	50.032	52.581	1.25	14	17
June, ...	29.675	58.033	29.676	55.300	57.000	2.25	13	17
July, ...	29.792	62.387	29.790	58.258	60.548	1.65	13	18
August, ...	29.622	60.129	29.614	56.613	58.161	1.55	17	14
September,	29.813	55.200	29.807	51.633	54.067	3.25	15	15
October, ...	29.668	48.097	29.660	47.258	48.226	1.60	14	17
November,	29.663	41.900	29.646	41.200	42.100	2.70	13	17
December,	29.971	39.548	29.958	39.774	39.935	.75	7	24
Average of the year,	29.744	49.653	29.740	47.162	48.587	23.10	159	206

ANNUAL RESULTS.

MORNING.

BAROMETER.

Observations. *Wind.*

Highest, 15th Dec. NW. 30.55

Lowest, 1st Dec. ... SW. 28.50

THERMOMETER.

Wind.

31st July, ... SE. .... 70°

28th December, ... W. .... 23°

EVENING.

Highest, 14th Dec. NW. 30.53

Lowest, 1st Dec. ... SW. 28.62

31st July, ... E. .... 66°

27th December, ... W. .... 26°

Weather.	*Days.*
Fair, ...	206
Rain or snow, ...	159
	365

Wind.	*Times.*
N. and NE.	29
E. and SE.	87
S. and SW.	138
W. and NW.	111
	365

Extreme Cold and Heat by Six's Thermometer.

Coldest, 28th December, ... Wind W. .... 22°

Hottest, 30th July, ... do. SE. .... 78°

Mean temperature for the year 1834, ... 48° 587

Results of Two Rain Gauges.

In. 100.

1. Centre of Kinfauns Garden, about 20 feet above the level of the sea, ... 23.10
2. Square Tower, Kinfauns Castle, 180 feet, ... 23.25

Abstract of Register of the Barometer, Thermometer, and Rain Gauge, kept at Edinburgh in 1834. By Alexander Adie, Esq.

Months.	Mean of Therm.		Mean of Register Therm.		Mean height of Barometer.		Total of Rain.
	Morn.	Even.	Min.	Max.	Morn.	Even.	
January,	42.42	40.71	36.77	46.06	29.307	29.399	3.28
February,	41.04	39.	35.12	45.88	29.781	29.746	.86
March,	45.29	41.29	36.90	48.87	29.856	29.881	1.65
April,	47.63	43.33	38.73	51.37	30.046	30.030	.44
May,	56.68	50.10	44.26	60.26	29.816	29.832	.51
June,	60.97	55.37	48.93	64.83	29.718	29.721	1.39
July,	62.39	57.90	53.19	65.32	29.829	29.833	3.20
August,	62.	56.26	51.19	65.55	29.665	29.684	1.18
September,	57.57	52.63	48.03	60.	29.867	29.871	4.50
October,	50.97	48.35	43.35	54.35	29.750	29.722	1.23
November,	44.80	42.67	38.77	47.60	29.707	29.668	1.22
December,	43.45	42.39	37.90	46.55	30.015	30.034	1.52
Annual mean,	51.262	47.436	42.832	54.829	29.727	29.891	20.98
Annual mean of morn. and even.	49.399		48.844		29.809		

The observations from which this abstract is taken, were made behind the Regent Terrace, on the south-east slope of the Calton Hill. The height of the instruments is 246 feet above the medium level of the sea. The morning and evening observations were made about 10 A. M. and 10 P. M.

SCIENTIFIC INTELLIGENCE.

METEOROLOGY.

1. *Influence of the Moon on the Weather. By F. Marcet.*—On the question whether the moon has any influence on the weather or not, there are two opposite opinions; the great mass of the people, including sailors, boatmen, and most practical farmers, entertain no doubt whatever of the influence of the moon; whether the change of the weather at the lunar phases will be from fair to foul, or from foul to fair, none of them pretend to decide beforehand, but most of them think, that at the new and full moon, there is generally a change of some kind. On the other hand, philosophers, astronomers, and the learned in general, attribute this opinion altogether to popular prejudice. Finding no reason, in the nature of atmospheric tides, for believing that changes should take place on one day of the lunation

rather than another, they consider the popular opinion to be unsupported by any extended series of correct observation. In the Annuaire for 1833, Arago, the learned editor, has presented the result of the observations of Schubler, in Germany, during twenty-eight years, or 348 synodic revolutions of the moon. During this period of 348 new moons, &c. the number of rainy days were as follows:—

It rained on the day of the new moon,			148 times.
Do.	do.	first quarter,	156 ...
Do.	do.	full moon,	162 ...
Do.	do.	last quarter,	130 ...

The observations of Schubler were made during eight years at Munich, four years at Stuttgard, and sixteen years at Augsburg. As a good meteorological register has been long kept at Geneva, the author thought it would be interesting to ascertain from the tables, (which have been carefully published in the Bibliotheque of that city), whether, during a period of thirty-four years, viz. from 1800 to 1833, any inferences could be drawn for or against the popular opinion on the subject of lunar influence. He finds, during these thirty-four years, the number of rainy days, and the quantity of water fallen, to be as follows:—

	Rainy days.	Water fallen.
At the new moon,	123	432 lines.
First quarter,	122	429.6 ...
Full moon,	132	415.7 ...
Last quarter,	128	368.6 ...
Throughout the whole period,	3,657	968 in. 93 lines.

Thus it appears, that during thirty-four years, or 12,419 days, comprehending 420 synodic revolutions of the moon, there have been 3657 rainy days. This gives for every 100 days 29.45 rainy days; and we find, that

For every 100	days of	new moon,	29.29	have been	rainy.
Do.	do.	first quarter,	29.05	do.	do.
Do.	do.	full moon,	31.43	do.	do.
Do.	do.	last quarter,	30.48	do.	do.

Hence, it is evident that, during these thirty-four years at Geneva, the days of new moon and the days of the first quarter have been just about as liable to be rainy days as any other common day of the month, while the days of full moon and those of the last quarter, have been rather more liable. But although the days of full moon have been rather more frequently wet days than those of new moon, it does not follow that more water has fallen at full moon than at the change. The result of observation in that respect is as follows:

For every	100 days of	new moon,	there fell	102.9	lines.
Do.	do.	first quarter,	do.	102.3	...
Do.	do.	full moon,	do.	90.0	...
Do.	do.	last quarter,	do.	87.9	...

The average quantity for every 100 days is 93.6 lines, whence it appears, that at the new moon, the first quarter, and the full moon, more water has fallen than on common days; at the last quarter less. The quantity fallen on the total of the lunar phases, surpasses that on other days in the proportion of 98 to 93.6. Another question is, whether a *change of weather* is more liable to happen on the four principal days of the lunar phases than on common days. But it must be decided what is meant by the term change of weather. This term should, the author thinks, be limited to a change from clear weather to rain, or from rain to clear weather, and not be understood to include, as some meteorologists make it, all changes, such as that from calm to windy, or from clear to cloudy, &c. As the author accepts it, the weather must have been steady during two days at least; that is, that the weather has been clear, or that it has rained more or less during two consecutive days. For example, a week has passed without rain; it rains on the eighth day, and on the ninth the weather is again fine. In this case, according to the author's definition, there is no change of weather. So also, if it has rained during five successive days, the sixth and seventh must be clear in order to constitute a change of weather. This may be arbitrary, but at least it is not vague, and, if practised, it will prevent, in the balancing of calculations, any leaning to a favourite hypothesis. To avoid another error, into which some have fallen, the author marks no change as occurring on lunar phases, but those which take place on the very day, and never those which may happen on the evening before or on the next day. With these precautions, he finds that, during the thirty-four years or 12,419 days, there have been 1458 changes of weather. Of this number, 105 have taken place at the epoch of the two principal lunar phases, viz. 54 at the new moon, and 51 at the full moon. Now the whole number of principal phases during the thirty-four years is 840; therefore, as 12419 : 840 : : 1458 : 98.6, the number of changes which would have taken place at new and full moon, had these lunar phases had no more than the share of common days, but instead of which, the number was 105. Of the 54 changes at new moon, 32 were from rain to fine weather, and 22 from fine weather to rain. Of the 51 at full moon 31 were from rain to clear, and 20 from clear to rain. Thus, at the new and full moon, the changes to fine weather are to those to rain as 63 to 42. Having thus proved that the epoch of new and full moon are not absolutely without some effect on the weather, the author examined whether this effect was confined to those very days, or extended to the day following. On the days following the new and full moon, there were 129 changes, instead of 98.6, which would have been the number had these shared the proportion only of common days. With respect to the days of the first and last quarter, the changes on these were 96, which bring them nearly to the condition of common days. It is thus shewn from the tables, that the chance of a change at new and full moon, compared with the chance on ordinary days, is as 125 to 117, and that the chance on the day following these two phases, compared with the common days is as 154 to 117. Upon the whole, therefore, this examination lends some support to the vulgar opinion of the influence of new and full moon, but none whatever to any special influence of the first and third quarters. With respect to the *barometrical pressure*, it is ascertained that out of the 1458 changes of weather, there were in 1073 cases a corresponding rise or fall of the barometer, according as the change was from rain to fair, or the contrary. This is nearly as 3 to 4. Of the 385 false indications of the barometer, 182 were on a change from rain to clear, and 203 on a change from clear to rain. Finally, of the 385 anomalies of the barometer, 17 were at full moon, and 10 only at new moon.

2. *Snow Blindness.*—When the division of Cordova marched from Cuzco to Puno, it halted at Santa Rosa. During the night there was a heavy fall of snow. They continued their march the next morning. The effects of the rays of the sun, reflected from the snow upon the eyes, produces a disease which the Peruvians call *norumpi*. It occasions blindness, accompanied by excruciating tortures. A pimple forms on the eye-ball, and

causes an itching pricking pain, as though needles were continually piercing it. The temporary loss of sight is occasioned by the impossibility of opening the eyelids for a single moment, the smallest ray of light being absolutely insupportable. The only relief is a poultice of snow, but as that melts away, the intolerable tortures return. With the exception of twenty men and the guides, who knew how to guard against the calamity, the whole division were struck blind with the *norumpi*, three leagues distant from the nearest human habitation. The guides galloped on to a village in advance, and brought a hundred Indians to assist in leading the men. Many of the sufferers, maddened by pain, had strayed away from the column, and perished before the return of the guides, who, together with the Indians, took charge of long files of the poor sightless soldiers, clinging to each other with agonized and desperate grasp. During their dreary march, by a rugged mountain path, several fell down precipices, and were never heard of more. Miller himself suffered only fifteen hours from the *norumpi*, but the complaint usually continues two days. Out of 3000 men, Cordova lost above 100. The regiment most affected was the *Voltigeros* (formerly the Numancia), which had marched from Caraccas, a distance of upwards of 2000 leagues.—*Mem. of General Miller.*

GEOLOGY.

