THE

EDINBURGH NEW PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

CONDUCTED BY

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⁂ Want of room prevents the notice of several Works, and also the insertion of Literary and Scientific Intelligence.

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THE

EDINBURGH NEW PHILOSOPHICAL JOURNAL.

Remarks on the Formation of Alluvial Deposites. By JAMES YATES, M.A. F. L. S. and F. G. S.* Communicated by the Author.

ALTHOUGH the formation of alluvium seems to have been very commonly regarded by geologists as a branch of their science too simple and elementary to be worthy of minute attention, yet in some respects it appears to claim a more exact study than any other class of geological appearances. As we can only infer the past history of our globe from our knowledge of the powers which are now in operation, alluvial deposites must be regarded as the proper index to guide our conclusions respecting the origin of analogous but more ancient strata. In another point of view they are also extremely interesting. By the cursory observer, storms, torrents, and inundations are regarded in no other light than as the agents of ruin and desolation: whereas, if their effects be duly examined, they will be found to be the very processes, by which the most barren rocks and inaccessible mountains are converted into scenes of fruitfulness, beauty, and animation. The Aiguilles of the Alps in their undisturbed position, can scarcely sustain the life of a moss or an insect. By a succession of changes, which will be described in this paper, they are converted into the finest soil, removed into cultivated regions, and made to support every conceivable form

* Read before the Geological Society of London in November 1830.

of animal and vegetable life; and, from the first origin of organized beings, similar processes must have been necessary to afford the means for their growth and propagation. We may further remark, that the laws of alluvial action form an indispensable and very prominent part of the science of *Hydrography*, and that without due attention to them, *Comparative Geography* must remain exceedingly imperfect. Even the most recent maps of the ancient world, edited by Reichard, Cramer, and the Society for diffusing Useful Knowledge, are so delineated as to remove ancient sea-ports to a great distance from the sea, and to include in the Continent what were formerly islands, so that many alluvial tracts in these maps are only ancient, in as much as ancient names are written upon them.

The observations which I shall venture to offer to the Society, will relate to the four following branches of the subject:—

1*st*, The preliminary processes of disintegration, not immediately dependent upon the action of running water, by which materials are furnished for the formation of alluvium.

2*dly*, The action of running water in distributing these materials over level or inclined surfaces.

3*dly*, The effects produced, when such materials are conveyed by *running* into *standing* water.

4*thly*, The case of a stream of water, which meets a stream flowing in another direction.

My views upon these subjects are founded upon observations made both in this island and in various parts of the Continent, but especially in Switzerland ana Savoy.

I.—*On the Preliminary Processes of Disintegration, not immediately dependent upon the Action of Running Water, by which Materials are furnished for the Formation of Alluvium.*

The question has often been debated, whether water, flowing with the greatest possible velocity, or in the largest volume, is sufficient by itself to erode the harder rocks, or to excavate in them ravines and valleys. My own opportunities of observation would lead me to answer this query in the negative. The unshaken solidity and durable forms of rocks and pebbles, which are exposed to the attrition of simple water, prove that its action, where perceptible in any degree, is exceedingly slow, and its effects inconsiderable. But very different are the appearances exhibited, when a stream of water is charged with fragments of rock, previously loosened and thrown within its reach. Such fragments not only impel and batter one another with tremendous fury, but shake, loosen, and separate their kindred rocks, which are in place, and destroy, to a much greater extent, the softer strata, to which they are carried. Hence the separation of fragments of rock by agents, distinct from flowing water, requires to be considered as the first step towards the formation of alluvium.

The processes of separation are of two kinds; in the one case, great masses are detached suddenly, in the other, the progress of disintegration is slow, gradual, and constant.

1. The sudden separation of a great mass is often called the fall of a mountain: but the term *Landslip* appears more appropriate. A slice from the side of a mountain is all that really falls.*

In all mountainous countries, which are subject to *earthquakes*, and in Switzerland among the rest, these events are sometimes attended by the sudden fall of great masses of earth and rock. Thus an earthquake is said to have detached parts of the mountain of Glärnisch, Canton of Glarus, in the year 1593. But such instances are very rare.

Landslips commonly take place, not in primitive mountains, but in the more recent and distinctly stratified formations, whether calcareous or sedimentary. The rocky strata of these formations are occasionally separated by a bed of clay, and still more frequently by a yielding shale or sandstone. Water, slowly insinuating into the clay, converts it into mud, or it gradually carries away portions of the soft shale or tender sandstone. When this has been done, the superincumbent stratum of rock, if destitute of support underneath, slips down, resolving itself into innumerable fragments. It is accompanied in its fall by rocks, woods, fields, houses, and whatsoever else rests upon

* See De la Beche's *Sections and Views*, Plate 33. "Fall of the Rossberg (conglomerate); also Pl. 35. fig. 3. Pinhay Cliffs, Lyme Regis (chalk); and Pl. 38. fig. 5. Diablerets (limestone).

it. If the loosened strata fall into a valley, a large part of the fragments is thrown across its bottom, and even to a considerable distance up the opposite declivity; so that the appearance of the ruin is that of an enormous wave, rushing down one side of the valley, dashing up the other side, and there arrested and fixed.

Another circumstance, by which we may recognise the existence of a landslip, is, that the large fragments are often composed of several strata; whereas, by the more gradual processes of disintegration, hereafter to be described, the strata are always cleft asunder, and the form and size of the fragments is determined by the *structure of separation* of the parent rock, which is subdivided as minutely as is conformable to that structure. While going through the pass of the Gemmi, in the Canton of Valais, where it borders upon the Canton of Berne, I observed, amidst the extensive ruins of a landslip, numerous masses of thinly stratified limestone, bounded on four sides by cleavages perpendicular to the planes of stratification, and hence bearing a strong resemblance to square towers of mouldering masonry. These masses are thrown on every side in wild confusion, often lying prostrate upon the ground.

The fall of mountain masses across valleys sometimes produces *lakes*, by arresting the water flowing from above. The *Öschenen-see* in the Canton of Berne is a fine example of such a lake. It occupies the head of a narrow valley, and is overhung by lofty mountains, the perpendicular sides of which constitute its eastern boundary. Several cascades fall immediately into it from the impending snows and glaciers. The dam, thrown across the valley so as to form the western boundary of the lake, consists of loose angular masses of limestone; and, on looking up to the mountain on the south, we see, directly above the dam, the smooth surface of a stratum of limestone, totally cleared of its former burthen of earth and rocks, and inclining towards the valley. A considerable part of the dyke is now covered with fir-trees, which prove the ancient date of the slip, although the cleared and sloping stratum above remains destitute of vegetation, in consequence of its great height. The water of the lake escapes through the broken masses of the dyke. Rather turbid, as it enters, it emerges in numerous clear springs, and forms a beautiful mountain stream, called the *Öschenen-bach.*

On comparing those cases of landslips in the Alps, which are attested by living witnesses, or by written records, with similar appearances, such as those now described, respecting which history is silent, we are enabled to draw the conclusion, that landslips have occurred very frequently in the stratified mountains.

2. But, notwithstanding the frequency of landslips in the Alps, and their very striking and terrific appearances, their supply of materials for alluvial action is inconsiderable, compared with the quantity furnished by those agents, such as frost and oxidation, which separate rocks more gradually and more constantly.

No clearer examples of the agency of frost in disintegration can be found than in the large masses which fall upon the sea-shore from our own chalk-cliffs in the course of every winter. Upon all rocks, in every situation, freezing water acts in a similar way. But in mountains of sufficient elevation, water freezes only in the summer; and then, by melting and freezing every successive day and night, it must exert a proportionably greater effect in loosening the rocks, into the exposed parts of which it has penetrated. The more frequent freezing of water in a great elevation is the necessary consequence of the nearer approach of the ordinary temperature of the place to the freezing point, and its effect is seen upon the glaciers, where, during summer, innumerable small pools are, in the morning, covered with a pellicle of ice, and in the middle of the day converted into flowing rills. We only need reflect on the corresponding daily change in the surfaces of the rocks, by which these glaciers are surrounded, in order to be satisfied that the effect of frost must be greater in cold than in temperate regions.

The older rocks disintegrate more or less rapidly, in proportion as they are more or less prone to oxidation. Hence we sometimes find granite and other primitive rocks hard, smooth, and tough, to the very moment when they fall; and, at other times, the slightest blow of the hammer separates them into flakes, or with the hand alone we may reduce them to coarse sand. In all their various degrees of comminution, we find these rocks upon the summits of the Alps as well as in lower situations, and hence we see different glaciers either embrowned with gravel, or loaded with boulder-stones. An adventurous traveller, Dr Hugi, states, that it is dangerous to walk at the foot of the Lauteraarhorn, and some other ridges, on account of their extreme tendency to decay*.

Rocks, which fall by these gradual processes, always divide according to their natural *structure of separation*, and hence every distinct concretion of the rock becomes a separate fragment of its debris.

Two principal forms of mountain masses result from this law. The *first* is that exhibited chiefly by all calcareous and all conglomerate or sedimentary rocks. These are commonly arranged in strata, which approach more or less to an horizontal position, and their cleavages, crossing one another in various directions, are nearly perpendicular to the planes of stratification. The fragments, separated from them, continually expose fresh cleavages, and the mountain side exhibits the appearance of vast walls, while its detached summits take the form of mighty towers. These walls can only be ascended by means of the projections of the strata, or of slight inequalities in the cleavages, and hence Mont Blanc itself is more accessible than many Swiss mountains of less elevation, which consist in a great measure of limestone. The debris of these rocks is disposed with great regularity at the base of the vertical walls, its largest fragments rolling or sliding to the bottom of the talus; and the consequence is, that such an eminence is characterized by three principal lines, viz. the summit of the wall, the summit of the talus, and the base of the talus,—all parallel to the lines of stratification in the rock.

(The drawing, Plate I. Fig. 1., is designed to show this form. It represents part of the Selisberg, on the Lake of Lucerne).

The *second* principal form, resulting from the above law of disintegration, is presented by many of the schistose rocks. The strata are in this case highly inclined, and the cleavages meet the planes of stratification at an acute angle. The distinct concretions have the figure, often very exact, of rhomboidal crystals. The outline of the mountain mass consists of pointed summits, the form of which resembles that of the distinct concretions.

* Natur-historische Alpen-reise, 1830, pp. 236, 246, 367.

PLATE I.

Edin. new Phil. Jour Vol. XI p.6.

Fig. 1.

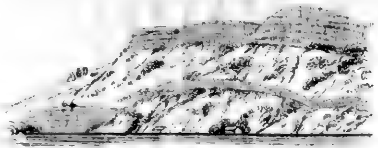


Fig. 2.

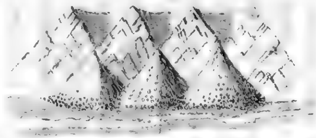


Fig. 3.

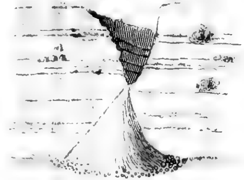


Fig. 4.

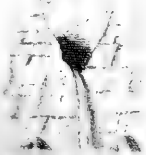


Fig. 5.

Fig. 6.

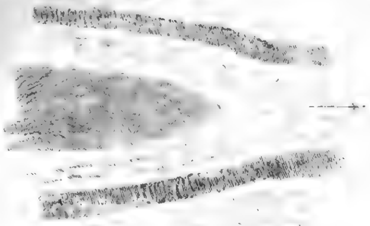


Fig. 16.

PLATE I.

One side of each peak is formed by the surfaces of the exposed strata, the other side by the cleavages of the strata, and from the latter side the fragments chiefly fall. The debris, discharged from the bottom of the hollow, which separates two contiguous peaks, assumes the form of a cone; and hence, in mountains of this character, we sometimes see a row of conical masses of rock in place, and below them a corresponding row of cones of debris issuing from the intervening hollows. In this, as well as in the preceding case, the largest fragments fall to the bottom of the slope, and, in both cases, the angle of inclination approaches 45°.

This second form of ruined mountains is less obvious than the first, because, to perceive it, it is necessary that the observer should look along the planes of stratification and cleavage, which he can do only from certain points of view. It is often found in the slate on each side of the Rhine in Germany, and may be discerned not only in the bare rocks, but in hills covered with vegetation. Thus, at Bad-Ems, we see it in the beautiful wooded eminence on which the Moos-hütte is erected, when we stand on the opposite side of the Lahn.

The *Acute Cone* (as we may call this form of debris) often exhibits, towards its summit, an approach to a spiral figure, arising from the obliquity of the ravine to the mountain side, down which it discharges its loose contents.

(The drawing, Fig. 2., shows part of a mountain on the south side of the Col de la Seigne, on the confines of Savoy and Piedmont, with a series of peaks, intervening hollows, and cones of debris. Fig. 3. shows the modification of the Acute Cone, arising from the obliquity of the ravine to the mountain side.)

Rocks, which are either not at all or less distinctly stratified, and the masses of debris emitted from them, assume forms, according to circumstances, more or less approaching those which have been described. Nothing is more common than to find a ravine in the steep face, not only of schistose rocks, with an internal rhomboidal structure, but of granite, gneiss, mica-slate, and other primitive rocks, and even of stratified limestone, grit, or conglomerate: in all such cases, the earth and stones, discharged from the ravine, will make an Acute Cone. If, on the other hand, the unstratified rocks rise in long walls, as is often the case with basalt and greenstone in particular, their debris will form a regular talus. Nevertheless, the two forms of mountain masses which have been described, are in nature strongly contrasted, and usually characterize the rocks to which I have assigned them.