3. *Discovery of Saurian Bones in the Magnesian Conglomerate near Bristol.*—Although some of the earliest noticed Saurian remains were the fossil Monitors of Thuringia, discovered in the Continental equivalents of our magnesian limestone, —characterized by the same testacea and fishes which occur in corresponding formations in the North of England,—it does not appear that Saurian remains have been until now detected in this geological site in our own series. Recently, however, a quarry of the magnesian conglomerate, resting on the highly inclined strata of carboniferous limestone, at Durdham Down, near Brisstol, has afforded some Saurian vertebræ, ribs, femora, and phalanges, together with claws, the latter of considerable proportional size: a coracoid bone has also been found, approaching very nearly to that of the Megalosaurus. The general character of the bones seems intermediate between those of this genus and the

crocodile. Dr Riley, who submitted the specimens hitherto discovered to the Literary and Philosophical Society of the Bristol Institution, is understood to be preparing a detailed account of this interesting discovery for the Geological Society. The only Saurian remain hitherto found in this island in a site approaching to this, was a fragment of a lower jaw apparently of a gavial discovered in the lower beds of the new red sandstone at Guy's Cliff, Warwickshire. This fact is noticed in Parkinson's small work on Organic Remains.—*London and Edin. Phil. Journ.*

4. *Analysis of the Fossil Tree seen at present imbedded in the Sandstone at Craigleith Quarry, by Mr Robert Walker.*—Exposed to heat in a tube, it gives off bituminous matter and water. Dissolves with considerable effervescence in diluted muriatic acid, carbonaceous matter being at the same time deposited. Its constituents are, carbonate of lime, 50.36; carbonate of iron, 24.65; carbonate of magnesia, 17.71; coal, with silica and water 6.15; = 98 87.

5. *On the Origin of the Erratic Blocks of the North of Germany.*—The following conclusions are given as the result of Klöden's investigations on this subject; they form the concluding paragraph in his interesting work, entitled, "*The Petrifactions of Brandenburg, and especially those which occur in the rolled Stones and Blocks of the South Baltic Plain.*" 1. A part of the erratic blocks of the plain of North Germany, and indeed, by much the larger portion, have a great analogy to the rocks of the north of Europe, and those rolled masses which contain petrifactions, also agree in their organic remains with northern rocks; and indeed, there are even rocks and petrifactions among them which are peculiar to the Scandinavian peninsula. On the other hand, many of the rocks and petrifactions which are characteristic of the north, have not been found among the rolled masses, and those petrifactions which are extremely abundant in Norway and Sweden, are replaced by others in the erratic blocks. 2. Another part of the rocks containing petrifactions, which occur as blocks, agree in external characters with the rocks of the north, but contain petrifactions which have not yet been found in Scandinavia. Many of these petrifactions are amongst the most abundant which occur in the blocks. 3. A third class belong to rocks which are entirely awanting in the north, and

the petrifactions which some of them contain are never met with in Norway or Sweden. 4. The first only of those divisions of rocks can, with probability, have a northern origin assigned them; in regard to the second it is more doubtful; but we cannot admit such a view in regard to the third class, and that which is the richest in petrifactions. 5. The last cannot with probability be asserted to have been derived from the mountains which bound the South Baltic Plain. 6. Nor can they have come from mountain masses destroyed in their original situation. 7. They cannot be supposed to have at an earlier period existed in the north, unless we assume what is very improbable. Thus it appears that the result of my labours in regard to answering the question of the native country of the erratic blocks is almost a negative one. It is doubtful if a more intimate acquaintance with these masses will lead more speedily to the answer to this question than a fortunate hypothesis. It is certain, however, that complete investigations on the nature of erratic blocks will afford a secure basis for inquiries as to their origin, and it is therefore to be wished that we should receive numerous and accurate contributions to our knowledge of the blocks of all parts of the South Baltic Plain. So much, however, is decidedly proved by my labours, that the great geognostical phenomenon of the erratic blocks in the South Baltic Plain, cannot be explained by one simple event, and that much more complicated causes and forces must have co-operated than has hitherto been believed. It is equally evident that we stand at a greater distance from the solution of the problem than we imagined; that apparently the key to the great riddle is not yet found, and that the question seems now less satisfactorily determined than ever.

6. *Wollaston Medal.*—The Wollaston Gold Medal has been awarded by the Geological Society to Dr Mantell of Brighton, for his many important discoveries in Fossil Comparative Anatomy, particularly of the genera *Iguanodon* and *Hylæsaurus.*

7. *Royal Medal for Geology and Mineralogy.*—At a meeting of the Council of the Royal Society of London, held last December, the following report from the Committee appointed to consider the award of the royal medal in Geology and Mineralogy, for the current year, was read.

"The committee appointed to consider and report upon the most proper award of the royal medal for Geology and Mineralogy, recommended that the said medal be given to CHARLES LYELL, Esq., author of a work entitled '*Principles of Geology.*'

"The Committee, declining to express any opinion on the controverted positions contained in that work, beg to state the following as the grounds of their recommendation.

"1. The comprehensive view which the author has taken of his subject, and the philosophical spirit and dignity with which he has treated it.

"2. The important service he has rendered to science, by specially directing the attention of geologists to effects produced by existing causes.

"3. His admirable descriptions of many tertiary deposits; several of these descriptions being drawn from original observations.

"4. The new mode of investigating tertiary deposits, which his labours have greatly contributed to introduce, viz. that of determining the relative proportions of extinct and still existing species of fossils, with a view to discover the relative ages of distant and unconnected tertiary deposits.

"Resolved—That this report be received, and adopted as the opinion of the Council; and that the royal medal for Geology and Mineralogy be accordingly awarded to Charles Lyell, Esq. for his work entitled '*Principles of Geology.*'

"Resolved—That the royal medal for Geology and Mineralogy, for the year 1837, be given to the author of the best paper, to be entitled, 'Contributions towards a System of Geological Chronology, founded on an Examination of Fossil Remains, and their attendant Phenomena,' and to be communicated to the Royal Society after the present date, prior to the month of June in that year."

MINERALOGY.

7. *Diamonds at Algiers.*—The Sardinian consul at Algiers, M. Peluzo, lately purchased from a native three diamonds, which were found in the auriferous sand of the river Gumel, in the province of Constantine. One of them was purchased by M

Dufresnoy, the other two by M. Brogniart, for the museum and collection of M. de Dreé.

8. *Allanite of Greenland.*—This rare mineral occurs imbedded in the granite of Greenland, where it was discovered by the late Sir Charles Giesecké. Mr Allan conjectured it might be a variety of gadolinite, but Dr Thomson of Glasgow, who was furnished with specimens for examination by Mr Allan, determined that, chemically considered, it must be owned as a new species, which he named Allanite, in honour of Mr Allan. Thomson found it to contain, of silica 35.1, oxide of cerium 33.9, black oxide of iron 25.1, lime 9.2, alumina 4.1, volatile substances 4.0, = 112.0. The imperfection of this analysis, shewn by the excess of the constituent parts, rendered a repetition of it desirable. Fortunately the Allanite has been again analyzed by the celebrated Stromeyer, who gives the following as the result of his analysis: Silica 33.021, alumina 15.226, protoxide of cerium 21.600, protoxide of iron 15.101, protoxide of manganese 0.404, lime 11.080, and water 3.000; = 99.432. It follows from this analysis, that the Allanite, although in composition nearly allied to the orthite of Berzelius, differs from it in not containing yttria. It is still uncertain if the Cerin of Haidinger is the same mineral as Allanite; and it is equally doubtful if the mineral from the Mysore, analyzed by Wollaston, belongs to the Allanite species.

9. *Needle Ore.*—This was first analyzed by John, who proved that it was not, as had been previously supposed, an ore of chrome, but a combination chiefly of bismuth, lead, copper, and sulphur, in which the proportions were as follows: Bismuth 43.20, lead 24.32, copper 12.10, *nickel* 1.58, *tellurium* 1.32, sulphur 11.58, loss 5.90; = 100.00. In a late analysis of this ore by Hermann Frick, in Poggendorf's Annalen for 1834, the nickel and tellurium (which, by the by, John had placed as conjectural substances) were not found. After repeated analyses, he gives the following as the composition of this ore: Sulphur 16.61, bismuth 36.45, lead 36.05, copper 10.59; = 99.70. The formula of composition,

$$C\dot{o}p\dot{B}i+2\dot{P}b\dot{B}i.$$

10. *Platina and Gold of the Uralian Mountains.*—It would appear, from some late investigations, that the platina occurs in

disseminated grains and also in masses several pounds weight, in serpentine, in which it is associated with chromate of iron. Part of the gold of that region occurs in quartz veins, along with auriferous iron-pyrites, and grains of gold have also been detected in the serpentine. The chlorite slate of the Urals probably also contains platina.

11. *Hydroboracite, a new mineral.*—Colour white, radiated and foliated, and soft like gypsum. Specific gravity = 1.9. It is readily distinguished from such minerals as it might be confounded with, by its easy fusibility before the blow-pipe. According to H. Hess, it contains the following ingredients: Lime 13.298, magnesia 10.430, water 26.330, boracic acid 49.922; = 100.00.

12. *Idocrase in the Island of Skye. Discovered by G. B. Greenough, Esq.*—This mineral was found at the junction of a trap dike with the calcareous rock it traverses. Its locality is about a mile and a half south of Broadford, on the way to Kilbride. The dike averages about four yards in width. Mr Greenough could not determine its extent, from the heather, &c. which covers the surface.

13. *Chiastolite.*—According to Dr G. Landgrebe of Marbourg, as stated in Schweigger-Seidel's Journal, H. 5. 1830, this mineral contains, silica 68.497, alumina 30.109, magnesia 1.125, water and carbon 0.269; = 100.00. The remarkable structure of this mineral is well known; we may add, from Weiss, that many salts, as muriate of soda for example, when dissolved in fatty substances, as butter, and again crystallized from them, exhibit in their crystals the same structure as observed in chiastolite.

14. *Antimonial Nickel.*—Our latest discovery from the ever inexhaustible Andreasberg is a very interesting mineral, a combination of nickel and antimony, resembling at first sight copper-nickel; but, having attracted the attention of a pupil of mine, Mr Charles Volkmar of Brunswick, Stromeyer and self followed up the examination. The ore is found in minute thin hexagonal plates, which seem to be regular, and in interspersed particles, on galena and speiscobalt. Fracture uneven, passing into small conchoidal. The terminal planes are of a high metallic lustre, the planes of fracture shining. The colour is a light cop-

per-red, with a strong inclination to violet. This bluish exterior resembles certain variegated colours, but the character is the same in its fresh fracture. The powder is reddish-brown. The ore is brittle. Its hardness rather that of copper-nickel, being scratched by felspar, but scratches fluor. The specific gravity cannot as yet be ascertained, on account of the smallness of the specimens. Stromeyer's analysis is, nickel 31.207, antimony 68.793; = 100. We gave it the name of Antimonial Nickel (Antimon. Nickel).—*Hausman.*

15. *Carbonate of Strontites discovered in the United States.*—This comparatively rare mineral has been discovered at Scoharri, New York, in the vicinity of Ballcave, which has already furnished so many fine minerals.—*Silliman's Journal for October last.*

ZOOLOGY.