In illustration of these preliminary processes, I shall only further observe, that, in the highest mountains, the loosened earth and stones fall upon masses of ice and snow, which carry them many miles, and that, having been transported from their source, they descend by their own weight into such slopes as have been delineated.

II.—*On the Distribution of Debris by Streams flowing over inclined or level surfaces.*

Fragments of rock and masses of earth, falling by their own weight, rest in a steep slope. If the force of running water be united to their weight, it carries them much farther, so as greatly to diminish the steepness of the slope. Hence, if a ravine discharges water as constantly as earth and stones, instead of an acute cone of debris we see a cascade, which forms a basin within the debris, and then a ravine across it; and through this channel the torrent continually discharges both its water and its solid contents. In such cases the form of the Acute Cone is almost obliterated by the removal of its upper and more characteristic portion. (See the sketch, Fig. 4.) But the lengthened talus, so commonly found at the base of calcareous, sedimentary, or trap-rocks, retains its form, except that it is scalloped or indented by a ravine under each cascade. (See sketch, Fig. 5.)

The mass of debris is, however, chiefly acted on, not by water thus accompanying it in its fall, but by streams meeting it transversely. The materials carried, to borrow an expression from chemistry, *in the dry way*, and disposed into the form either of a talus, or an Acute Cone, or perhaps originating in a landslip or in an earthquake, commonly fall down the sides of some glen or valley, at the bottom of which flows a torrent. The torrent, fed by numerous cascades, springs, and rivulets, exerts upon the base of these masses a force proportioned to its depth and rapidity. Then, first, the angular fragments begin to be rounded into boulder-stones and pebbles. By continually rubbing, grinding, and beating upon one another, and upon the sides of their channel, and by the renewal of this action during their passage through great distances, they are converted into all the varieties of *detritus* from vast boulder-stones to the finest sand or mud. In these varieties we find detritus reposing in all those parts of glens and valleys which are sufficiently level and expanded to afford it a resting-place; and, from these temporary resting-places, it is liable to be removed whenever the volume of water is sufficient to overcome the obstruction*.

The effects produced by a stream of water depend not only on its depth, volume, and rapidity, and on the quantity of solid materials with which it is charged, but also on the nature of the channel through which it passes. A comparatively small force being necessary to remove loose earth and stones, it will chiefly carry forward the materials, furnished by the processes which have been described in the former part of this paper, or already deposited by the same stream in a previous period of its action.

A case of the first description I had an opportunity of observing last summer in Savoy. The cliffs on the right hand of the valley of the Arve, going from Servoz to St Martin, consist of stratified limestone, with numerous softer beds of black sandy shale. At this spot one of the greatest landslips occurred in 1751. The ruin covers more than a square league, and is crossed by a small torrent, which is called the *Nant Noir*, in consequence of its blackish colour. This stream, seemingly inconsiderable, is continually undermining its banks. At the beginning of last July a greater quantity of rain than usual had caused it to act more vigorously, so that its channel was excavated to the depth of 100 feet, and the surface of the ground, on each side of it, marked by fearful rents. Only a week before I saw it, the water, pent up for a short time by fallen masses, in an instant broke through this barrier, and unfortunately carried away the supports of a bridge, while two men

* Dr Hutton (Theory of the Earth, vol. ii. p. 154. Part ii. ch. iv.) denies that rounded pebbles can be "thus worn by travelling in the longest river;" and maintains that the attrition, which produced their form, was that of the waves of the sea upon some former coast. Nevertheless, we trace these pebbles through the valleys up to the rocks, from which they have fallen, and every stream which rolls them exhibits an impelling force not inferior to that of the ocean's waves.

were passing over it. Ten years ago the passage of the Nant Noir was interrupted by a similar accident.

Next to debris and detritus, the softer strata, which are in place, yield to the action of flowing water. Beds of shale, similar to those which occasioned the slip at Servoz, always give to alpine torrents that traverse them the colour of the Nant Noir; and in various instances, where quantities of water are retained in the soft strata of clay or shale, they burst forth in the state of thick mud, carrying variously-sized fragments of rock. Even the softer kinds of graywacke and clayslate are very quickly eroded, so that in the Eifel I have seen deep gullies worn in such slate by the side of a newly made road, where it could have been exposed but a few months to the action of the rain-water.

The same law, which has been mentioned as regulating the disintegration of rocks, independently of the action of streams, also modifies the action of running water. The fragments which it removes are very frequently portions, the forms and boundaries of which are determined by the *structure of separation*, which characterizes the parent rock. The ravine in the annexed sketch (Fig. 6.) shows, on the one hand, a smooth highly inclined plane, which is either a seam or a cleavage in the mountain mass; while, on the other, the distinct concretions are gradually worn away and cut through in every direction. In the falls of Imatra, as represented by Mr Strangways *, the same principle is well illustrated, the sides of the chasm being formed by highly inclined strata of gneiss. In nearly all cases the action of streams appears to be directed to those parts of the rocks exposed to them, which have a natural tendency to yield to their action. Hence we not only find that ravines follow the course of pre-existent rents, but we observe valleys hollowed at the junction of distinct formations, where, generally, the rocks of each formation are more subdivided, more indeterminate in their character, and more prone to disintegration. Thus, in the long valley which forms the western boundary of the group of Mont Blanc, extending from the Col de Bon Homme to St Gervais, the Bon Nant separates the schistose from the calcareous mountains; the same general fact is exhibited on a sub-

* Geological Transactions, vol. v. Plate xviii.

lime scale in the Allée Blanche; and in two of the lateral glens of the Valorsine, the torrents of La Poyaz and Barbarine flow at the junction of the granite and the slate. Another appearance, also dependent upon structure, and upon the subordination of aqueous action to that structure, is seen in the parallelism and conformity of valleys excavated in the same mountain-ridge. If we look along a straight valley situated at the base of such a ridge, the summits of the minor ridges separating the lateral valleys, which descend into the principal valley, form so many parallel lines. The sketch (Fig. 7.) is an exact outline of several of the ridges of Mont Blanc, as seen from the eminence of La Flegere, and shows the similarity of the valleys which contain the successive glaciers of Les Pelerins, Bossons, Taconaz, &c.

On the harder and less separable rocks, such as limestone and slate in thick solid strata, or granite and porphyry, the action of streams is far more gradual, and is accomplished by a very distinct and curious process. The stones, whirled round by the water, form hollow cylinders at the bottom, and segments of such cylinders in the sides of the channel; and these cylindrical impressions go on multiplying, deepening, and enlarging, until they intersect one another, or the seams and cleavages of the rock, and thus separate it into fragments of all shapes and sizes. The bed of the Avon, in Lanarkshire, a short way from its junction with the Clyde, is thickly perforated with holes, about the size and shape of a drum of figs. Traces of the same operation may be observed in the Clyde itself about Cora Linn. A very fine example of a cylinder is now presented in a rock, which divides the stream of the Hinter-Rhein, in the upper part of the gorge of the Rofla, Canton of Grisons. We see here two beautiful cascades in the middle of the river; one falls into the cylinder, the other constitutes its overflow. Large and frequent segments of cylinders are seen in the high walls of chlorite-slate, which form the sides of this gorge. But nowhere probably can the phenomenon be better seen than by walking along the scaffold, which leads at the bottom of the frightful gorge of the Tamina, from the Hotel at Pfeffers-bad to the hot-spring, through a distance of more than a quarter of a mile. The cliffs of limestone here amount to several hundred feet in height, and are marked, at frequent intervals, either by vast cylindrical impressions, or by the cleavages which these impressions have intersected *.

It is manifest that this peculiar action of stones in water depends upon the structure of the channel. The distinct concretions of the rock, and its less yielding portions, project in salient angles, which drive the current, with its load of stones, against the opposite wall, and, by repeated blows, it is chiselled into the forms which we now survey.

Another characteristic circumstance of gorges thus formed, is their astonishing depth and narrowness. In various alpine valleys we see them some hundred feet deep, while the opposite rocks are as near each other at the top as at the bottom of the gorge, sometimes nearly touching, and never many yards asunder. This, however, manifestly results from the grinding action of the stones, which, as they occupy the bottom of the stream, must always tend to deepen the channel, not to widen it.

Here the question arises, If alluvial action produces only deep and narrow gorges, is it not necessary to assign some other cause for those more expanded valleys, at the bottom of which they are situated † ?

Without presuming to deny the possibility of other modes of action, it appears to me, that the formation of more expanded valleys above the gorges (as represented in the section, Fig. 8.) is a necessary consequence of the process which we are considering. Notwithstanding the extraordinary form of these gorges, when excavated in remarkably hard and solid rocks, the time must come when their walls, not only intersected by seams and cleavages, but subject to the action of numerous lateral torrents, and of powerful atmospherical influences, will collapse by their own weight; and, as we see banks of sand, clay, or gravel, fall in large flakes, as the stream undermines them, so the solid and

* See also the paper of Mr Strangways above referred to, Geological Transactions, vol. v. p. 341, and Plate xviii., fig. 1. and 2., F. Sir T. D. Lauder, in his instructive and valuable "Account of the Great Floods of August 1829," 2d edition, p. 365, mentions the appearance of these "circular holes" in the mica-slate of the Cuach, a tributary of the Dee in Aberdeenshire, "the shaking of the rocks" at one of the falls of this stream, and the removal by it of "immense masses" from the walls.

† De la Beche's Geological Notes. London, 1830. 8vo. No. III.

perpendicular walls of alpine gorges must in time give way from the same cause, the erosion of their base. In all the gradations from the hardest granite to the most yielding sand, it will follow, that the more durable the banks of the channel, the more deeply must that channel be cut before they will collapse; and hence in all valleys of erosion, as a general rule, the width of the valley will exceed its depth, in proportion to the softness of the materials composing its sides. One river meanders in an expanded vale between banks of clay, sand, or gravel, a few feet in height; another flows at the bottom of a deeper valley between cliffs of chalk or sandstone; and a third at the base of precipitous mountains, where it is often concealed from sight between lofty walls of the older rocks.

The inclination of any mass of sediment is found to correspond to the inclination of the current, by which it is deposited. Of the forms of alluvium resulting from this law, one of the most striking is the *Obtuse Cone*, which is to be seen in every alpine valley, where streams enter it through ravines or smaller lateral and more elevated valleys. The same form also frequently presents itself on the margins of lakes at the termination of such ravines or valleys. (See the Sketch, Fig. 9.)

The obtuse cone makes an angle with the horizon of from 5° to 15°. In many cases its apex is not less than 500 feet higher than its base, and its diameter 3 or 4 miles. It is distinguished from the acute cone, not only by the obvious difference of form, but by the circumstance that the largest fragments remain at the top of the cone, and the finest are washed to the bottom; whereas, in the acute cone, the reverse arrangement takes place.

Every obtuse cone, in the present state of the Alps, exhibits several varieties of surface. A space, enclosed by two radii proceeding from the apex, serves as the bed of the torrent. It exhibits a sloping surface, consisting entirely of boulder-stones and coarse gravel, over which the current takes various directions, and continues to deposit its solid contents. Another large portion, especially the higher part, consists of similar rough materials, but is covered either with a forest of firs, or with alders and other coppice-wood. Other parts are destitute of trees, and not more productive than the stony flanks of high mountains usually are, bearing a little coarse grass intermixed with herbaceous plants. A more fertile portion, occupying in general the lower part of the cone, is covered with orchards and cultivated fields, with cottages and hamlets. Some of the largest villages in the alpine valleys are situated upon such cones near their base. The path leading to the parish church of Chamonix, rises from the village a short way up a very regular and richly cultivated cone. Mayenfeld, a town in the Canton of Grisons, is on the declivity of an obtuse cone, which is crossed by one of the great roads leading from Italy to Germany between Chur and Feld-kirch. Matt and Linth are two villages, beautifully situated very near one another, on an obtuse cone in the Linth-thal. These cones being at the base of ravines or lateral valleys, which descend rapidly from the highest ridges, it is easy to trace the origin of their materials. The Chamonix cone is formed by the excavation of the Breven; that of Mayenfeld is in the same way derived from the Falkniss. In going from Sitten (Sierre) to the Baths of Leuk, Canton of Valais, we see a splendid example of the formation of an obtuse cone. Receding northward from the Rhone up the transversal valley of the Dala, we observe, on looking back, an obtuse cone of extraordinary dimensions, with a vast ravine rising from its apex directly up the southern declivity of the valley. As we ascend, we are able to trace further and further the course of the stream which passes through this ravine, until we see its whole length in one nearly straight line. We view it issuing from its glacier, descending through successive stages of the mountain ridge, and at length diffusing itself over the barren sector of the flattened cone.

The sketch No. 10, represents the head of the Lake of Brientz. On the left is seen an obtuse cone, which terminates on the border of the lake, and extends almost to the mouth of the Aar. Krenholtz stands upon it, formerly a more important place than the neighbouring village of Brientz, but once nearly obliterated by the descent of an unusual quantity of calcareous debris and mud from the ravine above it.