16. *The three Races of the Human Species, as connected with different Languages.*—Prichard has compared the distribution of languages with that of the races of the human species, and has shown the contradictions which occur in regard to the origins of languages, by assuming the existence of three distinct races; since by applying the principle of physical characters to the consideration of the races, nations are united with one another, which, in respect to their languages, belong to entirely distinct classes. He instances that in the Mongolian race, the two great tribes which compose it, the Chinese and the Mongolians, are unnaturally united, since their languages proceed from entirely opposite principles. The language of the Mongolians is polysyllabical, and has declensions and conjugations; while the language of the Chinese contains only words of one syllable, which, without declension and conjugation, come into different relations to one another by difference of accent and position. The religion of Fo, which is common to both nations, cannot be adduced as an argument, as it was adopted by the Mongolians at a later period. The American Indians, who, in respect to their features, seem to resemble the Mongolians, have, on the contrary, an entirely excluding peculiarity in their languages, in so far as that the American languages, however different they may be from one another, possess, nevertheless, a number of polysylla-

bical words, the forms of which are almost infinite. We can at once perceive that these objections of Prichard's cannot affect the principle of the division of the human race upon physical principles, but that they are merely directed against certain attempts to carry out this principle. Further, although the nations of the Caucasian race are for the most part completely connected by their language, while the Fins and Hungarians, which were considered by Cuvier as belonging to this race, must, according to Prichard, be separated from it on account of the peculiarities of the roots of their languages,—peculiarities which are common to themselves alone; and although, likewise, the Tartars and Turks, who are also referred to this race, on account of the relation of their language to that of the Jacutes, have also a resemblance to the tribes of the Mongolian race, still this is not a good argument against the existence of races, but it is only at most a difficulty in the consideration of the Caucasian race, and an objection against a peculiar mode of classification. Still more groundless are Prichard's objections to the Negro race, whose languages are so various; and it can hardly be regarded as a serious remark, when he says that all the separate Negro tribes, viz. the woolly-haired inhabitants of the mountains of New Guinea, and the Papuas of the Eastern Ocean, have acquired their characters from the climate of these regions, for it is known that physically distinct races preserve their physical characters in the same climate. The actual existence of races is proved by the indestructible distinctions of the Negro and all other races. The difficulty lies only in the classification of the races besides the Negro one,—a difficulty which will probably never be solved, and owing to which we must limit ourselves to an uncertain determination of the boundaries, by the united assistance of the physical and moral characters, and of languages and history. The conclusion of Prichard, that originally there was only one stem of the human race, is, it is true, not contradicted by the belief that, under the present relations of climate, there exist various constant races of the human species; but such a conclusion is not rendered more probable than it formerly was, by the interesting observations of Prichard on languages and nations.—*Professor Müller of Berlin.*

17. *Descriptive Catalogue of the Preparations in the Anato-*

mical Department of the Museum of the Royal College of Surgeons in Ireland.—In Dr Houston's excellent catalogue there are numerous interesting details regarding the anatomical and physiological relations of animals well deserving the attention of naturalists. Of the different portions of the collection, as remarked in the Dublin Medical Journal, that devoted to the anatomy of the circulating system seems most complete, consisting of nearly 300 specimens. We shall make our extracts from this portion of the Catalogue. Here we meet with one of those wonderful contrivances—those adaptations of means to end—with which comparative anatomy abounds; and as this subject seems to have been a favourite with our author, we shall follow him out in his researches. The existence of a double heart, warm blood, and an active inervation, implies a corresponding respiration, which cannot be interrupted for any length of time without producing death by asphyxia. But we find among the vertebrated and warm-blooded animals a class in which the temporary suspension of respiration is a necessary result of their mode of life, as we see to occur in the whole tribe of warm-blooded diving animals. Thus, the whale, the seal, the porpoise, the otter, and also diving birds present examples of this. Here, so long as the animal remains under water, the mechanical, chemical, and vital acts of respiration are suspended, and were it not prevented by some special provision, the accumulation of blood in the venous system must be injurious. In order, however, to obviate such accidents, a beautiful provision is adopted, consisting, first in the existence, of what may be called a supplementary or additional venous apparatus; second, in the increase of volume of certain of the internal trunks; and, thirdly, in the formation of vast reservoirs communicating with the venous system, and which receive the blood during the stoppage of respiration. The discovery of this curious apparatus is not new to comparative anatomists; but our author has the credit of first demonstrating its existence in many animals, and also in shewing that the amount or extent of the apparatus was proportioned to the length of time the animal usually remains under water. We shall insert some of his descriptions:—" B. c. 379. A dried injection of the heart and bloodvessels of a seal *(Phoca vitulina)*, the arteries red, the veins yellow. There is nothing very remarkable in the distribution of the arteries: their size is, however, somewhat diminutive. The whole venous system presents a most striking exhibition. The vena cava abdominalis is of a very inordinate size: the venæ hepaticæ, which joins the former near the right auricle of the heart, are dilated into vast reservoirs for the blood: the veins in the spinal canal, extending its whole length, and two in number, were of such a size when injected, that, in order for the exhibition of one, the other was obliged to be removed: on the back part of the neck there is a mass of huge vessels coiled and twisted together in a very unique manner. J. H."—" B. c. 381. The bloodvessels, gall-bladder, and ducts of the liver of a seal injected and dried. In this preparation, the great disproportion between the venæ hepaticæ and the other vessels of the liver is well shewn. The hepatic artery, filled with red wax, is very small, and divides into two at the place of its junction with the liver: the vena porta, injected green, bears the usual proportion in size to the artery; the venæ hepaticæ, to be known by the yellow wax, appears as a great bag, with three projections from it, representing the offsets from the bag which passed into the lobes of the organ. The gall-bladder and its ducts are small."—" B. c. 383. The heart and principal bloodvessels of an otter *(Lutra vulgaris)*, injected and removed from the body. The preparation shews a dilatation in the hepatic veins like that in the same vessels of the seal, though not to such an amount. The venæ cavæ and innominatæ exhibit a like tendency to enlargement. These great dilatations in the venous system leading to the pulmonary cavities of the hearts in these animals, serve, no doubt, the purpose of temporary reservoirs for the blood, when prevented passing on freely through the lungs during the long-continued periods of submersion to which the animals are accustomed.—J. H." But the same provision, as might be expected, is found in the diving birds, a fact first noticed by our author: " B. c. 407. An injected preparation, shewing the circulation in the great northern diver (*Colymbus glacialis*). The vena cava abdominalis is vastly dilated, and near its entrance into the right auricle forms a distinct bag, larger than that of the auricle itself. The venæ hepaticæ are much wider than they are ever found in birds not accustomed to diving.—J. H."—" B. c. 408. A dried preparation of the heart and bloodvessels in a gannet (*Sula alba*). In the gannet, which nearly equals in size the diver, there is not that inordinate dilatation of the great veins leading to the heart, so remarkable in that bird. Although the gannet lives on fish, its food is taken by a mode different from that adopted by the diver. Like the eagle, it pounces suddenly on its prey from a height, when discovered near the surface of the water, and then carries it up to some dry spot, impaled in its strong sharp bill. It is not habituated, like the diver, to lengthened stoppages under water, and stands not in need of those provisions, so amply given that bird by nature, to obviate the derangements which its circulatory and respiratory organs might be exposed to, during repeated efforts of submersion.—J. H."—" Our admiration of this beautiful provision will be increased, when we reflect on the consequences of its absence in man, a being never intended for long submersion. But when, from disease, the circulation, either in the lung or the right side of the heart becomes interrupted, we then find that the condition of the venæ cavæ hepaticæ represents, to a certain degree, their natural state in these animals during submersion. They become turgid, enlarged, and the congestion extends to the liver; but as no provision has been made for such an occurrence, this organ swells by congestion, and the vessels relieve themselves by pouring out their serum. Dropsy results, and continues until the obstruction is removed, when it disappears, but certainly to return on every renewal of the central obstruction. Here the effect of disease is exactly that of a prolonged diving; and as there is no apparatus for the reception of the blood, its accumulation becomes a source of evil. Before leaving this subject, we may remark, that those physiologists who are disposed to adopt the doctrine of Serres, namely, that in many cases disease in man only represents or reproduces the normal state of organs in lower animals, might find, in the state of the hepatic circulation in cases of obstruction of the pulmonary heart, some analogy to the venous development of the amphibia and cetacea."—*Dublin Journal of Med. and Chem. Science*, No. xviii. vol. vi. p. 435.

18. *Introduction of Frogs into Ireland.*—It is not generally known that the introduction of frogs into Ireland is of comparatively recent date. In the seventeenth number of the Dublin

University Magazine, there is a quotation from the writings of Donat, who was himself an Irishman, and bishop of Fesulæ, near Florence, and who, about the year 820, wrote a brief description of Ireland, in which the following passage occurs:

> "Nulla venena nocent, nec serpens serpit in herba;
> Nec conquesta canit garrula rana lacus."

"At this very hour," says our respected contemporary, "we have neither snakes nor venomous reptiles in this island; and we know, that, for the first time, *frog-spawn* was brought from England in the year 1696 by one of the Fellows of Trinity College, Dublin, and placed in a ditch in the University park or pleasure-ground, from which these very prolific colonists sent out their croaking detachments through the adjacent country, whose progeny spread from field to field through the whole kingdom. No statue has yet been erected to the memory of the natural philosopher who enriched our island with so very valuable an importation of melodious and beautiful creatures." We may state, however, that we have learned from good authority, that a recent importation of snakes has been made, and that they are at present multiplying rapidly within a few miles of the tomb of St Patrick.—*Dublin Med. and Chem. Journal*, vol. v. No. xv. p. 481.

19. *Apparent Death, which continued for twenty days, by Dr Schmid.*—A young man died in the hospital at Paderborn, who could not be buried until three weeks after he had breathed, at least to all appearance, his last breath. It was not till the twentieth day that the characteristic phenomena of death became manifest. The circumstances of the case were these. This young man had been a little time before cured of a tertian ague, when he re-entered the hospital, presenting some signs which caused an apprehension of phthisis, without, however, presenting any well-marked symptoms of this disease. In other respects, no disturbance in his health. On the day he died, his eyes were suddenly opened, and for some minutes we found an irregular beating of the pulse. Several small wounds resulting from cauterizations, to which we then had recourse to rouse him, suppurated the second, third, and fourth days. On the fifth, the hands of the body were turned back; from the fifth to the ninth day there exhaled from half the body an abundant sweat, free from odour. Towards the end of the ninth day, there ap-

peared over a considerable part of the dorsal region serous bullæ, similar to those of pemphygus. The limbs still preserved their natural suppleness, and on the eighteenth day the lips still retained their red vermilion colour. For nine days the forehead continued furrowed with vertical wrinkles, and all this time the countenance preserved an expression never presented by the face of a dead body. The body was kept for nineteen days in a warm room: it exhaled not the least fetid odour, and there was observed on no part of its surface any cadaveric lividity. The emaciation was very considerable, a circumstance which, if it had existed, might have served to explain these different phenomena.—*Dublin Journal of Med. and Chem. Science*, Vol. v. No. xiv. p. 304.

20. *Chemical Composition of Oyster Shells.*—Professor Rogers, in Silliman's Journal for July 1834, gives the following as the result of his examination of the chemical nature of the shell of the common oyster (*Ostrea edulis*):—Carbonate of Lime, 95.18; Phosphate of Lime, 1.88; Silex, 0.40; Water, 1.62; Insoluble animal matter, 0.45; Loss, &c. 0.46; = 100.00. Oyster shell is therefore a carbonate of lime, nearly in a state of purity; and it is in this light that it should claim attention, either in agriculture or medicine. Professor Rogers adds, "the scollop shells (*Pecten Jeffersonius* and *P. Madisonius*) of the marl beds of the Southern States, yield a larger proportion of animal matter than the recent oyster shell; and indeed in many instances these shells seem to have sustained no loss of this or in fact of any of their original constituents. The larger kind of coral (*Astrea*), which belongs to the same marl, contains a very minute portion of animal matter, and nearly the same per-centage of phosphate of lime as the oyster shells.

BOTANY.

21. *Use of Opium.*—The use of opium and the hookah is almost universal in the country, and in these the Cutchee finds a solace for every distress of mind or of body. Whether at home or abroad, the hookah is his constant companion. He has recourse to it at every moment of leisure; and I have myself travelled with horsemen in the service of his Highness the Rao, who, although they kept their horses at a smart pace, contrived to

smoke all the while. In every species of native society in Cutch, the influence of opium is apparent. The character of the people has even acquired a dull phlegmatic cast from its effects, though it must be remarked that these may bear no proportion to the immense quantity of the drug that is used. With the exception of an unwillingness on the part of the opium-eaters to exert themselves, which probably arises partly from natural laziness, the use of this powerful narcotic does not appear to destroy the powers of the body, nor to enervate the mind to the degree that might be imagined. Visragee, the Iharejah chief of Roha, whose name has been famous in the history of Cutch for the last sixty years, has, during the whole of his life, indulged freely in opium, and has suffered so little from its debilitating effects that he was last year detected in ambitious projects against the government, and banished to his own castle in consequence. He is now at the age of eighty, paralyzed by years, but his mind is unimpaired. His case is not a singular one; and, on investigation, I am convinced, it will be found in general that the natives do not suffer much from the use of opium. No doubt, however, East Indian opium is less deleterious in its effects than that which is produced in Turkey. It is generally taken in small cups rubbed up with water, and the quantities that are swallowed would almost exceed belief. Its stimulating effects are sometimes very apparent. On one occasion, I had made a very fatiguing night march with a Cutchee horseman. In the morning, after having travelled above thirty miles, I was obliged to assent to his proposal of halting for a few minutes, which he employed in sharing a dose of about two drachms of opium between himself and his jaded horse. The effects of the dose was soon evident on both; for the horse finished a journey of forty miles with great apparent facility, and the rider absolutely became more active and intelligent.—*Burness' Narrative of a Visit to the Court of Sinde, &c.* p. 230.

22. *On the Rapidity of Vegetable Organization.*—The vegetable kingdom presents us with innumerable instances, not only of the extraordinary divisibility of matter, but of its activity in the almost incredible rapid development of cellular structure in certain plants. Thus, the *Bovista giganteum* (a species of fungus) has been known to acquire the size of a gourd in one night. Now, supposing with Professor Lindley, that the cellules

of this plant are not less than the $\frac{1}{200}$th of an inch in diameter, a plant of the above size will contain no less than 47,000,000,000 cellules; so that, supposing it to have grown in the course of twelve hours, its cellules must have been developed at the rate of nearly 4,000,000,000 per hour, or of more than 96,000,000 in a minute! * and, when we consider that every one of these cellules must be composed of innumerable molecules, each of which is again composed of others, we are perfectly overwhelmed with the minuteness and number of the parts employed in this single production of nature.

23. *How to make Eatable Food from Wood.*†—To make wood-flower in perfection, according to Professor Autenrieth, the wood, after being thoroughly stripped of its bark, is to be sawed transversely into disks of about an inch in diameter. The saw-dust is to be preserved, and the disks are to be beaten to fibres in a pounding-mill. The fibres and saw-dust, mixed together, are next to be deprived of every thing harsh and bitter which is soluble in water, by boiling them, where fuel is abundant, or by subjecting them for a longer time to the action of cold water, which is easily done by enclosing them in a strong sack, which they only half fill, and beating the sack with a stick, or treading it with the feet in a rivulet. The whole is then to be completely dried in the sun, or by fire, and repeatedly ground in a flour-mill. The ground wood is next baked into small flat cakes, with water, rendered slightly mucilaginous by the addition of some decoction of linseed, mallow stalks and leaves, lime-tree bark, or any other such substance. Professor Autenrieth prefers marsh-mallow roots, of which one ounce renders eighteen quarts of water sufficiently mucilaginous, and these serve to form four pounds and a half of wood-flour into cakes. These cakes are baked until they are brown on the surface. After this, they are broken to pieces, and again ground, until the flour pass through a fine boulting-cloth, and upon the fineness of the flour does its fitness to make bread depend. The flour of a *hard wood* such as beech, requires the process of baking and grinding to be repeated. Wood-flour does not ferment so readily as wheaten-

* Introd. to Bot. p. 7.

† In a former number of this Journal we gave some details in regard to bread made from wood and from bark.

flour; but the Professor found fifteen pounds of birch-wood flour, with three pounds of sour wheat-leaven, and two pounds of wheat-flour, mixed up with eight measures of new milk, yielded thirty-six pounds of *very good bread.* The learned Professor tried the nutritious properties of wood-flour, in the first instance, upon a young dog; afterwards he fed two pigs upon it; and then, taking courage from the success of the experiment, he attacked it himself. His family party, he says, ate it in the form of gruel or soup, dumplings and pancakes, all made with as little of any other ingredient as possible: and found them palatable, and quite wholesome. Are we, then, instead of looking upon a human being stretched upon a bare plank, as the picture of extreme want and wretchedness, to regard him as reposing in the lap of abundance, and consider henceforth, the common phrase, "bed and board," as compounded of synonymous terms?—*Quarterly Review, November* 1834.

STATISTICS.

24. *Extent and Population of Great Britain and her Colonies.*

Divisions.	Area in Sq. Miles.	British Subjects.	Divisions.	Area in Sq. Miles.	British Subjects.
England, } United Kingdom,	50,520	13,086,675	Jamaica,	6,400	359,090
Wales,	7,409	803,000	Trinidad,	2,400	44,163
Scotland,	29,605	2,365,930	Barbadoes,	166	102,277
Ireland,	26,798	7,839,469	Grenada,	109	28,732
Bengal,	306,012	72,000,000	Antigua,	94	35,678
Madras,	141,323	14,700,000	Montserrat,	47	7,406
Bombay,	64,938	7,000,000	Dominica,	275	20,039
Ceylon,	27,000	1,200,000	St Vincent's	131	27,738
Penang, &c.	1,317	136,000	Nevis,	20	12,154
New Holland,	1,000,000	100,000	St Kitt's,	68	26,922
Van Diemen's Land,	240,000	48,720	St Lucia,	225	18,351
			Tobago,	44	13,952
Mauritius,	1,000	104,479	Tortola, &c.	120	10,642
Cape of Good Hope,	120,000	136,375	Bahamas,	312	16,836
Western Africa,	1,080	34,923	Bermudas,	36	8,920
Canada (Lower),	205,863	562,980	Demerara, &c.	70,000	80,124
Canada (Upper),	95,125	250,000	Berbice,	25,000	22,965
New Brunswick,	26,704	94,392	Honduras,	10,000	4,839
Nova Scotia,	14,031	139,000	Malta, &c.	122	128,960
Cape Breton,	3,125	30,000	Gibraltar,	3	17,024
Prince Edward's Island,	2,159	32,000	Jersey, &c.	0	65,836
			Man,	220	36,000
Newfoundland,	35,923	80,000			
Hudson's Bay Settlement,	525,000	2,000	Total,	2,824,040	121,829,501

From the Quarterly Journal of Agriculture, No. XXVII. p. 461.

25. *Concerning the Probability of Human Life in Glasgow. By James Cleland*, LL. D.—That Glasgow is a place of average health for statistical purposes may be inferred from the daily state of the weather, which I published in 1831, by which it appeared that the average quantity of rain which fell yearly during thirty years preceding that period, amounted to rather less than 23 inches. But more particularly, the degree of health may be known, and tables formed for ascertaining the probability of human life, from a series of the mortality bills, where the age of the living and that of persons who have died are narrated, in connexion with the population, and a table of longevity for Scotland, which I prepared in 1821, by which it appeared, that, on an average of all the counties of Scotland, there was one person eighty years of age for every $143\frac{92}{100}$ of the population; while, in the county of Lanark, with a population of 316,790, including 263,046 who live in towns, viz. in Glasgow 202,426, and in other towns 60,620, there was one such person for every $169\frac{71}{100}$, shewing a degree of health in the population of Glasgow nearly equal to that of the whole of Scotland. The following results have reference to Glasgow, and its suburbs which partake of a mercantile and manufacturing population, or something between Liverpool and Manchester, the town population being 198,518, and the rural 3908. In 1831, the population was found to be 202,426, the burials 5185, and the rate of mortality consequently $39\frac{4}{100}$. The births being 6868, there is one birth for every $29\frac{47}{100}$ persons. The number of marriages being 1919, there is $3\frac{57}{100}$ births to each marriage, and one marriage for every $105\frac{48}{100}$ persons. The number of families being 41,965, there are $4\frac{82}{100}$ persons to each family. It is very satisfactory to know, that with the same machinery in 1821, the population being 147,043, the burials 3686, the rate of mortality was $39\frac{89}{100}$, or, in other words, as near as may be to the mortality in 1831. By reference to the bills of mortality between the years 1821 and 1831, similar results will be found. It appears from all the authentic bills of mortality I have ever seen, that there are more males born than females; but, taking the population above fifteen years, the number of females preponderates. The following results for Glasgow are derived from the census of 1831 —

Births—Males,	3,527	Females,	3,341	Excess	of Males,	186
Males under 5 years,	15,422	......	14,855	...	of Males,	567
...... 10 years,	28,549	......	27,435	...	of Males,	1,114
...... 15 years,	39,040	......	38,155	...	of Males,	885
...... 20 years,	47,529	......	50,411	...	of Females,	2,882
...... 30 years,	62,706	......	73,419	...	of Females,	10,713
Entire Population,	93,724	......	108,702	...	of Females,	14,978
Burials—Males,	2,701	......	2,484	...	of Males,	217

Addenda for 1831.—*Description of Householders.* Married men, 30,032. Widowers, 1790. Bachelors, 1437. Male householders, 33,259. Widows, 6824. Spinsters, 1882. Female householders, 8706. Total families, 41,965.—*Country to which the Population belongs.* Scotch, 163,600. English, 2919. Irish, 35,554. Foreigners, 353. Total, 202,426.—*Religion of the Population.* Established, 104,162. Dissenters, Episcopalians, and Jews, 71,299. Roman Catholics, 26,965. Total, 202,426. —*Number of Paupers, and Expense of Maintaining them.* The number of paupers in the city and suburbs being 5006, and the population 202,426, there is one pauper for every $40\frac{43}{100}$. The number of paupers being 5006, and the sum expended for their maintenance or relief L. 17,281 : 18 : $0\frac{1}{2}$, shews the cost of each pauper to be L. 3 : 9 : $0\frac{1}{2}$. If the sum for the relief of paupers were equally paid by the whole non-recipient population, the proportion to each would be *one shilling and ninepence and a small fraction.* The sum of L. 17,281 : 18 : $0\frac{1}{2}$ includes the entire expenditure of the out and in-door paupers, surgeons' salaries, medicines, clothing and educating children, maintaining lunatics, funeral charges, &c. The cost of each pauper in St John's Parish is L. 3 : 8 : $10\frac{1}{2}$. The poor in that parish are maintained or relieved on the parochial system introduced by Dr Chalmers in 1820, *i. e.* by the Kirk-Session from its own resources, without receiving any part of the general assessment for the poor, although the inhabitants of St John's Parish are assessed for the maintenance of the poor generally, in the same manner as other citizens.