With respect to the origin of the obtuse cone, it may be observed, that its formation depends upon the comparative quantity of water and debris brought down the ravine. If the quantity of water so much exceeds the quantity of debris as to carry nearly the whole of it away, a cascade remains, as is represented in Fig. 4, and seen in the well-known example of the Pissevache. But if the quantity of solid matter is too great for the water, an obtuse cone is formed with its apex at the mouth of the ravine. If the torrent has yielding materials to work upon, the quantity brought down by it is often so great as to make it appear rather a solid than a fluid substance, and to overspread the surface of the cone to an enormous depth. Hence the Alpbach above Meiringen, in the Canton of Berne, has twice proved nearly fatal to that village by burying it in "lias-marl," notwithstanding the vast mounds of stone, diverging from the apex, which were built nearly a century ago to restrain its ravages. A village near Aigue-belle, in Savoy, was enveloped by the same process in 1752, so that only the tower of the church was left rising above the sediment, which formed a stratum 15 or 20 feet thick *.

The obtuse cone often has the effect of obstructing the course of a river, so as to produce inundations. The abundance of earth and stones brought down by the lateral stream is occasionally so great as to hem in the principal stream, which thus forms a lake above the dam. But from the nature of the materials, the obstruction is easily removed; the principal stream swells again, asserts its pre-eminence, rapidly tears away the base of the encroaching cone, and sinks again to its former level. The effect of this abrasion of obtuse cones by the principal stream is seen in planes cutting across them near the base, and inclining at an angle of about 45° to the horizon. These steep declivities, if we may judge from the forest trees growing upon them, are often not less than 100 feet high. They occur more frequently in proportion to the narrowness of the valley. In the Linth-thal, which descends with uncommon rapidity, and has numerous lateral valleys, the cones occur so frequently as to en-

* De Luc, Lettres sur l'Hist. de la Terre, t. ii. p. 75.—I have found De Luc's account of the alluvial and disintegrating processes in the 30th and 31st letters remarkably correct and interesting. He designates the form of alluvium, which I am describing, by the general term *cone,* and says, p. 67, that it has the shape "d'un pain de sucre fort applati, coupé par son milien du sommet à la base."

croach on one another. Hence they must have operated more effectually in producing occasional stoppages of the river, which, on regaining the mastery, has cut away the bases on either hand.

This form of alluvium (Fig. 11) may be distinguished as the *obtuse cone truncated at the base.*

After the clipping of the base, the obtuse cone becomes subject to a still further modification. The streams, which, in its entire state, might have flowed in every direction pretty evenly from its summit to its base, are diverted from their course on arriving at the edges of its steep declivities. They immediately begin to cut through the edges, and thus intersect the declivities with ravines. A very beautiful and distinct example of an obtuse cone thus modified is seen in the valley of the Reuss some miles above Altorf. The high road passes over it a little below Amsteg. The ravines formed in its truncated base are large and verdant, and adorned, together with the other parts of the cone, with fine walnut-trees and beeches. Diverging from the apex, they give to the cone the appearance of being scalloped. The materials carried out of one of these ravines are seen deposited at its mouth in a very regular, but comparatively small obtuse cone, and this cone also is clipt at its base. Another example is presented in the valley of Schams. As we enter that valley from the Via Mala, the high road passes under the clipt base of a vast obtuse cone, and crosses the entrance (on the left hand) of two or three ravines, by which it is furrowed. Looking back upon this cone from the upper part of the valley of Schams, the edges of the ravines strike the eye by their regularity and parallelism, and are more conspicuous than in the preceding case, because this cone is bare of trees.

We may call this form (Fig. 12) the *obtuse cone truncated at the base, and scalloped at the edges.*

Still another form is impressed upon the alluvium of the alpine valleys from the same agency. When the valley is more than usually expanded, the principal stream, winding round the base of the obtuse cone, scoops out the level alluvium on the opposite side of the valley, so as to form a steep declivity arranged as an arc of a larger circle, parallel to the circular base of the cone. A beautiful example of this presents itself a little below Chamonix, the Arve flowing between the cone and the steep circling bank, which rises above a small and fertile plain, like the side of an amphitheatre. (See the Plan, Fig. 13.)

Notwithstanding the frequency of obtuse cones in elevated regions, this form of alluvial deposites is very rare compared with that of *even surfaces*, which, under the denomination of *haughs*, *straths*, *plains*, &c. indicating their various degrees of magnitude, recur continually in all valleys through the whole of their ramifications, and from their first sources to the standing waters of lakes, seas, or of the ocean.

A body of water, flowing with a perfectly even stream, and carrying solid particles of equal weight and dimensions, would deposite them so as to form perfectly even slopes, corresponding in their inclination to the inclination of the stream ; and, accordingly, widely spreading rivers, charged with fine siliceous or clayey particles, leave behind them a surface of alluvium which, to the eye, appears as level as a sheet of water. But, in ordinary circumstances, the evenness of the slope is liable to be disturbed in consequence of inequalities either in the channel, or in the solid contents of the stream. We shall proceed to consider the chief modifications of even surfaces, or plains of alluvium, arising from the separate or combined operation of these two causes.

The successive slopes, often passing into perfect levels, which are found along the course of every stream, are frequently separated from one another by *ledges*, seldom exceeding a few yards in height, and commonly very much lower, according to the dimensions of the valley and the nature of the detritus. The formation and destruction of these ledges appear to be among the most important and curious processes in fluvial action.

If we throw a quantity of gravel or coarse sand into a clear and rapid stream, we observe that the lighter and finer particles are instantly washed away, that the larger follow them in considerable quantity, but are soon arrested, and that, in a few minutes, all the loose pieces, of whatever size, either disappear, or fix themselves in some permanent position. In this state things remain, until the increase or diminution of the water produces a difference of force. The larger pieces shew a tendency to arrange themselves in a ledge placed across the direction of the current ; and the process, thus completed before our eyes, on a small scale, may enable us to account for similar results, the steps of which necessarily escape our observation.

Among the pebbles, or other pieces of stone, carried in a stream, some will, in consequence of their size, weight, and form, be arrested and detained by inequalities in the bed of the stream. Thus a flat stone is, for a while, carried swiftly along, moving on its circumference like a quoit, but continually vacillating with the varying impressions of the water. At length it impinges against some projection in the bed, which turns its broad surface against the stream, and there, if the projection be strong enough to retain it, it will remain. (See Fig. 14.) Other stones, whether flat, or approaching more to an oval or spherical form, are often wedged between those above and below them, (Fig. 15); and a few strong points of support, thus provided, form the basis of a natural dam or weir. Hence arise the numerous minor waterfalls or rapids, which occur in rivers flowing over beds of detritus, no less than in those which pass over rocks in place. Pebbles and finer materials fill the hollow behind the dam, as fast as it rises, until the bed of the river above it becomes perfectly level. The ledge, thus produced, often crosses the bed of the stream in a devious and serpentine form, because the lateral action of the banks, or of inequalities in the bed, forces portions of the stream from its direct course, and thus hurls the stones sideways as well as downwards.

So long as the flood which has deposited these materials continues unabated, the dam and the level above it will extend uninterruptedly across the river. It is remarkable that these firm dykes are demolished, not by the increase, but by the subsidence of the stream; and the action appears to be as follows. During a copious flood, the whole is covered by a mass of flowing water, so that each stone, being surrounded with water pressing it in all directions, remains in its place. But, when the flood subsides, the pressure is only from behind. The whole mass of stones and gravel being fully charged with water, that fluid drives before it certain portions, which, though fixed with sufficient firmness to keep their places, while aided by a pressure in front, give way as soon as that is removed. The removal of some masses occasions the removal of others which rest upon them, and all the waters now drain themselves through the breaches in the dyke, and (working backwards, as in all horizontal water-courses), cut deep and long channels in the alluvium, perhaps leaving islands between them. In this state things remain, until another flood covers all again, and either fills the channels with a part of its load, or sweeps away the whole, and deposites it lower down in the course of the river. In the valley of the Rhine, about Bonn, and in the elevated plain between that river and Juliers, now watered by the Röhr, sections of the gravel sometimes exhibit such a channel filled with sand (See Fig. 16); and, wherever this appearance is found, although the deposites be called *diluvium*, on account of their elevated situation, or any other circumstance, it is evident that they can only be the *alluvium of a former age.*

There is another mode of action which modifies the even slope of river deposites. Let us suppose a stream of any magnitude flowing between steep banks either of rock in place or of alluvium. When the quantity of water is so great as to be subject to reverberation from the banks, it is driven with its load of sand, stones, &c. from each side towards the middle of the current, where, consequently, the water is deepest, and its action most powerful. Hence the deposite will, previous to the subsidence of the stream, be most considerable in the middle of the bed, sloping from the middle towards the sides. On the other hand, so soon as the subsidence commences, the middle will become the most shallow and languid part, and the principal action will be on the two sides. If a level part of the bed be succeeded by a declivity, it aids the removal of the sediment in such a way that the central ridge of sediment is left terminating in a slope both towards the two sides of the channel and towards the declivity. (See Fig. 17). Over this tongue the water flows shallower and shallower as it subsides, and at length the tongue rises like an island between two branches of the river. Mean while these two branches, to which the principal action is transferred, will, according to circumstances, either deposite their sediment so as to fill up, in part, the two channels between the central ridge of sediment and the banks of the river, or they will erode the base of that central ridge, and carry away its materials.

Thus it appears that the same increase of water may, according to the form and situation of the banks which confine it, either produce the level, extending across the bed of the river, and terminating in a steep ledge, or the central ridge terminating in a gently inclined tongue. On the other hand, the *subsidence* of the water will, in either case, produce new and narrower channels.

The advance of rocks into the track of a river, though it produces a very rapid fall, where the rocks intrude, has the effect of a partial dam, retarding the current higher up, and hence causing an abundant deposition. Such appears to have been the operation of that fine assemblage of insulated cliffs in the valley of the Rhone, on one of which the Castle of Sion is erected. The portion of the valley above these cliffs, between Sion and Leuk, is studded with numerous hills of an entirely different character. They are very abrupt, frequently flat-topped, and some of them 200 feet in height. They appear to be the remaining fragments of a thick bed of gravel, which has subsequently been divided by numerous minor channels into banks and islands. Another striking example of the same relation of protruding masses of rock in place to deposites of alluvium, presents itself in the Canton of Grisons. In going from Chur to Reichenau we observe eight or ten very abrupt and sharp hills of slate or limestone, rising through the plain, and analogous to the eminences about Sion; and beyond them a ridge, which appears to have extended across the valley, as the corresponding portions of it appear on the two opposite banks of the Rhine. At Reichenau occurs the well known bifurcation of the Valley of the Rhine; and, in each branch, we see proofs that the water has formerly flowed at a much higher level over its own alluvium, which it has worn into deep channels. These appearances are the most remarkable in the Valley of Domleschg, which is traversed by the Hinter-Rhein. The bed of gravel, instead of being divided into an assemblage of hillocks, as is the case between Sion and Leuk, is here continuous, though intersected to the depth of some feet by ancient channels. In one of these channels stands the village of Bonaduz. From Reichenau we ascend by a road formed partly along this ancient channel, and in another part cut obliquely up the steep border of the plain. The river now flows 150 feet or more below the level of the plain, the declivity between the plain and the river forming an angle with the horizon of nearly 45°. Besides the marks of ancient channels formed by the river, the plain has been more recently intersected by ravines formed by lateral torrents and by the draining of rain-water from its surface. The subdivisions of these ravines, with the swelling prominences between them, now covered with grass, exhibit in miniature an exact copy of the forms of our chalk-hills. The steep declivity of naked gravel, with disseminated boulder-stones, is worn at some places by the rain into the sharp spires known under the names of *Erde-pyramiden* and *Cheminées des Fées*, which are seen developed in the greatest abundance and magnitude in the valleys above Botzen, and in other parts of the southern flank of the Alps.

An instance of the same mode of action, though with some remarkable modifications, is exhibited nearer home in the bed of the Mersey above Liverpool. Opposite to that port the river is so narrow, that the stream, mainly produced by the rising and falling of the tide, flows with great rapidity. Higher up the Mersey opens, as Camden expressively states, "patenti gremio," and assumes something of the aspect and nature of a wide lake. The stream being here less active, in proportion to the expansion of the channel, an abundant deposition takes place, and, at low water, a very large portion of the bed is seen to consist of banks of sand, which terminate before the narrowing of the channel.

Neither by consulting books, nor by conversing with scientific men, have I been able to arrive at clear and satisfactory ideas respecting the *rationale* of the action of streams, in carrying along heavy substances. The following law, however, appears to be supported not only by innumerable facts, but by the authority of all hydraulic writers of the highest reputation, viz. *that, in the same channel, the increase of the depth of any stream is attended by a corresponding increase of power to move heavy bodies at the bottom.* The Italians considered the depth and perpendicular pressure of streams as the main circumstances on which their action depends. Their doctrines are now considered as exploded. But the law here stated is conformable to the more modern, as well as to the more ancient theory. Michelotti, one of the Italians, maintained, that "the velocities of streams increase nearly as the square roots of their depths," and this is admitted by Professor Robison, who embraces the new theory. Du Buat, on whose authority the new theory principally rests, maintains, that, "as the depth increases, the velocity at the bottom of the stream increases even in a higher ratio than the velocity at the top," and this is also the opinion of Professor Robison*. The opponents of the old theory, who say that the velocity is the essential circumstance to be considered, must therefore allow, that an increase of depth in any stream produces an increase of power to carry heavy substances at the bottom, and this is all that is necessary for my present purpose.

The effect of increased depth, in augmenting the force at the bottom of a stream, is evident in the case of water discharged from any opening. Whether the water flow through artificial spouts and conduits, or over natural channels of rock, we observe that it is emitted with a force proportioned to its depth. If the current be very low, it moves so sluggishly, that it does not overcome the adhesion of its under surface to the surface of its channel, and hence it discharges itself by trickling over the edge, and will even move some distance backwards, if the edge overhangs. If, by an addition to the quantity of water, or in any other way, its depth be augmented, the current will discharge itself more freely and perpendicularly; and, on a still further increase, it will quite overcome the adhesion to its channel, and will fly off from it in a curve.

In this inquiry I leave out of view *the inclination of the bed*, because it is my object to account for the distribution of alluvium over extensive tracts, which either have no inclination, or none which is sufficient to account for the appearances. In any case where there is a perceptible declivity, as in torrents, rapids, and waterfalls, it is manifest, that the velocity of the water, and of the earth and stones contained in it, is increased, because they are urged to fall, not only by the force impressed, but by their own weight. Nevertheless, the quantity of direct vertical motion thus acquired, is destroyed almost immediately by their impinging upon various obstacles, so that, if we look at the water

* See Encl. Brit. Art. Rivers, sect. 71 & 77.

of a river or torrent below any cascade or rapid, we find that, so soon as the channel resumes its usual degree of inclination, the stream resumes its ordinary velocity.

The principle being admitted, that, in the same channel, the force of running water, exerted in carrying detritus, increases in proportion to the depth of the water, let us now investigate those causes, which, by producing variations in the volume or mass of water, produce corresponding variations in its depth. These are,

1*st*, Long continued rains, which fall upon extensive districts of moderate elevation. They produce widely-spreading inundations in the lower grounds, and, as we know from the experience of our own island, often wash away the alluvial banks of rivers, and in various ways enlarge and deepen their bed. The muddiness of the water indicates the vast quantities of earth which they convey towards the sea. All tropical countries have their *rainy season*, when they are deluged by such inundations.

2*dly*, Sudden heavy showers, especially thunder-storms. These occur in summer, and produce as striking effects in elevated regions as long-continued rains in low countries. A shower of this description in the Alps, often swells the torrents in a few minutes, so that they rush with irresistible fury, burst their ordinary limits, and carry down with them immense quantities of sand and gravel, with large fragments of rocks. They subside as quickly, leaving their channels almost dry. Being at Chamonix on the 16th of last July, I had the opportunity of witnessing some of the effects of a thunder-storm among mountains. It commenced after sunset, and lasted about three hours. The noise of a torrent on the opposite side of the river was like continued thunder, being produced not only by the vast quantity of water falling almost perpendicularly, but by great boulders tossed over the precipices. Next morning the whole atmosphere was clear, the Arve and its tributaries at their usual height. But all along the northern and western flanks of Mont Blanc, the effects of the brief shower were visible in cottages deserted, pastures and corn fields destroyed, and roads washed away. The obtuse cones, and the levels surrounding them, were strewed with fresh deposites of boulders, pebbles, and sand, amounting to the depth sometimes of several feet, and exhibiting various degrees of size and coarseness, according to their proximity to the centre of action, the apex of the cone, or to the middle of some principal stream.

3dly, The melting of Alpine snows and glaciers. In winter the torrents and rivers, which flow immediately from the snows and glaciers of the Alps, are nearly dried up. I saw them in a state of vigorous action, and often remarked the peculiar thumping sound of the boulders, which they drive along so as to keep up an almost constant cannonade *. These stones are invisible, in consequence of the opacity of the water, until, by its subsidence, it displays their chiselled and whitened surfaces throughout its bed.

4thly, The breaking up of ice in rivers. In regions of such a temperature as to contain rivers which freeze in winter, their breaking up advances the progress of their alluvium, both because the pieces of ice cut away the banks, and because they collect in certain parts, so as to keep back the water. Last winter, at Winnengen, a short distance above Coblentz, the Moselle, being hemmed in by the accumulation of its broken ice, rose 20 feet in an hour and a-half. Having overcome this barrier, it carried away 300 yards of the road between Layen and Mosel-weiss. In the Rhine, débâcles are produced by the same cause. Through certain spaces of the river's course, where the stream is narrow, deep, and strong, the ice floats downwards. It stops where the bed becomes broader, and the current consequently more shallow and more languid. The broken pieces, for the most part reared upon their edges, and crowding over one another, rise to the height of many feet, and are consolidated by the freezing of the water, which they intercept. At the commencement of a thaw, the water, coming from above, quickly accumulates, in proportion as the ice is disposed to yield. It then breaks the dykes, and rushes forward with tremendous force, overflowing the plains, breaking down the banks, and carrying along immense quantities of mud, sand, and stones.

* Sir T. D. Lauder, in his last work, gives an exact idea of the *sound* to which I refer, when, in a similar case, he remarks that the stones were *muffled* by the water.

5thly, The bursting of lakes. This takes place in summer, and in elevated regions. The lakes, which are liable to produce débâcles*, are formed,

a. By landslips, as already explained, (p. 4).

b. By the advance of obtuse cones (p. 15). Every *obtuse cone truncated at the base* indicates the previous existence of a lake which has burst the barrier and produced a sudden inundation. Above such cones, the traces of lakes are often very apparent. In the verdant spot called the *Combe de Taconaz*, situated at the junction of the Taconaz glacier-water with the Arve, we see extensive terraces which are nearly, if not altogether, upon a level, and which indicate the former height of the water.

c. By the advance of glaciers and their moraines. The base of every glacier is continually subject either to recede or to advance. In many cases, we now see the glaciers protrude their moraines so as to form mounds across the valleys, and, in some instances, they detain the water flowing from above. This appearance is magnificently displayed before the traveller, who descends on the southern side of Mont Blanc through the Allée Blanche. The first glacier boldly throws its rejected earth and stones, so as to meet the opposite mountain, a rapid and copious stream passing underneath the barrier. Next comes the enormous refuse of the glacier of Miage, itself a mountain, which, by barring the streams from above, gives origin to the Lake of Combal. Having passed this barrier, we see before us, in the third place, the termination of the glacier of Brenva, whose moraine also forms a vast mound across the valley, but admits the river to pass under it. The well-known débâcle in the Valley of Bagnes, A. D. 1818, was the discharge of a lake, caused by the accumulation of ice, which fell from the glacier of Getroz †. The following summer, a similar inundation was oc-

* It may be proper to observe, that I always use the word *Débâcle* in its strict sense, and not to denote a great rush of water, however produced. A Débâcle is a rush of water, produced *by the sudden removal of a barrier.* In this sense the word is explained, and its etymology given, in Menage, Dict. Etymologique de la Langue Françaisc, v. BACLER and DEBACLER; and in this sense it is, I believe, constantly used in those countries where French is spoken.

† See Edinburgh Phil. Journal, No. 1. A. D. 1819.

casioned by the breaking down of the side of a glacier in the valley of the upper Doron in Savoy. The Lake of Aletsch, Canton of Valais, stood formerly at the height of sixty or seventy feet, being hemmed in by a mountain ridge on three sides, and by the glacier of the same name on the fourth. The water, having undermined the glacier, ran out with such violence as to become very destructive. A canal has been recently formed across the mountain ridge to prevent the lake from rising above a certain elevation.

In the course of the Arve above Chamonix, we see proofs that the two great glaciers of Bois and Argentiere have formerly blocked up that river so as to form two deep and extensive lakes. The sketch, No. 19, is a view of the lower termination of the glacier de Bois. A ridge, distinguished by all the peculiarities of a moraine, but of great size, and of such antiquity as to be now clothed with a forest of firs, is seen immediately beyond it. The breach in the ridge, through which the Arve flows, is also very conspicuous. Above this barrier, we find an assemblage of terraces, which indicate three different levels in the water, and three successive breaches in the dyke. The sketch, No. 20, represents part of these terraces on the north side of the valley.

On examining any recent moraine, we find that the glacier itself so far penetrates into it, that it consists of ice as well as of gravel, sand, and rocks. It is manifest how easily such a mass must give way to the pressure of water from above, as soon as a very hot summer arrives. Of all causes now in operation, glaciers and moraines probably occasion the most sudden and the deepest inundations.

Such are the causes by which rivers are liable to be swollen, and which operate in different elevations, in different climates, and in different seasons. The general effect of all these augmentations in the depth of streams is, that the greater the depth, the more abundant the whole quantity of detritus, and the larger the single masses which are carried along.

It being proved that the carrying force at the bottom of streams increases with their depth, and causes being assigned, which alternately and in various degrees augment and diminish the volume of water, it remains to notice the variations in the depth of the same stream, flowing in the same volume, which are produced by differences in the form of its channel.

The most important of these differences consists in the comparative *width* or *narrowness* of the channel. The quantity of water being the same, a narrow channel, by increasing its depth, adds in the same proportion to its carrying force; whereas an expanded channel, by diminishing its force, and diffusing its influence, causes it to strew its contents over every spot of ground which it reaches. If the depth be sufficiently increased, it acts with all the force of a solid body, but with the advantage of continually changing its direction. It may therefore be regarded as a lever, not only of immense power, but of infinite flexibility. In passing through a narrow gorge it is continually reflected from the sides and bottom, and hence it assails every loose mass of stone with impressions upon all sides, and carries it in the direction in which there is the least resistance.

Every river exhibits expansions and contractions in continual alternation: but they are most evident, and their respective operations most distinct, in elevated regions. I have never seen the contrast more strikingly displayed than in the upper part of the Valley of Bagnes, on coming to a nearly circular expansion, succeeded by a narrow and lofty gorge. In this scene of desolation we observe the plain, which is more than a mile in diameter, covered with large pebbles and boulder-stones, many of them 6, 8, or 10 feet thick. These were carried through the gorge in a few hours by the débâcle of 1818; and it is, I conceive, only by taking into account the extraordinary height of the water, that we can explain the passage of such a vast quantity of materials, containing pieces of so great size, in so short a time, through a channel, which is nowhere more than a few yards wide, and which is full of anfractuosities and projections. The effect can only have been produced by the impinging of the water against the various unevennesses of the sides and bottom, which occasioned its reverberation upwards and sideways, and which, being exerted with a force proportioned to the depth, kept rocks and stones of every size suspended and dancing in the mighty ebullition. On escaping suddenly from the gorge, the stream, spreading itself out, shot the rocks over every part of the plain, where we now find them dispersed.

Where the channel is moderately deep, the effect of reverberation is often very apparent in the curvature of the upper surface of the stream. A section of one of the branches of the Arve at Chamonix, as I saw it last summer, would exhibit the form represented in Fig. 21 *. The elevation of the middle above the sides appeared to be about 3 feet; and the acceleration of the current down the middle, arising agreeably to the law of the composition of forces from the union of all the minor currents reflected transversely from the sides and bottom, was perfectly manifest to the eye. These appearances seem to warrant the inference, that the minor oblique currents conveyed all the transportable materials towards the middle, and that, if we could see the interior of such a stream, when in vigorous action, we should observe boulder-stones tossed along the bottom, pebbles shoved with them, and in a great measure suspended above them, coarse sand floating still higher, and other particles increasing in fineness in proportion as they reach the surface. Even at the surface, where alone they are subject to inspection, many of the particles are so large as to be visible to the naked eye; and if, after the subsidence of the stream, we go to the expanse, where its contents are deposited, we find all the varieties distributed at different distances from the *embouchure* according to their size and weight, the large stones being carried a very little away, the pebbles forming a zone around them, masses of coarse sand removed still farther, and the finest sand deposited in bays and recesses, where the water must have been reduced nearly to a state of quiescence.

The same mode of action is conspicuous both in the tongues of alluvium above described, and in the slopes which form the convex bank, wherever the stream, being diverted from its direct course, destroys the high concave bank upon which it impinges. In all these cases the reverberation from the steep bank carries the detritus in the same direction, and causes its deposition as soon as the force of the stream is overcome.

In proportion as the banks become lower or more remote,

* Buffon describes the same appearance in the Arveiron; but Professor Robison's explanation of it is far from satisfactory.

Fig. 21.

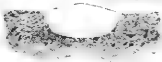


Fig. 22.

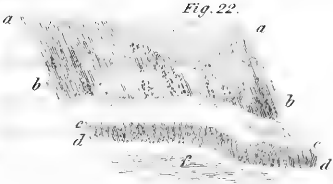


Fig. 23.

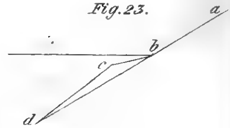


Fig. 24.

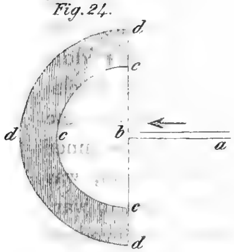


Fig. 26.

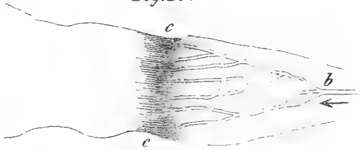
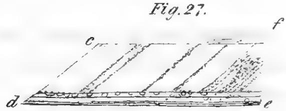


Fig. 27.



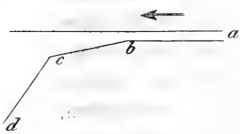


Fig. 29.