NEW PUBLICATIONS.

1. *Bibliographia Palæonthologica Animalium Systematica.* Auctore G. F. DE WALDHEIM. Mosquæ, 1834.

THIS well arranged, generally accurate, and comprehensive Bibliography of Fossil Animals, we consider an important addition to the works already published on this subject. It will prove useful to those studying or writing on the geological history of extinct animals.

2. *Outlines of Comparative Anatomy.* By Dr GRANT, Professor of Comparative Anatomy and Zoology, London University. Part 1st, Osteology, Ligaments, and Muscles. Illustrated with 65 Wood Cuts. J. B. Baìlliere, London.

WHEN this valuable outline, destined, we trust, to become the manual of Comparative Anatomy for our students, is completed (promised before October next), we shall lay before our readers an analysis of it.

3. *Aide-Mémoire du Voyageur, ou Questions relatives à la Geographie Physique et Politique ; à l'Industrie et aux Beaux-Arts, &c. A l'Usage des Personnes qui veulent utiliser leur Voyages.* Par JAC. R. JACKSON. Paris, 1834. Small 8vo. pp. 534, and 4to, Vol. ii. Tables.

WE recommend this useful work to the attention of those intending to visit with advantage different countries, or who may be required to furnish instructions for scientific and literary purposes to travellers, because it contains a very full series of questions in regard to the more important departments of physical geography, statistics, politics, and the fine arts.

4. *Exposition of the Principles of Mr James Lang's invention for Spinning Hemp into Rope-yarns by Machinery, and its effect on the Strength and Durability of Cordage.* By MACNAB & Co. Greenock. 1835.

" IT was only towards the end of the 18th century that the art of Rope-making engaged the attention of scientific men, and began to be conducted on scientific principles. Then it was discovered, that by the mode of operation formerly in use, the yarns could not be brought to bear equally with each other ; and, therefore, that a great loss of strength in the rope behoved to be the consequence. Great exertions were accordingly made by several intelligent individuals to remedy this defect, and between the years 1783 and 1807, no fewer than twenty-two patents were taken out for improvements in the art, and for machines of various descriptions,—these it is not to our purpose to describe. It may be sufficient to state, that the one invented by Captain Huddart of London, was greatly approved of, and obtained the highest celebrity. This plan was introduced into Greenock in 1802 by the late firm of Messrs John Laird & Co., but was in some measure superseded a few years after by the method now in use, and which, by the application of the same principle, but of a more simple construction, was found to secure the same object, while, at the same time, it was better adapted for general purposes. For this improvement on Captain Huddart's plan we believe we are indebted to Mr W. Chapman of Newcastle. The principle by which an increase of strength in the Cordage was effected (amounting to about 30 per cent.), is simply by so constructing the strand of the rope as that *every yarn is made to bear its own proportion of the strain.* That the application of such a principle should be followed by such a result, must be apparent to every one, and *it is by carrying out this same principle to its full length*, as we shall afterwards shew, that we have been enabled to effect an additional increase of strength, and, consequently, of durability to the rope.

"That a great improvement in rope-making was effected by these gentlemen, there can be no question, but that perfection in the art might be attained, it was still necessary that the mode of preparing the yarns should also be improved. The usual process of hand-spinning was considered very defective, as evidently it did not impart to the yarns that degree of strength which it was thought the material was capable of affording. Endeavours were accordingly made to obviate this defect also. Three patents were even taken out for machines, but these were found not to answer expectation ; those constructed by Mr Chapman are still used by some houses in England, but as they are very defective, they have never been introduced into general practice. A moment's consideration must be sufficient to convince any person, the least conversant in rope-making, that, if the strength and durability of the rope depend on the proper arrangement and equal bearing with each other of the yarns in the strand, so its strength and durability must also depend on the just arrangement, regular twisting, and consequent equal bearing of the fibrous substances which are employed in the composition of the yarns. Indeed, after the improvement above alluded to, this was the only thing requisite to complete the scientific construction of cordage ; and by the application of machinery on a principle somewhat analogous to that which we have already referred to, this desideratum has also been supplied. Mr Lang, who had for many years directed his attention to the subject, and was convinced of its practicability, upon taking the active management of our works, got a set of machines constructed under his own direction, which, on repeated trial, were found completely to accomplish the object. By this invention, the regular spinning of the yarns which had hitherto been prepared in a tedious and clumsy manner by hand-labour, is one object which has been effected ; but this, although in itself important, is one of its least advantages. By the same plan, the hemp, to whatever purpose applied, being drawn over a succession of gills, or small hackles, is dressed in the highest degree ; hence the fibrous substances of the hemp are regularly split and subdivided ; they are also multiplied to such an extent as that their number in a Patent-spun yarn will be found more than double the quantity of those which compose a handspun yarn of equal grist ; this, every one will admit, must increase its strength in no inconsiderable degree. Again, while the fibres are thus greatly multiplied, they are also completely elongated and laid straight, so as to admit of being regularly twisted, and each fibre being stretched its full length and laid parallel to the others in the yarn, they are all made to bear at the same time, and equally, in the strain ; thus every fibre of the hemp is called into action, and contributes its own proportion of strength to the fabric : this is certainly a most important feature in our Patent plan, and such a result could never be expected from the most careful and best conducted hand-spinning. But this is not all, by hand-labour the hemp can only be spun from the middle, or *bight*; and therefore only one-half of the length of its fibre is extended in the yarn, consequently, some qualities of hemp have hitherto been considered inferior, because, on account of the shortness of their fibre, they would not admit of being doubled: thus, a material in other respects as good, while of lower price, has been rejected in the manufacture of Cordage, not so much on its own account, but because, by the process of hand-spinning, only the one-half of its length could be employed. Now, Mr Lang's plan has this additional advantage, that the hemp is spun by the end of the fibre, and thus, by having its whole length extended in the yarn, those qualites of hemp hitherto considered inferior, because shorter, may be applied with equal safety and advantage, and do in reality produce Cordage as strong and as durable as the others. When we take into account the very depressed state of this branch of our manufacture, in consequence of the facilities enjoyed by our neighbours on the continent of underselling us in a foreign market,* as also the present state of the shipping interest, it will, by every candid person, be acknowledged that an invention such as this, by which we are enabled to produce a superior article, and at a cheaper rate, ought, even in a political point of view, to be regarded as a public good; and is consequently entitled to public encouragement and support."

So far Messrs Macnab. We have seen the rope-yarns, understand the machinery employed, have read carefully the exposition, and do not hesitate to say, that this new cordage has answered the expectation of those who have tried it, and that severely too, in many seas. The public, the best judges in such cases, will, we doubt not, after a careful perusal of the "*Exposition*," and examination of this new kind of cordage, feel it their interest to employ it extensively.

5. *Lethæa Geognostica; or Figures and Descriptions of the characteristic Petrifactions of the different Rock Formations.* By Dr H. G. Brown. In 4to fasciculi. Heidelberg 1834.

This beautiful, accurate, and interesting work, of which the first number has reached us, is creditable to the well known practical skill and learning of the author. Every possessor of a geological cabinet, and all who study the geological history of the remains of the animals and plants buried in the crust of the earth, will find in the Lethæa Geognostica a safe and instructive guide.

* We learn, upon good authority, that Ropemakers in Russia are paid at the rate of only 3½d. per day; hence the importance of machinery, which, by lowering the price of the article, prevents our being shut out of the foreign market.

Proceedings of the Royal Society of Edinburgh.

1834, *December* 1.—Sir Thomas Makdougall Brisbane, K. C. B. President, in the Chair. The following communications were read :—

1. On Phosphuretted-Hydrogen Gas. By Thomas Graham, Esq., Glasgow.

2. On the Fossil Fishes of the Limestone of Burdiehouse. By Dr Hibbert.

In this paper the author gave an account of a communication received by him from M. Agassiz, relative to the remains of fishes which had been discovered in the limestone of Burdiehouse, and which had been submitted to his examination.

The genus found in greatest abundance had been referred by Dr Hibbert to the Palæoniscus, which view was confirmed by M. Agassiz, who, in pointing out its distinction from the Palæoniscus angustus of Autun, which it most resembled, regarded it as a new species. This very characteristic fish of the limestone of Burdiehouse, Dr Hibbert has named Palæoniscus Robisoni, in honour of Mr Robison, General Secretary of the Royal Society of Edinburgh. Another fossil fish of a new and extraordinary genus, received the name of Eurynotus crenatus. A third, which was the first animal relic discovered by Dr Hibbert in the quarry of Burdiehouse, was named, at his request, the Pygopterus Bucklandi.

The bony rays, of immense dimensions, and beautifully configurated, in the possession of the Royal Society of Edinburgh, M. Agassiz refers to a new genus of fish ; and he proposes to name the individual to which they belong the Gyracanthus formosus. He is also inclined to refer to the same individual certain teeth found in another locality near Edinburgh. This genus belongs to his Placoidian order, and to the family of Cestraciontes, so named from their approach to the Cestracion of New Holland. With regard to the alleged Saurian character of the teeth, scales, and some of the large bones discovered in the quarry of Burdiehouse, M. Agassiz was induced to consider them as *Sauroid,* rather than exactly Saurian, and to assign them to a large sauroid fish, akin to the extant Lepidosteus. In the form of its teeth, and in a very near resemblance of its scales to those of a reptile, the Lepidosteus agrees with Crocodilean families. Nor does this general correspondence fail, even with regard to the internal structure of the animal. M. Agassiz has described the result of an investigation of the swimming bladder of a specimen of the Lepidosteus spatula, preserved in spirits, from the dissection of which he was enabled to demonstrate, not only that it is a real lung, but that it even approaches closely to the structure of the lungs of reptiles, having characters in common with the lungs of salamanders, and of the reptiles improperly called doubtful reptiles. The lung or swimming bladder of the Lepidosteus is not only cellular, but has also a trachea, which extends the whole length of its anterior surface, and communicates with a glottis, surrounded by ligaments, intended to open and shut it, constituting an apparatus even more complicated than what is found in many reptiles. M. Agassiz also adds, that the heart has not the appearance of that of a common fish: it is destitute of the inflation named bulbus aorticus, so characteristic of fish, and hence has much more the aspect of the heart of a reptile.

With this fish, in its well marked external characters, M. Agassiz has compared the sauroid relics discovered at Burdiehouse, and, in this inquiry, he has been assisted by the entire head of a large fossil fish, preserved in the museum of Leeds. From the aid thus derived, he has been enabled to establish a new genus under the name of Megalichthys. With regard to the scattered and disjointed bones found at Burdiehouse, it is conceived that they indicate a distinct species, to which M. Agassiz has some time since given the name of Megalichthys Hibberti. To the remains of another species of the same genus, discovered near Glasgow, and distinguished by a greater flatness of its teeth, M. Agassiz is disposed to assign the appellation of Megalichthys falcatus.