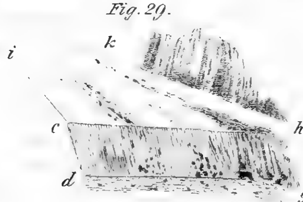


Fig. 28.

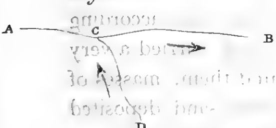


Fig. 20.

E. Mitchell sculpt.

the stream is more diffused, and its contents more evenly distributed. It thus forms plains or gently sloping levels, terminated by transverse ledges. (p. 19.)

The tongues and levels [illegible] less the stream [illegible] are intersected [illegible] above p. 18, 19). [illegible] channels being [illegible] or level, the [illegible] in proportion [illegible] the increased [illegible] tions of [illegible] land, when [illegible] converted into one vast [illegible] may be traced by the [illegible] of the water [illegible] versing [illegible] on the [illegible] [illegible] been [illegible].

Such [illegible] water carrying [illegible] the principles on which its action [illegible] abundant, and [illegible] of conveying earth, stone, and [illegible] any distance. To [illegible] may refer many of [illegible] flow. For if [illegible] bited on a vast scale, the agents concerned [illegible] been powerful in the same proportion; and [illegible] that, under present circumstances, when the [illegible] by the supply of alluvium during thousands of years [illegible] longer furnish débâcles and inundations of equal magnitude, when the ocean itself having been to a considerable extent filled up by these processes, must be supposed to have risen to a higher level; when, with the exception of regions of eternal frost, the whole face of the earth is protected by its vegetable covering; and when human art and labour do their utmost to curb the destructive influence of the atmospherical waters, that [illegible] the stream is more diffused, and its contents more evenly distributed. It thus forms plains or gently sloping levels, terminated by transverse ledges, (p. 18).

The tongues and levels, thus formed, would never move unless the stream were to subside. But after its subsidence they are intersected by numerous smaller channels. (See above, p. 18, 19). Hence when the water rises again, the depth of those channels being added to the depth above the intersected tongue or level, the force of the water within the channels is increased in proportion. Even on the surface of the flood, the effect of the increased depth is visible. As we learn from the observations of Major Rennell in India, and of Sir T. Lauder in Scotland, when a whole valley is inundated, and thus converted into one vast channel, the course of the former channels may be traced by the greater swiftness, turbulence, and discoloration of the water above them, which indeed forms distinct currents traversing the flood. These powerful currents work unseen upon the sides of the minor channels, and thus in a short time carry way the entire masses of detritus, in which they have been excavated.

Such appear to be the chief modifications in the action of water carrying detritus over level or inclined surfaces, and such the principles on which its action depends. If it be sufficiently abundant, and if it rise and fall alternately, it appears capable of conveying earth, stones, and rocks over the earth's surface to any distance. To this action of the atmospherical waters, we may refer many of the greatest plains through which rivers flow. For if in low lying plains the beds of alluvium be exhibited on a vast scale, the agents concerned in producing them have been powerful in the same proportion ; and it is to be considered, that, under present circumstances, when the mountains, lowered by the supply of alluvium during thousands of years, can no longer furnish débâcles and inundations of equal magnitude; when the ocean itself, having been to a considerable extent filled up by these processes, must be supposed to have risen to a higher level ; when, with the exception of regions of eternal frost, the whole face of the earth is protected by its vegetable covering ; and when human art and labour do their utmost to curb the destructive influence of the atmospherical waters ; that influence can bear no comparison with the vast effects which it must have produced before population was extended, before man was created, and while this same agency was preparing the bare and desolate lands for sustaining the growth of plants, and was thus gradually rendering them capable of their present methods of conservation.

III.—*Of Detritus conveyed by Running into Standing Water.*

Whenever a stream, charged with detritus, meets standing water, a separation takes place between those parts of the detritus which are sufficiently fine to be held in suspension by the stream, and those which it pushes or rolls along the surface of the ground. The stream, diffusing itself over the standing water, until its impetus is destroyed by the resistance, carries with it the fine particles, and lets them fall slowly in clouds to the bottom; whereas the larger and heavier particles, the moment they reach the standing water, fall by their own weight, and assume the two forms described in the former part of this paper, *i. e.* according to circumstances, either the lengthened talus or the acute cone, the upper part of each form being, however, modified by the water flowing over it.

An accidental occurrence afforded me, last summer, an opportunity of observing this process as distinctly as if an experiment had been contrived on purpose to illustrate it. Among other works recently executed on the Birmingham Canal, there had been a deep cutting through a bank, which consists of a mixture of sand, clay, and pebbles, and thus a fresh smooth slope *a b*, Fig. 22, was exposed to the action of the atmospheric waters. At the bottom of this sloping bank, and between it and the towing-path, there was at intervals a slight depression, which held the water, so as to form small pools at the foot of the bank. There had been very heavy rains a day or two before, and the bank bore traces of their influence in the numerous furrows upon its surface. The water having sunk through the ground, the pools were left dry. There remained at the bottom *f* a thin coat of glistening slime or mud, and along the foot of the bank an even terrace, the upper slope of which *b c* was nearly flat, whereas the lower slope *c d* was as highly inclined as the bank above. The terrace consisted of grains of sand and small pebbles, mixed with red clay.

Having been struck with the miniature resemblance of this terrace to the parallel roads of Glen Roy, as described by Dr Macculloch, and having reflected upon the way in which the rain-water had produced it, I was soon led to form a general conclusion respecting the conveyance of all kinds of sediment by running into standing water, viz. that, if *a b d*, Fig. 23, instead of representing merely the section of an artificial bank of gravel, represent the side of a hill, a mountain, or any other declivity, descending into a pool, lake, or any other piece of standing water, and, if water flow along *a b*, carrying earthy materials of different degrees of fineness, its course will be changed at the point *b*, where it meets the standing water; that it will diffuse itself over the surface of that standing water, carrying with it the finest particles; that all the particles, which are too large and heavy to be held in suspension, will fall by their own weight; that, by the continuance of this process, a terrace will be formed, having a gently inclined surface *b c*, over which the stream will continue to roll and shove the coarser detritus; and another surface *c d*, inclined at an angle of about 45°, down which that detritus will fall, as it would in air; and that the line *c d* will continually advance by the accession of fresh materials, preserving always the same inclination until the pool is filled.

In several of the Swiss lakes I had an opportunity of finding this view confirmed. For example, in the Lungernsee, Canton of Unterwalden, nearly the whole margin is accompanied by a terrace, which varies in breadth from 5 to 12 or 14 feet, sloping very gradually under the water, and then terminating in a steep declivity. The terrace is easily distinguished, even at a distance, by the brown colour of its stones, contrasted with the green of the deep water. In some parts its extent is equally well defined by the reeds, rushes, and water-lilies, which grow upon it, but do not pass beyond the edge of its steep declivity. According to the observations of Dr Macculloch * and Sir Thomas Lauder †, the mountain-lakes in Scotland and Italy, as well as in Switzerland, have similar terraces along their shores.

* Trans. of Geological Society, vol. iv. p. 369, 370.

† Trans. of Royal Society of Edinburgh, vol. ix. p. 16, 17.

By a singular coincidence, these two gentlemen introduced the subject to the notice of men of science nearly at the same time, and each gave a separate account of the process, by which he supposed the terraces to be produced. Both conceived them to be formed by the action of waves, impelled by wind against the shores of an ancient lake; but Sir T. Lauder (l. c. p. 15.) supposed the waves to form the terrace, by eroding the banks along the edge of the water; and Dr Macculloch (l. c. p. 371), by throwing back the pebbles as on a sea-beach.

To Sir T. Lauder's explanation it may be sufficient to reply, that such erosion of the banks utterly exceeds the power of simple water, and that the banks above the margin of the lakes do not exhibit the concavities, which would denote the erosive action of waves, but descend into the water with the same forms and appearances which are to be seen on mountain-sides in ordinary circumstances.

To Dr Macculloch's explanation it may be objected,

1*st*, That many of the stones which lie upon the terraces, are from one to four feet in length, and that the waves could never have moved them.

2dly, That the stones of which these terraces consist are commonly angular, and as sharp as those on the mountain-side above the terrace, and that rolled pebbles are only found where brooks and torrents enter the lake over beds, likewise consisting of rounded stones, which have been transported from a distance, and so shaped in their passage.

3dly, That banks or terraces, thrown up by waves, are only found on gently sloping beaches, and then only where the motion of the pebbles is not impeded by their being enveloped in clay.

4thly, That in the case of a terrace formed by the action of waves, the edge of the water coincides with the top of the steep declivity, so that, according to this explanation, the surface of the lake ought to reach only to the point *c* (Fig. 23.), instead of rising above the slope from *c* to *b*, as it uniformly does.

There are undoubtedly cases, where the waves form terraces on the borders of lakes as well as of the ocean. I saw an instance of this on the shelving beach at Neuchatel, and remarked, that the sound of the pebbles and the other appearances were the same, which a few days before I had observed on the sea-shore at Dover. But the terraces, which are now the subject of investigation, are of a different class. All the circumstances agree with the supposition, that the loose earth and stones are washed down by the rains, and in still greater profusion by the melting snows; that they change their course on reaching the point *b* (Fig. 23.), and rush together over the inclined plane *b c;* that the water then pursues its course, diffusing itself for some distance over the surface of the lake; and that all the larger particles, whether pebbles or sand, on arriving at the point *c*, fall down the declivity towards *d*. I think it probable also, that these terraces were chiefly formed, before the mountain-sides were cultivated or much protected by vegetation. If any lake, having such terraces, were drained, the appearances would exactly agree with those in Lochaber and above Subiaco, which Macculloch and Lauder have described with so much exactness and ability*.

The formation of these lengthened terraces, with a submerged talus, is, however, much less important in modifying the earth's surface than the production of those forms which are analogous to the before mentioned acute cone, and which arise, wherever the stream, instead of being diffused over a mountain side, diverges from a single point. As the heavier particles go on depositing themselves, they form a semicircular area, with a slope from the centre, and with the different kinds of detritus arranged to a considerable degree in successive zones, according to their comparative coarseness or fineness. The part of the area round the centre continues to be raised, by successive depositions, above the level of the standing water, while, on the other hand,

* My view of the origin of these terraces seems to obviate the various difficulties which Dr Macculloch states as attending his own hypothesis. Judging from his maps, and those of Sir T. Lauder, and not having visited the place, I think it clear, that there were, as Sir T. Lauder supposes, three ancient lakes, Loch Gluoy, Loch Roy, and Loch Spean; that the barriers, which produced the two former, were obtuse cones, formed by the streams which now issue from ravines, or small lateral valleys, immediately below the termination of the terraces; that the discharge of each lake was caused, not by any "convulsion," but by the increase of the principal stream, which carried away the base of the obtuse cone; and that these valleys always discharged their surplus water in the same direction as at present, and not from their upper extremities, as Sir T. Lauder supposes.

its lower part always extends with the stream to some distance under the water, and then terminates in the usual steep declivity. The form of alluvium thus produced is that of an *acute cone truncated by an obtuse cone.*

I was enabled to observe this process very distinctly in Savoy and Switzerland, in consequence of a practice, common in those countries, of conducting the surface-water of the rivers along artificial channels into small enclosures, which are thus, in the course of a few hours, filled with fine sand. The sand is dug out to improve the cultivated grounds, and the pool is left to fill again. The appearances, of course, vary according to the declivity of the channel, the swiftness and volume of the stream, and the form of the reservoir. The plan and section, Fig. 24, are designed to represent a case as free as possible from adventitious circumstances: *a b* is a straight horizontal channel, through which a stream charged with sand constantly flows. The side of the reservoir is also straight, and the stream meets it at right angles at the point *b*. The reservoir has an overflow at the other end. The stream carries the grains of sand in nearly straight lines, to all parts *c* of the circumference of the smaller semicircle, from which, as soon as they have reached it, they fall by their own weight down the steep declivity from *c* to *d*.

In natural lakes, we frequently observe the process effected on a greater scale. A small rill, carrying down sand, shews it most distinctly; and I have seen the form, produced without any artificial arrangement, quite as regular as is represented in the figures. But, as the conoidal deposite is not removed from natural lakes as it is from the reservoirs constructed by alpine husbandmen, the depositions of the stream, retarded as it is by meeting the standing water, tend continually to raise both its own bed and the central part of the semicircular area, over which it is diffused. Hence this area is gradually raised above the level of the lake, although its border always continues to dip under it. After this the stream either flows (from *b*) in a single current, or divides into several channels, and, in process of time, vegetation protects certain parts of the raised area, so that the stream, instead of acting equally in all directions from the centre (*b*) comes to be more or less confined, and hence the truncated acute cone is more enlarged in some parts than in others.

An obtuse cone, of great regularity, about half a-mile in diameter, and partly covered with coppice-wood, is formed in the Lungern-see, by the depositions of a small river flowing from the head of the valley. This obtuse cone extends a few feet under the water, and is then suddenly cut off by the steeper declivity of the acute cone, which descends to the depth of about 20 feet, and is seen to be strewed with fallen sand and pebbles as far as the eye can reach. A semicircle of surprizing magnitude is exhibited, where the Kander discharges itself into the lake of Thun, through an artificial channel, opened A. D. 1712. Within this time, an alluvial area has been formed of about 200 acres. From the shallows along its border, the lake deepens suddenly to 600 feet. The border advances several yards in almost every year. A work of the same kind was executed a few years ago in the Canton of Glarus for the purpose of discharging into the Lake of Wallenstadt the materials brought down in overwhelming quantities by the Linth. In these and similar cases, the newly formed area is in parts covered with various kinds of willow, alder, hypophäe, berberis, or viburnum, and in other parts gemmed here and there with the brilliant colours of a solitary alpine plant, the seeds of which have been brought by the waters from the high mountains.

It is evident that the complete semicircle, Fig. 24, can only be formed where the stream intersects a straight bank at right angles. But the greatest streams, which flow into lakes, commonly pass through valleys, which become lakes wherever the water is detained by a barrier. The sides of a lake, therefore, commonly converge in the direction from which the main stream flows, so that, instead of a semicircle, it forms only the *sector* of a circle, Fig. 26, dipping, as before, under the water, and then passing into a steep declivity. In this state things are found at the head of nearly all great lakes. The advance of the area *c c*, formed by the depositions at the head of the lakes of Geneva, Lucern, Neuchatel, Constance, Wallenstadt, and many others, is both attested by historical records, and is the subject of personal observation. In all these cases, as the arc which terminates the river advances, the older portion of its bed is continually brought nearer and nearer to an exact level, and becomes liable to all the changes described in the second part of this paper.

All the *deltas*, as they are called, at the mouths of the greatest rivers, whether flowing into seas or into the ocean, are repetitions of the same appearances upon a greater scale. The appellation Delta, though strikingly applicable in ancient times to the alluvium included between the branches of the Nile, is less descriptive of those sectors, or irregularly lozenge-shaped areas, which we observe at the mouths of the Volga, the Danube, the Po, and other great rivers. All of these have their types in the diagrams, Figs. 24 and 26, though various natural and artificial agencies produce modifications of them, which, on so great a scale, may strike the observer as very important deviations. The tendency of the apex of a delta (*i. e.* of the point *b* in Fig. 26,) to move downward, as remarked by Rennell, and exemplified in the ancient and modern state of the Nile below Memphis, is easily explained on the principles which have been illustrated.

M. De la Beche states *, that the pebbles carried into the Mediterranean by the Var and Paglion, are immediately deposited in deep water, where they remain undisturbed, extending but a short distance seaward; and, on the other hand, Sir T. Lauder observes †, that in sailing down Loch Linnhe, which is an arm of the sea, he found, on its south side, the same kind of shelf, which occurs along the border of fresh-water lakes, but on a larger and ruder scale.

In the ocean, tides and currents modify both the regular conoidal forms of fluvial sediment, and the taluses produced by atmospheric agencies along the shores; but whenever the sediment is conveyed to sufficiently deep and still water, it obeys the same laws which are observed to prevail in lakes and tideless seas. The soundings on the eastern coast of South America prove, that the ground shelves gradually from St Mary's Point at the mouth of the La Plata to the distance of about 100 miles out at sea, and then in about 75 fathoms water, suddenly passes into a steep declivity. This abrupt passage, from comparatively shallow to very deep water, is common along sea-coasts, especially off the mouths of the great rivers.

Independently of the discharge of rivers into the ocean, its own waves, tides, and currents, distribute the alluvium after the same manner, not only in estuaries, but upon all shores, and es-

* Geological Notes, p. 10. † Tr. of R. S. Ed. vol. ix. p. 17.

pecially in straits and shallows. In this view, the English Channel itself is analogous to an estuary; or rather, it may be considered as one branch of a still greater estuary, which also includes the Irish Sea, the Bristol Channel, and St George's Channel. From the Straits of Dover, it deepens gradually from 180 to rather more than 500 feet. Immediately beyond this even slope, the ground sinks to more than twice its former depth. Here, then, we apparently come to the boundary, where the currents of various kinds cease to sweep the bottom of the ocean, and all the detritus consequently falls in a steep declivity. The line which marks this sudden fall is an arc, including the south-western extremity of Ireland on the one hand, and the north-western angle of France on the other. In going southward, it preserves a very exact parallelism to the line of the French coast, and seems to be analogous to the shelf which is found beneath the margin of a fresh-water lake *.

With regard to the *stratification* of these deposites, I can only form a conjecture grounded upon the process of their formation. It seems that the successive masses of detritus, varying, according to the quantity and force of the stream, from the finest sand to the coarsest gravel, and falling over the declivity *c d*, Fig. 27, must produce a stratification always parallel to that declivity. In those Swiss lakes which are supplied by the melting of ice and snow in summer, it is true, that, on the subsidence of the water, which takes place every winter to the extent of about six feet of perpendicular depth, masses often fall from the upper part of the declivity, probably in consequence of the pressure of the water with which the whole mass is charged, and which bursts the sides of the declivity, wherever it is weakest and most pervious to water. But the masses thus thrust out of their place will fall over the lower part of the cone, making the stratification more uneven, but without materially altering its angle. The agitation of the water by winds must also wash down portions from the top of the declivity, so as to round off the angle *f c d*; but these portions, in falling to *d*, will be inclined as before. From other causes, however, a stratification nearly horizontal will take place at the bottom and at the top of the deposite. Agreeably to the observations formerly offered, the largest masses will fall continually to the bottom of the slope, and will

* The French Coasting Pilot, London, 1805, 4to. Pl. 8 and 17.

thus produce nearly level strata *d e*, intermixed with the inclined stratification. Also the materials deposited by the stream before reaching the point *c*, will be in strata either horizontal or very gently inclined, *c f.* In proportion as the mass *c e* is allowed scope to arrange itself in the complete semiconoidal form, Fig. 24, the successive strata will consist of distinct zones, all having reference to the point (*b*) of the divergence of the stream as their centre. In the language of Werner, they will have the arrangement of *mantle-shaped* formations. Where the field of action is limited by the convergence or parallelism of the sides (Fig. 26), as at the head of lakes or in deep estuaries, the inclined strata may be supposed to be nearly parallel planes, inclined at an angle of about 45°. The submerged taluses, traced along the margins of lakes, seas, and of the ocean, may be presumed to be stratified in a similar way.

When we see a level plain between mountains, we are naturally reminded of the surface of a lake, and the inference has often been drawn, that such a level has been formed by the subsidence of earthy matters to the bottom of the lake. This view, however, will not bear examination. Water flowing at any depth whatsoever is not a lake, but a river; and it is impossible to account for the distribution of detritus evenly over the bottom, except by supposing the water to flow at the bottom. Even the fine particles held in suspension are carried but a few miles into the deep water, and can only form a thin film a little in advance of the base of the sub-aqueous cone or talus; so that, if a deep and extensive lake were drained after hundreds, or even thousands of years, its bed would be found in many parts unchanged by the action of its waters, scarce a pebble having advanced beyond the line which is to be traced along the bottom of all its lateral terraces and cones. By parity of reason, one of the fundamental positions of the Huttonian theory, which supposes that alluvium is carried into the depths of the ocean and strewn over its bed, cannot be maintained, unless it be proved that there are streams in the depths of the ocean.

That lakes have in numerous instances been filled up may be readily granted; but it can only have been by the processes above described. The declivities, represented by the line *c d* in the diagrams, advancing from every quarter of the lake in proportion to the activity of the streams in supplying materials, the alluvium will contract the dimensions of the lake continually, and will then be traversed by those streams, which will go on depositing their contents until the lake is obliterated, and one or more gentle slopes or flat plains remain above its level. These slopes and plains are what we find in nature. A tract of alluvium, which is regarded by many as the bottom of an ancient lake, but which more nearly corresponds with its surface, is often seen either inclosed on every side by mountains, or having on two sides the same elevated ridges, which stretch forward and embrace beyond it a lake, or an arm of the sea. That this tract is not a perfect level, is manifest from the circumstance, that, if we compare its height at many successive points with the height of the river flowing through it, we find that they are still at the same distance the one beneath the other ; and, in addition to this clear proof of the gradual declivity of the plain, we observe its successive portions to be divided by those transverse ledges which are among the most characteristic features of fluvial action.

IV. *The case of a Stream which meets a Stream flowing in another direction.*

At the mouths of rivers, where they enter the ocean, the current of the rising tide comes directly against the current of the river. Hence they destroy one another's motion over a transverse line, the exact position of which varies continually according to the respective force of the two opposite currents. The result is, that the water, being brought to a state of comparative rest, deposites its solid contents, and thus forms a *bar* across the mouth of the river. Where rivers enter lakes, the same effect is sometimes produced by the prevailing winds, which here take the place of tides. The formation of banks by opposing currents on the shores of the sea, such as the Chesil-bank, and that by which St Michael's Mount is joined to Merazion, are instances of the same action.

Every case in which one stream falls into another on the same level is so far similar, that the motion of one, at the moment of junction, destroys in a greater or less degree the motion of the other ; and the water being so far reduced to a quiescent state, a deposition takes place at the angle between the two streams, varying in its form and extent according to their respective force and quantity of detritus. The deposites thus formed tend continually to remove the point of junction lower down, and to reduce both streams nearer to a state of parallelism. Thus if A B, Fig. 28, be any stream flowing from A to B, and if it be met in the point C by any other stream flowing from D, the accumulation of detritus in the angle A C D, accompanied by a wearing away of the bank in the adjoining angle B C D, causes the point C to move lower down towards B, the channel D C revolving round the point D. This constant tendency of two rivers uniting into one to sharpen the angle of their confluence, was remarked by Guglielmini, and striking instances of it, as exhibited along the course of the Ganges, are mentioned by Rennell and Colebrooke in their accounts of the bed of that river *.

Not unfrequently the principal stream, being overpowered by the tributary, is for a time hemmed in by the force of the latter, and, rising to an unusual height, begins to work with great power upon the bank opposite to the entrance of the tributary. Of this, several remarkable instances are mentioned in Sir T. Lauder's late work on the Floods of Morayshire. In such cases D C, Fig. 28, becomes for a while the principal stream, and A C, bearing to it the relation of a tributary, begins to revolve round the point A.

It is obvious that this action can only be rendered manifest in alluvial plains, or where the banks are soft enough to be easily eroded. In descending from Rosen-laui to Meiringen, I saw the results of a similar concurrence of two streams, where the banks were hard and rocky. A lateral torrent, almost dry when I crossed it, was suddenly swollen by a thunder-storm, and brought down an enormous load of rocks, sand, and mud. On reaching the principal stream, the Reichenbach, it threw the largest rocks, two yards or more in thickness, across its channel. The smaller fragments, with the semi-fluid masses of more comminuted detritus, were diverted from their course by the Reichenbach, and carried downwards to the Aar.

If a lateral stream brings down a large quantity of detritus, the frequent consequence is the raising of its bed, so that it flows *at a higher level* than the principal stream. On meeting the

* Phil. Trans. for 1781. As. Researches, vol. vii.

principal stream it is suddenly turned aside. Every pebble and all the smaller detritus which it brings, are also hurried downwards, so that the bed of the lateral stream is abruptly terminated by a line, coinciding with the surface and direction of the principal stream. Thus by the joint action of the two streams a talus is formed, similar to those beneath the margins of lakes, but differing in this, that the edge of the steep declivity is inclined instead of being level. I have observed cases of this action in the valley of Chamonix, where, supposing *c d g h*, Fig. 29, to be a bank of stones and gravel forming part of the channel of the Arve, *i c h k* is part of the bed of a stream descending through a lateral valley. The stones and other debris brought down from the region of the snows and glaciers, as soon as they reach the border of the principal stream *c h*, fall down the steep declivity, and are hurried along with the solid materials of the Arve. In mountain valleys we often see a terrace of this description, where the waters have been nearly or altogether discharged, and the only method of deciding whether they have been produced by a lake or a river, seems to be by ascertaining whether the line *c h* is level or inclined.

As a case of similar action in the sea, may be mentioned the entrance of the Southampton Water below Portsmouth *. The sediment of this river has a tendency to form a semicircle projecting towards the Isle of Wight. It is cut off in a nearly straight line passing from one headland to the other by the strong current of the Solent, and terminates in a declivity analogous to *c d g h* in Fig. 29. In estuaries and channels of the sea, still more than in rivers, the actions of different currents are infinitely modified. One portion of a stream may be considered as at rest relatively to another portion, which forms a stream within it, and the minor streams conflict and unite with endless varieties of force and direction. The general bed of the whole stream is consequently varied by numerous channels, slopes, and terraces, formed by the contemporaneous action of the included currents, and in its shoals and banks it exhibits a repetition, upon a larger and more expanded scale, of the same forms which are produced by similar influences in the beds of rivers.

* G. Tr. New Series, vol. i. pl. xii. and p. 92

Observations on the History and Progress of Comparative Anatomy. By David Craigie, M. D., &c. (Continued from former volume, page 307.)

Section III.—*Early Zootomical Authors to Eustachius.* 1501-1576.