December 15.—James Russell, Esq., Vice-President, in the Chair. The following communications were read :—

1. General Remarks on the Coal-Formation of the Great Valley of the Scottish Lowlands. By Major-General Lord Greenock.

In this paper the author stated, that although there is sufficient evidence in the mechanical origin and organic contents of the beds (some of them of extraordinary thickness and extent), which form the coal-measures, to prove the pre-existence of much larger tracts of dry land, in connection with each other, than could possibly have been afforded by the older portions of the present countries ; such proofs are altogether wanting when we endeavour to restore, in imagination, what might have been the probable extent of that land, the greater part of which may now lie buried beneath the ocean, or have since been covered by more recent deposits. It appears, however, to have been clothed with a luxuriant tropical vegetation, and sufficiently elevated to have given rise to the rivers and torrents, by which the materials for composing the coal strata had been carried down into the lakes or estuaries, where to all appearance they were deposited.

The circumstances in which the large fossil trees are seen imbedded in the strata of the coal-measures, and other similar phenomena, have led the author to suppose, that these rivers and their estuaries may have been of greater magnitude than would probably have been the case if they had been situated in small islands, according to the opinion of many geologists. The intermixture of terrestrial and marine remains in the same beds, is a strong evidence in favour of their fluviatile origin ; and the fact frequently observed, of these beds being covered by, or alternating with, others containing only marine remains, may, with great probability, be referred to changes in the relative level of the land and sea that may have taken place while these deposits were forming.

The author then proceeded to describe the limits within which the coal appears to have been deposited in the Scottish Lowlands, which, with the exceptions pointed out by him, may, according to Williams, be indicated by a line drawn from the mouth of the Tay passing through Stirling, to the northern extremity of Arran ; and another nearly parallel to it from St Abb's Head on the east coast, to Girvan on the west. Although coal may not have been equally distributed in every part of this district,—the deposition of the vegetable matter from which it was derived, having probably been more or less influenced by local circumstances, which may also have caused occasional varieties in the mineral structure and organic contents of the associated strata,—yet, in the opinion of the author, there are sufficient grounds to justify the conclusion, that the whole series originally constituted one great formation, the strata of which it is composed appearing to have been deposited continuously, more or less, in a horizontal position at the bottom of the sea, that must then have covered at least the whole of that portion of the Lowlands, forming either a strait or channel between two islands, or perhaps a vast estuary in which the rivers of the neighbouring primeval countries discharged their waters. The ripple-marks observable on the surface of most of these beds give much additional probability to this supposition.

This original continuity of the beds occupying the carboniferous district, appears to have been subsequently interrupted by the intrusion of the igneous rocks and hills so universally prevalent in that formation, by which they have been separated into the fields or basins where they are now found. The effects of Plutonic action, by which these hills were produced, seem to have been the chief agents employed in modifying the external surface of this important district, and occasioning those chemical changes and combinations in the interior of the earth, by which, when elevated above the waters, it was destined to become a more suitable habitation for the human race.

The Pentland, Campsie, and Ochil hills, as well as many others of a similar description within the limits specified, afford striking examples of the effects produced by their intrusion among the coal strata, at periods subsequent to the consolidation of the latter, of which some instances were noticed by the author. In fact, the whole country occupied by the Scottish coal-measures, displays more or less the influence of such igneous hills, or of the dykes connected with them. A certain degree of parallelism may be traced between the principal ranges, their general bearing being from the eastward of north to the westward of south, which corresponds with the general strike of the fossiliferous strata ; but they often appear to have been protruded through the surface without any order or regularity, and the dikes are found to proceed in every direction from the principal masses.

The author farther remarked, that rivers, estuaries, or portions of the sea, now flow through or cover strata of this coal formation, which, from the appearances on their opposite shores, were in all probability once continuous. The connection between the Lothian coal-fields and that of Fifeshire is very apparent, both in the general direction of the strata, as seen by their outcrop on the opposite shores of the Frith of Forth, and in the number and thickness of the beds of coal in each, which exactly correspond. The appearance of the carboniferous series in Arran, and at Campbelton in Kintyre, as well as the indications of its existence at Ballycastle, and other places on the Irish coast, within the prolongation of the lines before adverted to, seems fully to establish the geological connection in this, as well as in most other respects, between the west of Scotland and the north-east of Ireland.

2. On the composition of the Rangoon Petroleum, with Remarks on the composition of Petroleum and Naphtha in general. By William Gregory, M.D. F.R.S.E.

The author first adverted to the discovery, nearly about the same time, of paraffine by Reichenbach and of petroline by Dr Christison. The former occurred among the products of destructive distillation; the latter was found in the Rangoon petroleum, and they were soon found to be identical. Reichenbach's researches on naphtha were then quoted, by which it appears that that indefatigable observer could not discover, in the kind of naphtha which he examined, any trace either of paraffine, or of any other product of destructive distillation. On the contrary, he found that naphtha to possess the characters of oil of turpentine, a product of vegetable life; and he succeeded in obtaining a precisely similar oil from brown coal by distillation at 212°. These facts had led Reichenbach to the conclusion that naphtha in general is not a product of destructive distillation, and, consequently, must have been separated at a comparatively low temperature. The author showed that Dr Christison's discovery of paraffine, of which Dr Reichenbach was necessarily ignorant, is inconsistent with this view; and detailed some experiments, by which he has rendered highly probable the existence in petroleum of eupion, another of the products of destructive distillation. This substance is a liquid of Sp. gr. 0.655, boiling at 110°, and very fragrant. The author obtained from the Rangoon petroleum a liquid of Sp. gr. 0.744, boiling at 180°, and rather fragrant. The oil of turpentine, as is well known, boils at 280, and has a Sp. gr. of 0.860; so that, at all events, the naphtha from the Rangoon petroleum is not oil of turpentine. This was farther proved by the tests of nitric acid and iodine. Similar experiments on one or two other species of naphtha led to similar results. They all yielded a liquid of Sp. gr. about 760, and, consequently, could not be oil of turpentine. The kinds of naphtha tried were Persian naphtha, obtained from Dr Thomson, and commercial naphtha, sold by M. Robiquet of Paris.

The author concluded, that if the naphtha examined by Reichenbach were genuine, there must be at least two kinds of naphtha; one a product of destructive distillation, the other the oil of turpentine of the pine forests of which our coal-beds are formed, separated by a gentle heat, either before or after their conversion into coal. It is obvious that our common coal-beds have never yet been exposed to a heat sufficient for destructive distillation, since they are destroyed by a moderate heat, and we may therefore expect the petroleum of these coalbeds to be of the kind described by Reichenbach; while the Rangoon and Persian petroleums, being products of destructive distillation, must have their origin, if in coal-beds at all, in such as have been exposed to a high temperature, and must, consequently, be very different from the ordinary coal-beds. In confirmation of this view it may be stated, that Dr Christison could find no paraffine either in the petroleum of St Catherine's, or in that of Trinidad or Rochdale.

The author finally directed attention to the application of the paraffine as a material for giving light, as, when pure, it burns with a clear bright flame, like that of wax, and might doubtless be obtained at a cheap rate in the East.

January 5. 1835.—Sir T. M. Brisbane, President, in the Chair. The following communication was read:—

On Water as a constituent of Salts. By Tho. Graham, Esq.

19*th January*.—Dr Hope, V. P. in the Chair. The following communications were read:—

1. On the Refraction and Polarization of Heat. By Professor Forbes.

2. Supplementary Notice on the Chemical Analysis of the Animal Remains of Burdiehouse. By Arthur Connell, Esq.

Since the Author's former communication to the Society, he has analyzed a portion of a bony fin-ray from the limestone belonging to a fossil fish which has been designated by M. Agassiz, Gyracanthus formosus.

The constituents were found to be,

Phosphate of Lime with a little Fluoride of Calcium,		53.87
Carbonate of Lime,		33.86
Siliceous matter,		10.22
Potash and Soda, partly as Chlorides,		.71
Bituminous matter,		.54
Phosphate of Magnesia,	trace	
Animal matter,	trace	
		99.20

He has also analyzed a portion of the fossil scales embedded in the limestone. These scales belong to a fossil genus of fish, to which the name of Megalichthys has been given by M. Agassiz, and which is supposed to approach in character to the Lepisosteus, or Lepidosteus of Agassiz. The scales were about three-fourths of an inch long by somewhat less in breadth, and possessed a fine lustre, and the usual delicately punctured surface. They were found to contain—

Phosphate of Lime, with a little Fluoride of Calcium,	50.94	
Carbonate of Lime, ...	11.91	
Siliceous matter, ...	33.10	36.58
Water, ...	3.48	
Potash and Soda, ...	.47	
Bituminous matter, ...	.12	
Phosphate of Magnesia, ...	trace	
Animal matter, ...	trace	
	100.02	

It is remarkable that the composition of these scales is very analogous to that of the scales of the recent Lepisosteus, if we suppose the perishable animal matter in the latter to be replaced by infiltration by the hydrated siliceous matter in the fossil scales. In those of the recent Lepisosteus, Chevreul found—

Phosphate of Lime, ...	46.20
Carbonate of Lime, ...	10.00
Gelatinous Animal matter, . . .	41.10
Phosphate of Magnesia, . . .	2.2
Fatty matter, ...	.10
Carbonate of Soda, ...	.10
	100

The result of the analysis of the bony rays of the Gyracanthus may also be compared with the constitution of certain recent fish bones. Those of the pike, as determined by Dumenil, consist of—

Phosphate of Lime, ...	55.26
Carbonate of Lime, ...	6.16
Animal matter, ...	37.36
Traces of Soda and loss, . . .	1.32
	100.

If we suppose the animal matter to be replaced partly by siliceous matter and partly by carbonate of lime, the composition of the recent and of the fossil bones becomes very similar.

The ratio of the phosphate of lime to the carbonate of lime in the Coprolites, according to the analysis formerly communicated to the Society, does not differ much from the proportions in the above analysis of recent fish bones. The Coprolites may therefore be viewed as aggregated masses of fish-bone earth, the animal matter having decayed almost without any substitution, from fecal matter not possessing that structure and solidity which seem usually essential to the proper process of mineralization by infiltration. Since his former communication, the author has found a trace of fluoride of calcium in the Coprolites.

It is remarkable, that the limestone matrix itself contains a very decided trace of animal matter, doubtless derived from the great quantity of animal remains which have been entombed in it.

Proceedings of the Wernerian Natural History Society.

1835, *Jan.* 24.—Professor JAMESON, P. in the Chair.—A paper by Mr Hay Cunningham was read, on the Geology of the Islands of Mull and Iona. The author considers the rocks of Mull as referable to four periods of formation, and he described these in detail, viz. the Primary stratified Rocks; the Granite; the Sandstones, Shales, and Limestones of the liassic series; and the great assemblages of Trap rocks, which constitute by much that larger part of that island. A particular account was given of the distribution and the limits of these different formations, their external physical aspect, their mineralogical characters, the fossils which some of the rocks contain, and the various relations of the members of the series to one another; and more especially, the relations of the granite to the primary slates, and of the trap to the primary and secondary strata. In describing Iona, various interesting particulars were communicated regarding the limestone or dolomite connected with the primary rocks of that island, and the felspar rock which occurs near the limestone. The paper was illustrated by an extensive series of coloured sections of the strata and veins, and by specimens of the rocks.