Hieronymo Cardan, whose name has been introduced into anatomical history by Douglas, and retained by Haller and Portal, is with little justice entitled to that distinction. He was certainly a man of genius, as well as learning; and the number of sciences which he cultivated, with sufficient success to command the admiration of his contemporaries, indicates the activity and comprehensiveness of his intellectual powers, as well as the ambitious and aspiring character of his mind. Besides grammar, rhetoric, music, history, and ethics, Cardan was ambitious to excel in physics, arithmetic, geometry, astronomy, astrology, anatomy, medicine, and natural history. There are very few, however, whose mental powers admit of this universality; and the expectation of excellence in all, is dearly purchased by the sacrifice of useful and accurate acquaintance with several branches of science. The genius of Cardan was more under the influence of fancy than judgment. Almost void of accurate observation, and utterly destitute of patient research, his habits of study were desultory and irregular; and he appears, in most of his pursuits, to have been more solicitous of the glory and distinction ascribed to superior knowledge, than of that pure satisfaction which results from the discovery of truth, and the acquisition of useful information. His writings, which are bad copies of the ancients, abound in puerile and fabulous stories, with much of the astrological and geomantic physiology then fashionable. His incidental sketches of the anatomy of animals contain nothing new, original, or important; and I should have omitted him entirely, had I not found that he had observed a fact in animal physiology which has exercised the observation of Hunter and others,—that birds, and especially pheasants, are liable to change sex.

The example which Rondelet set in the finny tribes, was followed as to the birds by his contemporary, Pierre Belon of Mans, a learned traveller, and an assiduous student of botany and zoology. Belon is the author of several works on zoology and natural history, distinguished for numerous original and accurate observations.

The first of these, on the Natural History of Fishes, consists of two books, which appear to be merely preliminary sketches of what he proposed to do *. In the first he gives short sketches with illustrative figures of the sturgeon, the *attilus* or adano of the Po, and which appears, from its projectile tubular mouth, to be a species of sturgeon, probably the *Acipenser huso*, the tunny, the *citharus* or sea-bream, the *trigla* or gurnard, one which he names the sea-serpent, and another the sea-boar. All these he is at pains to distinguish from the dolphin, not only in habit, but in structure and function.

The dolphin he distinguishes into three species, the dolphin proper or the sea-goose, so named from its long snout, (*Delphinus delphis*, Lin.) ; the porpoise or sea-hog (*Delphinus phocœna*, Lin.) (*phocœna*, Cuv.) ; and the grampus or orca (*Delphinus orca*), characterized by a bent obtuse snout (*bec camus et moulce*), and a less degree of corpulence than the dolphin. The specimen from which his description of the latter animal is formed, was caught in the sea on the coast of Freport in Normandy, weighed 800 pounds, measured 3 paces, or at least $9\frac{1}{2}$ feet in length, and 7 feet in girth at the thickest part of the body. This animal, which he allows to be the largest fish he had seen, had further 40 teeth in each jaw, exclusive of 4 rudimentary fangs before.

In the second book he gives an account of the anatomical peculiarities of the dolphin and porpoise, with occasional observations on the comparative characters between these and fishes on the one hand, and mammiferous animals on the other. In both he remarks the blowing tube above the head, the outlet of the windpipe, though that of the dolphin is less advanced than that of the porpoise. Both, he remarks, have lungs similar to those of man, and differing only in being in two lobes or right and left, with the heart between them, instead of being rather inferior to the lung, as in man.

The lungs, he states, are susceptible of inflation from the

* L'Histoire Naturelle des Estranges Poissons Marins, avec la vraie Peincture et Description du Daulphin et de plusieurs autres de son espece, Observée par Pierre Bélon du Mans. A Paris 1551. 4to. Pp. 115.

blowing tube (*fistula ou fluste*) attached to the windpipe, with the larynx above fixed in the tube much in the same manner as the reed of wind instruments (*anches au cornemuse*), and covered by a valvular membrane which he names at once *epiglottis* and *luette*, with two productions on each side. This account is, on the whole, accurate; and the slight mistakes are to be ascribed to the erroneous notions then entertained on the uses of the parts. It shews that Belon was aware of the peculiar mode of respiration in the cetaceous animals, and of their title to be ranked with warm-blooded animals.

This accuracy is not less apparent in his account of the heart, which, he remarks, is contained within the pericardium, and has two auricles and two ventricles, like that of man, to which, indeed, he represents it as altogether similar.

Though he appears to have examined carefully the alimentary canal and abdominal viscera, both in the dolphin and porpoise, and remarks the position of the stomach below the liver, he omits its quadruple form; and the only approach which he makes to this fact, is when he informs us that its portion termed *pylorus*, known among the peasantry by the name of *caillette*, because it is used for supplying rennet, is half a foot long, and contains as much as the third part of the stomach. The *jejunum* and *ileum* form numerous turns or convolutions, as in the intestine of the calf. The want of *cæcum* he accurately observes; and that the intestine for receiving the excrement, or colon and rectum, is more slender than the rest of the canal, in opposition to what is observed in other animals. The connexion of the canal with the spine by means of the mesentery, as well as the site of the mesenteric vessels, he also observes; and though, like the anatomists of that time, he does not distinguish the veins from the arteries, he correctly remarks the termination of the mesenteric veins in the portal trunk, which, he observes, is distinct, and sufficiently capacious to admit the finger. He distinguishes the situation of the *vena azygos* on the right side of the spine and its tributaries; and though he marks accurately the situation of the *vena cava*, he erroneously, like the ancient anatomists, represents it to arise from the liver. Lastly, it is a remarkable proof of the accuracy of his observation, that, while he mentions the situation of the spleen and the liver, and remarks that the latter is in one mass in the dolphin and porpoise, as in man, and that in young animals it is divided into lobes, yet that neither have gall-bladder.

The kidneys he mentions as large spongy organs, with the ureters descending from them to the bladder, which he inflated and filled, and found its capacity equal to that of a chopin. He further represents it to be as large as that of the sea-frog or devil-fish. The latter statement is another proof of the accuracy of Belon, and which shews that most of his observations are derived from personal inspection. The devil-fish or angler (*Lophius piscatorius*) is one of the few fishes which possess a urinary bladder.

He appears to have been particularly impressed with the development of the nervous system in the dolphin, compared with other inhabitants of the deep; and that he regarded it as approaching in this respect also to the class of warm-blooded animals, must be inferred from the fact, that he represents the brain and its ventricles and convolutions as similar to that of man. He also states that there are seven pairs of nerves, much more distinct than in the human subject, some of which proceed to the nose, some to the eyes, some to the tongue, and others by the lateral regions of the head into the ears. Deficient as this description is, compared with the modern account, it is quite equal to that of Vesalius; and it shews, along with other circumstances, that Belon had studied the anatomy of the human frame, as well as most of his contemporaries.

The osteology of the dolphin he had an opportunity of studying, in the skeleton of one which he found on the shore of the Cimmerian Bosphorus. From this it appears that he recognized the resemblance between the delphinic and human, that is, the mammiferous skeleton, excepting the want of the bones of the pelvic extremities, a fact verified by subsequent observation, and forming one of the organic distinctive characters of the family of cetaceous animals. He reckons 24 vertebræ, 12 ribs on each side, clavicles, and short or false ribs and *scapulæ;* adverts to the shortness of the bones of the thoracic extremities, in which he mentions an arm-bone, and *radius* and *ulna*, and terminating in a hand or paw with five toes and articulations. He remarks the round shape of the *cranium*, which, both in the dolphin and porpoise, he says, is similar in shape to the human *cranium*, and has the same number of sutures; and shews the accuracy of his observation, by informing his reader of the peculiar and separate situation of the lithoid or petrous bones, in which the nerve of hearing is distributed. I may remind the reader, that one of the peculiarities of the CETACEA is, that the lithoid or petrous portion is distinct from the squamous of the temporal bone, and that this fact indicates that the former is the proper auditory bone.

He describes at considerable length the reproductive organs in both sexes, and gives an accurate account of the manner of generation of the dolphin. Into this, however, my limits do not allow me to enter.

Besides the subjects now mentioned, Belon introduces others, with the view of illustration or explanation, all of which shew with what accuracy and diligence he had observed natural phenomena. When speaking of the *mammæ* of the dolphin, he informs his readers, that he dissected bats in the great pyramid of Egypt, and within the labyrinth of Crete; that he had observed the dams suckling the young bats by thoracic mammæ; that these animals build nests; and that they suspend by their wings their young ones while sucking, as if they were attached to the stone walls of the vaults. Multiparous animals, or those which produce several at a birth, *e. g.* moles, hogs, hedgehogs, and porcupines, have several teats or nipples extending along the belly; while those which rear only one at a time, of which he enumerates the giraffe, elephant, camel, horse, chamois, buck, &c. have only two. He had seen the heart pulsating, and the lungs moving, in the young of the camel and other animals; but he erroneously infers that the fœtus breathes within the womb. He was aware of the viviparous character of the angel fish (*Squalus squatina*), the great dog-fish, and the small dog-fish (*canicula*); and he mentions an instance in which he found in the *uterus* of a specimen of the latter, eleven young. He describes the *uterus* of the dolphin, remarks its *cornua* above the ovaries at the side, and its orifice and connexion with the *vagina* below, and describes and delineates a fœtal dolphin within the womb *in situ*. In this work also he delineates the sea-fox (*S. vulpes*), the hammer-headed shark (*Squalus zygaena*) the *hippopotamus*, the *nautilus*, and the mother-of-pearl shell.

The first book of the History of Birds, is devoted to the explanation of the anatomical structure. The most important remark is, that birds are void of kidneys and bladder, and that in place of the former they have fleshy lobes (*des charnures,*) resembling kidneys; that all birds have not a crop for receiving food before entering the gizzard; that some have in place of these organs a large and capacious gullet (*gosier*), named the paunch (*l'herbiere*); some have a hard fleshy callous gizzard; and others neither crop nor gizzard. In the males, he remarks the testicles (*les genitoires*) are contained in the belly near the kidneys; the females have a thin delicate membranous matrix (egg bed) above the intestines, with two *cornua.*

His account of the osteology is elaborate. He remarks the absence of sutures in the cranium; but as he allows that they are occasionally seen, it is not improbable that he alludes to young birds in which they are still visible. The two bones which compose the hyoid of quadrupeds, are situate in birds at the sides of the tongue. He had recognised a greater number of the cervical vertebræ in BIRDS, than in the MAMMALIA; but as he allows them to be twelve, it is probable that he had not dissected those genera in which they are more numerous, as the swan, ostrich, and stork. The dorsal vertebræ he makes only six, which is inaccurate, in so far as the most frequent number is seven, eight, and nine. In fixing the number of ribs also at six on each side, he shews that he had examined a small number of ornithological skeletons only. The peculiarities of the sacral and iliac bones he does not omit. But it is in the chest, he remarks, by which he evidently means the sternum and its appendages, that the greatest peculiarities are recognised. For besides giving a large bone to support the muscles of the wings and protect the lungs, and fixing the shoulder-blades firmly on the clavicles, nature has given birds another additional bone, denominated in French the spectacle-bone or forklike bone (*la lunette* or *fourchette*). "Car communement," he continues, "on la met dessus le nez en forme de lunette; ou bien on le nomme le bruchet; car il prend per devant l'estomach, et est conjoint au bout des deux clavicules en l'endroit des epaules, et de l'autre costé est joint au corselet (*sternum*), c'est-à-dire, à l'os de la poistrine. Car il est fait en maniere de fourchette." This is at least a characteristic account of the bifurcated bone. The coccyx which he names *cropion,* he represents to consist of six separable portions. They are most frequently seven or eight.

To illustrate more forcibly the comparative peculiarities of the human and volucrine skeleton, he gives a representation of each on opposite pages. The human skeleton, however, is not very well proportioned; and Belon has not only made the human chest too narrow and the pelvis too wide, but he has made the thigh bones preposterously short, and has failed to remark the arched appearance of their *diaphyses*, though these peculiarities had been already indicated by Berenger and Vesalius. He has also committed a more serious error in representing the *phalanges* of the fingers and toes as terminating in claws.

In collecting his ornithological anatomy, Belon appears to have been very assiduous and persevering; for he assures us that no animal fell into his hands which he did not dissect, and that he must have examined the internal parts of at least 200 different species of birds, "on which account," he observes with much simplicity and some vanity, "it need not appear strange if we describe the bones of birds, and delineate them with some accuracy *."

The work of Belon is illustrated with rude but spirited wood-cuts, in which the different birds then known in Europe are accurately represented. The second book is devoted to the birds of prey, of the vulture and falcon tribe; and, among other curiosities, we find some amusing observations on the art of falconry. In the third he gives the history of the web-footed swimmers *(Palmipedes)*; and the last chapter contains the description of the bill of a species of Toucan *(Rhamphastos)*, either the Aracan or the Green, illustrated by a figure, then recently imported from the new world. The fourth book is devoted to the river-birds without flat feet, or waders *(Grallae)*, as the crane, heron, bittern, spoonbill, egrette, night-heron, a black *ibis*, not positively determined by modern zoologists (Cuvier), the stork, sea-pie, curlew, godwit, spotted redshank, lapwing, spotted water-hen, water-rail, land-rail, woodcock, purre or stint, king-fisher, and bee-eater. The

* "Onc ne tumba animal entre noz mains, veu qu'il fut en nostre puissance, duquel n'ayons fait anatomie. Dequoy est advenu qu'ayons regardé les interieures parties de deuxcents diverses especes d'oiseaux. L'on ne doit donc trouver estrange si nous descrivons maintenant les os des oyseaux, et les portrayons si exactment."—*L'Histoire de la Nature des Oyseaux.* A Paris, 1555. Liv. I. chap. xii.

fifth, which is devoted to land-birds chiefly, which build on the ground, comprehends the ostrich, peacock, bustard, small bustard or bustarnelle, thick-knee, francolin, domestic cock, guinea fowl, turkey, cock of the wood, grouse, pheasant, various species of partridge, plover and quail, the bunting, crested lark, field lark, calandra, titlark, and snipe. The sixth book contains the history of those birds which find their food indiscriminately in all places; and under this head Belon arranges the birds of the crow and raven family, the jay, pie, hoopoe, parroquets, parrots, pigeons, and thrushes. The seventh and last is devoted to the history of the nightingales, linnets, grossbeaks, several of the passerine birds, and a few of the swallows. It will be seen that the classification of Belon is very imperfect. But it must be remembered that he was the first scientific ornithologist in modern times, and to him the science was new and unexplored. It must further be observed, that, whatever be the defects of his arrangement, his descriptions are so distinct and accurate, that it is, in general, easy to recognize the particular genera and species understood by the author. That he is mentioned by Portal only for some observations on the mode of making mummies, and that his anatomical and ornithological services are altogether omitted, I think can be ascribed only to his work not having been seen by that learned anatomist.