Professor Jameson exhibited a new bird, which appeared to belong to the genus Eurylaimus, and which he named Dalhousiæ, in honour of the Countess of Dalhousie, who has long been distinguished as an enthusiastic admirer of nature, and a successful cultivator of natural history. It was described in the following terms:—*Bill* greenish-black; on its edges, along the culmen, and at the tip, yellowish-white; length 3-4ths of an inch; breadth at base 3-4ths of an inch. *Nostrils* ovoid, inserted at the base of the bill, and partially covered with feathers. *Body* grass-green above; below, apple-green. Throat of a golden yellow, which extends round the neck, and terminates at the occiput with a few sky-blue feathers. Occiput and top of the head, greyish-black, with a crest of sky-blue. Ear-coverts and face golden-yellow, mixed with sky-blue. *Wings* short; 1st and 4th quills equal, 2d and 3d the longest; external webs of quill-feathers grass-green; internal bluish-black, with a broad band above in their centre of sky-blue; below, there is one of greyish-white, which extends across the internal web of the seven first primary quills. *Tail* Berlin-blue, very long, and strongly forked ; the two middle tectrices much the longest. *Tectrices* twelve in number. Total length of body from the tip of bill to point of tail, eleven inches ; tail, five inches. *Tarsus* weak, and rather longer than middle toe; length an inch and a quarter. *Toes*, external united to middle by two joints ; internal by one. The specimen of this very rare and beautiful bird, which is a native of Northern India, was brought from thence by Lady Dalhousie. It was remarked, that it is distinguished from the typical specimen by the following characters :—The first that strikes us is the position of the nostrils, which, as already noticed, are inserted at the base of the bill, and partially covered with feathers. In the typical species, they are quite naked, and inserted at a distance from the base. Secondly, the strong cuneiform tail, and shortness of the wings ; and lastly, the weakness of the tarsi. Although the bird presents a peculiar group of characters, it was not considered advisable to form a genus of it, until its habits and manners were made known. Its locality is also interesting, from it pointing out that this genus probably extends over all India proper.

At the same meeting, a specimen of a new Meliagris, from New Holland, was exhibited and described. The trivial name of Lindesayii was given in honour of Colonel Lindesay, a distinguished officer, and very active naturalist, formerly commander of the 39th regiment in New South Wales, but now removed to India. This bird gave rise to the erroneous opinion that *vultures* exist in the Australian continent.

Feb. 7.—Dr Greville, V.P. in the Chair.—Professor Jameson, in a series of geological observations which he read to the Society, among other interesting topics, noticed the following :

1st, *Beds of recent Shells on the banks of the Firths of Forth and Clyde, situate considerably above the present level of these estuaries.*—These beds, Professor Jameson remarked, had been pointed out by him to his pupils, during his geological walks, from the year 1806 up to the present time. One of his pupils, the late Assistant-Surgeon Macgregor, in 1811, read before the Society a paper on the recent sea-shells he noticed about $4\frac{1}{2}$ miles from Glasgow. Captain Laskey, in 1814, read a memoir on a bed of sea-shells, estimated 40 feet above the level of the Clyde, which he examined in the line of the Ardrossan Canal, a few miles from Glasgow, of which memoir an abstract was published in the 4th volume of the Society's Memoirs. He enumerated the following shells:—1. *Turbo* littoreus, 2. rudis, and 3. terebra; 4. *Nucla* minuta and 5. nuclea; 6. *Patella* vulgaris and 7. pellucida; 8. *Buccinum* lapillus, and 9. undatum; 10. *Mytilus* edulis; 11. *Venus* islandica, 12. striata, 13. literata; 14. *Pecten* opercularis, the subrufus of Donovan; 15. *Balanus* communis; 16. *Anomia* ephippium; 17. *Tellina* plana; 18. *Nerita* littoralis, 19. glaucina; 20. *Mya* truncata; 21. Trochus crassus; 22. Cardium echinatum. All these shells, Captain Laskey remarked, still inhabit the Frith of Clyde and its shores, but occur below Dunbarton, or where the water is constantly salt. Captain Laskey also described to the Society a bed of dead sea shells near to Dunbarton, and above the present level of the Clyde, among which he particularised Venus sulcata, Pecten islandica, and Ostrea islandica of Turton. Dr Fleming afterwards read to the Society "A short account of a bed of fossil shells found on the banks of the Forth to the west of Borrowstonness." This bed he described as entirely of sea-shells, mixed with a small portion of sand. The *common oyster* is in greatest abundance; and along with that shell all those species which are found in plenty on the shores of the Frith of Forth; such as *Mytilus* edulis, *Venus* rhomboidea, *Mactra* truncata, *Buccinum* undatum, *Turbo* littoreus, *Patella* vulgaris. The bed is about 3 feet thick, and below it a bed of gravel resting upon the sandstone of the district: it extends in a straight line along the bank of the Forth, in a direction from east to west, nearly three miles, and is about thirty-three feet above the rise of ordinary spring-tides. Mr Bald, in the Memoirs of the Society, mentions sea-shells as occurring at Alloa, twenty feet above the present level of the Frith of Forth; also sea-shells several miles to the westward of Stirling Castle, particularly valves of the oyster, of uncommon size, although no recent specimens are now found so large, nor any live oysters above Queensferry; also a bed of sand and oysters at the foot of Clackmannan hill. Mr Adamson, another member of the Society, in a memoir published in vol. iv. of the Society's Memoirs, describes a bed of sea-shells in the isle of

Lonach in Loch Lomond, twenty-two feet above the present level of the sea at Dunbarton, in which were some species apparently new to conchologists, and several echini. In 1821, in an account read to the Society of remains of the elephant found in an alluvial bed near to Kilmarnock, it was noticed that these remains were accompanied by sea-shells of the same species as those living in the present sea. In 1824, Mr Blackadder, land-surveyor, laid before the Society a paper, an abstract of which appeared in the 5th volume of the Society's Memoirs, on what he calls the Superficial Strata of the Forth district. He there mentions common sea-shells of the Forth as occurring at Polmaise, below Stirling, at Grangemouth, and other places near the shores of the Forth ; and also some instances of their occurrence far from the present natural habitat of these shells, but everywhere above the present sea level. Mr Blackadder of Edinburgh, a few years ago, described in a memoir laid before the Society the bed of sea-shells considerably above the present level of the Frith at Wardie and Newhaven. And within these few months, Mr Maclaren, in a well known periodical, " The Scotsman," describes a portion of the shell bed between Leith and Portobello, and Dr R. Thomson, in his interesting new journal, " The Records of General Science," gives several additional particulars regarding the shell bed on the banks of the Clyde. From these details, it probably follows, either that at some former period the waters of the Clyde and Forth were considerably higher than they are at present, or that the land has risen.

2. *Newest Flœtz-Trap of Werner.*—Werner, from the fact of trap-rocks resting upon sands, clays, marls, &c., inferred that these rocks were of comparatively recent formation. He further conjectured, that these very generally distributed rocks, were deposited from the waters of a deluge which overspread the surface of the globe. A similar opinion is now prevalent among geologists ; but with this difference, that modern geologists refer the formation of these rocks to igneous, not to aqueous, agency, and the rising of the water to a rising of the land.

3. *Coal Formation.*—Professor Jameson explained, that all the chief geological characters of the old and the new coal formations in Scotland had been amply and satisfactorily made out

by the Wernerian Society many years ago;—that he, in 1811, in a memoir read before the Society, maintained that nearly the whole, if not the whole, of the sandstone, both red and white, of the island of Arran, belonged to the old coal formation, and that, upon this sandstone, on the opposite coast of the mainland, as near to Saltcoats, the more common or newer beds of the coal formation were seen resting. He also noticed, that, in 1805, in his published Mineralogical Account of the county of Dumfries, he had described the occurrence of red sandstone in Dumfriesshire, as connected with the coal formation; and, in the same work, that, in Mid-Lothian, red sandstone was met with in the coal formation, as at Roslin, &c.; and that this red sandstone occurred, generally in the lowest part of the coal formation, abundantly in East Lothian, Fifeshire, Berwickshire, Roxburghshire, &c. The old red sandstone, a formation connected with quartz-rock, and older than the red sandstone of the coal formation, Professor Jameson remarked, was well displayed on the banks of Loch Ness, in the county of Sutherland, and in many other places in Sotland.

4. *Syenite or Granitel of Skye, Craig of Ailsa, St Kilda, Arran, &c.*—Professor Jameson requested the attention of geologists who may visit Arran, to the syenite and granite rocks, apparently in connexion with sandstone and conglomerate, in the line extending from the upper part of Glencloy to the great body of granite of the northern division of the island. He also recommended geologists to examine particularly the two chief granites of the island, viz. the small granular, and occasionally syenitic varieties on the west side, and the coarse granular on the eastern side of the island, and to bear in remembrance that these western and eastern granites might prove to belong to different formations. The Professor also mentioned a variety of particulars illustrative of the geological positions and mode of formation of the granular crystalline rocks of the Craig of Ailsa, St Kilda, and the island of Skye, from which it appeared to result, that these rocks, viewing them as of igneous origin, were of newer formation than the great coal formation.

5. *Organic Remains in the Coal Formation.*—The labours of Messrs Nicol and Witham, it was remarked, had added considerably to our knowledge of the plants of this formation; and the specimens and details furnished for publication by the Pre-

sident of the Society, also by Dr Fleming, Dr Hibbert, Lord Greenock, and others, were daily extending our acquaintance with the fossil corals, shells, and fishes of this interesting formation. In regard to the fossil fishes and coprolites in the limestone, slate, and ironstone, of the middle region of Scotland, it was remarked, that, in several districts on both sides of the Forth, they were met with in considerable abundance, where they were first pointed out by the President of the Society, and afterwards, in some new localities, by Walter Calverly Trevelyan, Esq., Lord Greenock, Dr Hibbert, and Thomas Jameson Torrie, Esq. Professor Jameson mentioned some beds in the coal formation so thickly studded with coprolites, that they might be named *coprolite beds*; while others abounded so much with fish scales, that they might not unaptly be called *scale beds*; and further, that the coprolites were not confined to the *fern limestones*, but were met with also, although hitherto not so abundantly, in the *coral* and *shell limestones* of the coal formation; and that hitherto no remains of undoubted fossil saurian animals had been met with in Scotland; the large crocodile-like teeth discovered in the coal formation by the late Rev. D. Ure, and figured by him in his History of Rutherglen and Kilbride, and since, in 1834, by Dr Hibbert, at Burdiehouse, near Edinburgh, belonging probably to an extinct tribe of fishes. The sauroidal character of some of these fossils has elicited the following remarks from Professor Agassiz:—

"It is in the series of deposits inferior to the Lias that we begin to find the largest of those monstrous *Sauroid fishes*, whose osteology reminds us in many respects of the skeletons of saurian animals, viz. by the closer sutures of the bones of the head, by the large longitudinally striped conical teeth, and by the manner in which the spinous epiphyses are articulated with the bodies of the vertebræ, and the sides at the extremity of the transverse epiphyses. The analogy which exists between these fishes and saurian animals, is not confined to the skeleton alone; for in one of the two recent genera I have found a very peculiar internal organization of the soft parts, which renders the similarity greater than it at first appeared. There is, in fact, in the *Lepidosteus osseus*, a glottis like that of the sirens and the salamandrian reptiles, a cellular swimming-bladder, with a trachea, like the lung of an ophidian. Finally, their integuments have often an appearance so similar to that of the crocodiles, that it is not always easy to distinguish them.

"The smallness of the number of fishes found in transition rocks, prevents us as yet from assigning to them a particular character. Nevertheless the species in the collection of Mr Murchison already indicate types which do not extend even to the coal formation.

"What is most remarkable in all the fishes inferior to the oolitic series, besides their analogy with reptiles, is, on the one hand, the very great uniformity of the types, and, on the other, the very great uniformity of the parts of the same animal among themselves; so that it is often difficult to distinguish the scales, the bones, and the teeth from one another. If we may be permitted to hazard some conjectures on this state of things, such as it is presented to us now, we are naturally led to think, that the principle of animal life, which developes itself at a later period under the form of ordinary fishes, reptiles, birds, and mammiferous animals, is at first entirely confined to those singular sauroid fishes which partake at the same time of the structure of fishes and reptiles, and that this mixed character is not lost in this class till the appearance of a larger number of reptiles, in the same manner as we see ichthyosauri and plesiosauri partaking in their osteology of the characters of the cetacea, and the large land saurian animals partaking of the characters of the pachyderma, which were not created till a much later period.

"We are thus led by observation to those ideas of the philosophy of nature which have presented us with an organic and regular development in all created beings, constantly in conformity with the different conditions of existence which are realized at the surface of the globe, in consequence of the changes which it itself has undergone.

"As a result of all the facts I have brought forward, I distinguish, in the whole series of geological formations, two grand divisions, which have their limit at the greensand deposit. The first, the more ancient, includes only the *Ganoïdes* and *Placoïdes*. The second, more intimately connected with beings at present in existence, includes forms and organizations much more diversified; these are more particularly the *Ctenoïdes* and the *Cycloïdes*, and a very small number of species of the two preceding orders, which disappear insensibly, and of which the analogous living species are considerably modified. As we do not find in the fishes of the first great period, differences corresponding to those which we observe at the present day between fresh water and salt water fishes, it appears to me that it is going beyond the facts we possess to admit in the oolitic series and lower down, the existence of distinct fresh water and marine formations. I think rather that the waters of these remote periods, circumscribed in basins less completely shut in, did not then present the marked distinctions which we remark at the present time."

At the same meeting of the Society an extract was read of a report by the lighthouse keeper at Lismore, of a small flock of brent geese having been attracted by the light in a dark and stormy night, and killed by the violence with which they struck the building. One of the birds happening to strike a pane of the light-room, formed of plate-glass a quarter of an inch thick, passed through it like a shot, with such amazing force, that pimples were raised on the polished metallic reflectors by the particles of the shivered glass.

A model of the head of the Dodo, which is preserved in the Tradescant collection at Oxford, presented to the College Museum by Mr Duncan of Oxford, was exhibited at this meeting, and an account was given by Professor Jameson of what is known respecting that bird, described by Clusius in 1598 as inhabiting the Mauritius, but which appears to be now extinct.

Feb. 21. Sir Patrick Walker, V. P. in the chair.—Mr Macgillivray read Remarks on varieties of the Fox observed in Scotland. The author distinguished four races or varieties: 1st, The *Hound Fox*, tall, slender in the limbs, with a very attenuated muzzle, a bright reddish-yellow fur, the lower parts of the body greyish-white, the tail yellowish-grey, with long black hairs scattered towards its extremity, and about three inches of the tip white. 2. The *Cur Fox*, similar to the Hound Fox, but smaller, with the body deeper, the legs shorter, the tip of the tail white. These two races seem to pass into each other, and can scarcely be distinguished, excepting in the extremes. 3. The *Dog Fox*, compact in form, with comparatively short limbs, the head rather broad, the muzzle pointed, the fur deep red, the lower parts brownish-red, the tail yellowish-grey, darkened with black hairs, and having the tip of the same colour. 4. The *Mastiff Fox*, larger and stronger, its limbs more robust, the head much broader, a dull greyish-yellow fur, profusely interspersed with whitish hairs, the tail dusky, with long black hairs scattered over it, and a small white tip.

A paper by Mr Hay Cunningham was then read, on the Geology of the Islands of Eigg, Rume, and Canna. The memoir was prefaced by some interesting remarks on the distribution of the newer members of the secondary class in the mainland and islands of Scotland. The author then entered into a detailed account of the stratified and unstratified rocks of which the three islands consist, and dwelt particularly on the mineralogical characters and geological phenomena presented by the various members of the trap series. The paper was illustrated by sketches of sections, and by specimens of the rocks and simple minerals of the islands.

At the same meeting there was read a paper by Mr James Macnab, on the local distribution of trees in the native forests of North America. (This memoir, so creditable to the young author as an accurate observer, has been published in the Quarterly Journal of Agriculture, No. 28.)

There was placed before the meeting a series of birds from the Himalaya Mountains, most of which were considered identical with the European species, including the Gypaëtos barbatus; Falco tinnunculus, subbuteo; Nisus communis; Circus cyaneus, cineraceus, æruginosus; Lanius excubitor; Oriolus galbula; Turdus merula; Gracula rosea, cyanea; Sylvia rubecola, tithys; Saxicola stapazina; Curruca atricapilla; Sturnus vulgaris; Upupa epops; Picus major, viridis; Yunx torquilla; Pyrgita domestica; Anthus arboreus; Hæmatopus ostralegus.

March 7. Bindon Blood, Esq. V. P. in the chair.—Sir P. Walker exhibited a specimen of a small species of the Mus family, possessing some of the characters of the Marmot, which has been found on his property at Drumsheugh in the neighbourhood of Edinburgh, its haunts having been disturbed by the progress of building.

Mr Macgillivray then read some observations on the Dipper, Cinclus aquaticus. The peculiarities of form and plumage adapting it for its amphibious mode of life were pointed out, and its habits minutely described. The alleged injuries to the salmon-fisheries by this species were rendered doubtful by the results of the author's observations, he having never found any ova or fry of fish in its stomach, which was usually found to contain fragments of coleopterous insects and mollusca, especially Lymnæa peregra and Ancylus fluviatilis.

Dr Traill then exhibited a series of beautiful and correct drawings of British quadrupeds, cetacea, birds, reptiles, and fishes, executed by Mr Macgillivray, in whom, he remarked, the naturalist and artist are fortunately united, and which are intended for his projected great work, on the Vertebrate Animals of Great Britain. The Society also expressed a very favourable opinion of these drawings.

There was then read Mr Nicol's account of his examination of the specimens of fossil wood from the Island of Mull, collected by Mr Cunningham ; also of various specimens from the North-African Desert and the Karoo Ground in Southern Africa. (This interesting paper is printed in the present Number of this Journal, p. 339 *et seq.*)

Proceedings of the Society for the Encouragement of the Useful Arts in Scotland.

The following communications were laid before the Society during the months of January and February 1835 :—

January 28.—1. Drawing and Description of a new Reed Instrument, called " The Caledonica." By Mr William Meikle, Townend, Strathaven.—The instrument was exhibited.

2. Drawing of his Improved Oboe and Bessoon. By the same.—The instruments were exhibited.

3. Petition of William Scott, wright and turner, Kinloch-Rannoch, by Pitlochrie, in regard to a machine constructed by him.—The machine was exhibited.

The following gentlemen were admitted ordinary members, viz.

John S. Russell, Esq. 8 Stafford Street.
David Christie, Esq. 20 Forth Street.

February 11.—1. An Easel for Painters, on a convenient construction. By John Robison, Esq., Sec. R. S. E., and Couns. Soc. Arts.

2. Description and Drawings of Improved Gas-Burners, by means of which one-third less of Gas is consumed, and the Light at same time rendered more pure and bright. By Mr Alexander Grant, surgeon and druggist, Broughton Street, Edinburgh.—Burners were exhibited.

3. Model and Description of a new method of constructing Wooden and other Bridges. By Mr James Edgar jun., 6 Newington Place, Edinburgh. Communicated by Dr D. B. Reid.

4. Notice of an Improved Latch for the Front Doors of Dwelling-houses, stronger, more durable, not requiring to be so often cleaned, and having a superior appearance, with no greater expense than those now in use. By Mr William Greig, smith, 133 Rose Street, Edinburgh.—The latch was exhibited.

5. Donation—The Pernicious Effects of Sea Insurance. Printed at Kirkaldy, 1834. Presented by Mr James Ballingal, Kirkaldy, Author of a Plan for Improving the Mercantile Navy of Great Britain and Ireland.

6. Donation—No. VII. of Loudon's Architectural Magazine. From the Author.

The following gentleman was admitted an ordinary member:

Alexander G. Groat, Esq. of Newhall, advocate.

Feb. 25.—1. Suggestions of Modes of Printing and Cyphering for the use of the Blind. By James Simpson, Esq. advocate.

2. Modes of Teaching the Blind to Read, &c. By Mr Dixon Vallance, Libberton, Lanarkshire.

3. Observations on the Liverpool aud Manchester Railway. By Mr David Stevenson, 1. Baxter's Place. Communicated by the Secretary.—Illustrative drawings were exhibited.

4. Donation—Nos. VIII. to XII. inclusive of Loudon's Architectural Magazine.

The following gentlemen were admitted ordinary members, viz.

Gilbert Marjoribanks, Esq. Accountant, Edinburgh.

James Hay, Esq. Merchant, Leith Links.

Corrections in the Number for July 1834 *on Dr Davy's papers on Euchlorine, and supposed errors of Sir H. Davy.*

Page 42, line 10, *for* decomposition *read* composition—page 44, line 8, *for* ought *read* weight—page 45, line 19, *for* in *read* or—page 46, line 6, *for* in *read* on—page 47, line 16, *for* rest *read* went—page 51, line 13, *for* . The *read* , the—page 52, line 37, *for* or to *read* on the—page 53, line 14, *omit* are

Corrections in the Number for October on Dr Davy's paper on Silicated Fluoric Acid Gas.

Page 243, line 13, *omit* Royal Society—page 244, line 17, *for* mass *read* excess—page 244, second line from bottom, *for* as *read* on

ADDITIONAL NOTICES.

Account of Artificial Felspar, by Professor Kersten.—Professor Kersten, as appears from a Number of Poggendorf's Annalen, No. 22. for 1834, has found distinctly formed crystals of prismatic felspar on the walls of a furnace, in which copper slate and copper ores were melted. Among these *pyro-chemically* formed crystals, some were simple, others twin. The surface of the crystals was smooth or vertically streaked; fracture conchoidal. Lustre of the crystals vitreous, and colour rose red, passing into violet blue. Are opaque, brittle, and hardness = 6 of Mohs' scale. Chemical trials proved that they are composed of silica, alumina, and potash, consequently the same constituents as felspar. As accidental parts, traces of manganese and lime may be mentioned. Mitscherlich, who examined these artificial felspar crystals, says, they exhibited the primitive planes of the oblique prism, and were truncated on the acuter lateral edges; a distinct cleavage was observed parallel with the truncating and terminal planes, which meet under an angle of 90°. Hitherto every attempt to make felspar crystals by artificial means has failed; hence, in a geological point of view, this fact of Kersten's is of very great importance.

Crystals of Oxide of Chrome.—Professor Wohler has prepared beautiful crystals of this mineral. These crystals were both single and twin, belonging to the same rhomboidal series as corundum. One of the most interesting features in these crystals is their great hardness, it being equal to that of corundum.

Phosphate of Lime in the Teeth, and Silica in the Skin, of the Infusoria.—Rose of Berlin has ascertained, that the hard parts which in certain tribes of infusory animals are called teeth, are composed of phosphate of lime; and that the hard case or cover with which many of these minute creatures are protected, is composed of silica.

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