It is painful to think that this assiduous and enthusiastic observer, after escaping the hazards, at that time not inconsiderable, of travelling in Greece, Arabia, India, and Egypt, fell under the dagger of an assassin in the vicinity of Paris in 1564.

Among the pupils of Gonthier of Andernach, Michael Servet, Revèz, or Renèz, born in 1509 at Villanova in Arragon, holds a conspicuous rank; and he merits a place in this sketch, because there is the strongest reason to believe that, in dissecting the lower animals under the eye of Gonthier, he began to form, in tracing the course of the blood through the cavities of the heart and pulmonary artery, those distinct notions which terminated in his discovery of the small circulation. Servet was born two centuries earlier than he ought to have lived, considering the fanaticism and bigotry of the times. In an evil hour he attempted to discuss the mystery of the Trinity, with the free spirit and the bold hand with which he investigated the structure of material bodies; and, to escape the paternal authority which the Inquisition exercises over her erring children, he fled from Spain to France, where he studied anatomy and medicine, and taught mathematics at Paris. From Paris he proceeded to Charlieu near Lyons, thence to Toulouse, and eventually travelled through several of the provinces of Germany, every where propagating his opinions, and every where persecuted. It must have been some time in the course of this erratic mode of life that he published his first work denominated *De Trinitatis Erroribus*, in 1531, probably at Basil; for it is without place. From Germany he returned to France, and was in the city of Vienne in Dauphiny in 1553, when he published his second work, entitled *Christianismi Restitutio*, and which is still more rare and valuable than the former. It required not the publication of this work to proclaim Servetus as the most impious of heretics, equally abhorred by the Catholic church and the new but not less violent proselytes of Calvin. At the instigation of the latter, who represented Servet as a wicked heretic, whose errors could only be expiated by the sword, several Genevese apprehended him in Vienne and conveyed him to Geneva, where he was brought to the stake on the 27th of October 1553, at the age of 44. It is impossible to doubt that this barbarous execution throws on the character of Calvin a stain which all his services in the cause of reformation cannot efface. Even Portal, who, like a good Catholic, remarks on this occasion, that one heretic put another to death, cannot refrain from bestowing on the Genevese the civil epithets of *fourbe* and *ignorant*, while he allows the victim the merit of being one of the greatest geniuses of Europe.

It is in the fifth book of his second work *Christianismi Restitutio*, and not in the treatise *De Trinitatis Erroribus*, which has been vainly searched by many curious persons, that Servet delivers his ideas of the small circulation. The work is extremely rare; and for my knowledge of his views I am indebted to De Bure, who has faithfully transcribed the passage from the original copy preserved in the Library of the President *De Cotte*, —supposed to be the only one in existence *. From this ex-

* "Vitalis spiritus in sinistro cordis ventriculo suam originem habet, juvantibus maxime pulmonibus ad ipsius perfectionem. Est spiritus tenuis, caloris vi elaboratus, flavo colore, ignea potentia, ut sit quasi ex puriore sanguine lucens, vapor substantiam continens aquæ, aeris, et ignis. Generatur

tract it appears that Servet maintains the existence of a vital spirit, which is seated in the heart and the arteries, and in the formation of the spirit and its combination with the blood, he represents life essentially to consist. The vital spirit, he continues, which is thin, of a yellow colour, elaborated by heat, originates in the left ventricle, but is chiefly completed in the lungs by combination of the inspired air with the elaborated refined blood which the right ventricle conveys to the left. This communication, however, he argues, does not take place through the wall of the heart, which is impervious ; but by an ingenious contrivance the thin blood is conveyed from the right ventricle of the heart by a long channel through the lungs, where it is prepared, assumes a yellow colour, and is transferred from the arterious vein (the pulmonary artery) into the venous artery (the pulmonary veins). Then, after being mixed with inspired air, and purified by expiration from *fuligo*, it is attracted by the left ventricle, from which, he afterwards remarks, it is distributed in the form of vital spirit through the arteries. This course of the blood, he concludes, is demonstrated by two facts, 1*st*, The communication of the arterious vein and venous artery in the lungs ; and, 2*d*, By the size of the arterious vein, which would not be so considerable merely for nourishing the lungs.

It deserves remark, that this contains not only the elements

ex facta in pulmone commixtione inspirati aeris cum elaborato subtili sanguine, quem dexter ventriculus sinistro communicat. Fit autem communicatio hæc, non per parietem cordis medium, ut vulgo creditur, sed magno artificio a dextro cordis ventriculo, longo per pulmones ductu agitatur sanguis subtilis; a pulmonibus præparatur, flavus efficitur, et a vena arteriosa in arteriam venosam transfunditur. Deinde in ipsa arteria venosa, inspirato aeri miscetur, et exspiratione a fuligine expurgatur ; atque ita tandem a sinistro cordis ventriculo totum mixtum per diastolen attrahitur, apta supellex, ut fiat spiritus vitalis. Quod ita per pulmones fiat communicatio et præparatio, docet conjunctio varia, et communicatio venæ arteriosæ cum arteria venosa in pulmonibus. Confirmat hoc magnitudo insignis venæ arteriosæ, quæ nec talis nec tanta facta esset, nec tantam a corde ipso vim purissimi sanguinis in pulmones emitteret, ob solum eorum nutrimentum ; nec cor pulmonibus hac ratione serviret, cum præsertim antea in embryone solerent pulmones ipsi aliunde nutriri, ob membranulas illas seu valvulas cordis, usque ad horum nativitatem ; ut docet Galenus, &c. Itaque ille spiritus a sinistro cordis ventriculo arterias totius corporis deinde transfunditur, ita ut qui tenuior est, superiora petit, ubi magis elaboratur, præcipue in plexu retiformi, sub basi cerebri sito, ubi ex vitali fieri incipit animalis, ad propriam rationalis animæ rationem accedens."—*Bibliographie Instructive,* vol. i. p. 421.

of the small or pulmonary circulation, with a slight approach to the large one, but the essential circumstances of the modern doctrine of respiration. The idea of Servet of the combination of the blood with the air in the communicating branches of the pulmonary artery and veins, is as distinctly expressed as in the modern physiological authors; and the notion that the blood is purified from some foul or sooty material *(fuligo)*, is quite analogous to that of the separation or elimination of carbon from the venous blood. The rarity of his work, however, and the melancholy fate of the author, appear to have kept these valuable doctrines in a state of comparative obscurity for nearly two centuries.

Hitherto anatomy, both human and animal, had been cultivated rather in a desultory and unsystematic manner, and without great attention to precision and accuracy; and even Vesalius himself was by no means free from this defect. Some attempts to rectify this evil were made, we have seen, by Ingrassias and Cannani; but the individual who made the most strenuous exertions, and who further availed himself systematically of the study of comparative anatomy, to illustrate the structure of the human frame, is Bartholomew Eustachio of San Severino, in the Anconese territory. This anatomist, who was not less distinguished, though greatly less fortunate in reputation, than Vesalius, was professor to the Roman College, and physician to Giulio della Rovere, Cardinal d'Urbino, not afterwards pope, as stated by Portal; for that cardinal never attained the papal dignity. Though assiduously devoted to the dissection of the human body, he may be regarded as almost the first, and, for a long time, the only anatomist who laboured on a rational plan to extend the science by the study of animal anatomy.

The first subject investigated by Eustachio was the structure of the kidneys; and it is almost enough to say, that his description of their granular and tubular portions, and the arrangement of the vessels in both, is quite as accurate and distinct as that of the best modern anatomists. The structure of these organs he had investigated not only in man, but in the dog, bear, and other animals. The granular or cortical matter, as it has been named after him, is reddish in man, he remarks, but whitish in the dog and other animals. A valuable observation is, that he remarked the lobulated structure of the kidneys of the bear, the inequalities on the surface of those of the calf, and of the fœtus and infant of the human subject, thus recording the fact, which is connected with the manner of development in distinct tubular conoids or lobules, which are eventually united.

His researches on the teeth, which come next, shew that he studied the structure and formation of these bodies attentively. It is interesting to observe, that, in describing the formation of the teeth in the fœtus, he recognises the fact, that the dentiferous sacs contain not only the temporary but the permanent set; and so accurate is his observation, that he remarks, that the only difference between the two ranges is, that the canine teeth correspond with the large incisors of the second range. He describes accurately the formation of the enamel, and recommends the anatomist to study it in the fœtus and young buck, if he has not opportunities of observing the process in the human fœtus. The internal canals or nutritious tubes, and their vascular pulp or sac, he describes from the human body, the ram, and the ox, in which he allows that the process of growth is most distinct. The whole description is most accurate, and deserves the attentive perusal of the anatomical reader.

In a subsequent account of the bones, he describes the osteology of the monkey with minuteness and accuracy, and compares it with that of the human subject. The object of this essay is not quite so laudable as that of his other works; and I regret to say, that his principal purpose appears to have been to establish the fact, that the osteology of Galen is not derived from the human skeleton. He has the courage in this treatise, however, to reject the human *allantois*.

In his chapter on the *vena azygos*, or *vena sine pari*, Eustachio announces a discovery, which alone is sufficient to confer immortality. The distribution of this vein he had studied in several animals; and, in observing its structure and relations in the carcass of a horse, he recognised, on the left side of the vertebral column, a white vessel full of watery fluid, connected above with the jugular vein, and with its lower end not yet ascertained, and forming the large central trunk of the lacteals, which was afterwards denominated the *thoracic duct*. This memorable fact is so interesting, that I cannot refrain from giving the description of the author.

"Ad hanc naturæ providentiam quamdam equorum venam alias pertinere credidi; quæ, cum artificii et admirationis plena sit, nec delectatione ac fructu careat, quamvis ad thoracem alendum instituta, operæ pretium est, ut exponatur. Itaque in illis animantibus, ab hoc ipso insigni trunco sinistro juguli, qua posterior sedes radicis venæ internæ jugularis spectat, magna quædam propago germinat, quæ, præterquam quod in ejus origine ostiolum semicirculare habet, *est etiam alba, et aquei humoris plena;* nec longe ab ortu in duas partes scinditur, paulo post rursus coeuntes in unam quæ nullos ramos diffundens, juxta sinistrum vertebrarum latus, penetrato septo transverso, deorsum ad medium usque lumborum fertur; quo loco latior effecta, magnamque arteriam circumplexa, obscurissimum finem, mihique adhuc non bene perceptum, obtinet."—*De Vena sine Pari. Antigr.* xiii.

In the same treatise he describes the situation and appearance of the large membranous fold in the right auricle, which still bears his name, and the small one at the beginning of the coronary vein.

His researches on the organ of hearing are original and interesting. In the tympanal cavity he described the internal muscle of the *malleus*, already delineated by Vesalius, and named the *tensor tympani;* the *stapes* and its muscles, and the tympano-pharyngeal tube which communicates with the pharynx, and which still retains his name. He first delineated the *cochlea* and its osseous plate.

Important, however, as were these discoveries to anatomical science, they form but an inconsiderable part of the labours of Eustachio. Assiduously devoted to the cultivation of human anatomy, and actuated also, we must admit, by a feeling of envy at the growing reputation of Vesalius, he undertook to illustrate the true and accurate structure of the human body, in a series of delineations representing the shape, size, and relative position of the different organs of which it is composed. This task, after years of assiduous dissection, he completed, in thirty-nine plates, in the 1552, nine years after the first impression of the work of Vesalius. But it was unfortunate, both for his just reputation and for the progress of anatomical knowledge, that he was unable to publish them during his life. At the period of his death, in 1574, he bequeathed them to his friend Pini, of the family of the Pope; and their seclusion in the Papal library till the year 1712, when they were presented by Clement XII. to Lancisi, who published them in 1714, has retarded for 150 years the progress of anatomical knowledge, and given celebrity to many names which would have been known only in the verification of the discoveries of Eustachio.

At the period of their rediscovery, these plates were without reference or description; and it is believed that any descriptive commentary which the author wrote, must have been lost. The object of Eustachio, however, may be conjectured partly from the delineations themselves, and partly from the observations contained in the *Opuscula*, which may be regarded as the commencement of the work. It appears that Eustachio undertook the opposite and contradictory task of defending Galen, and shewing the imperfection of the researches of those anatomists who attacked the physician of Pergamus. As he proceeded, he seems most fortunately to have lost sight of the first object, and adhered rigorously to the second; and the result has been, that he has made a greater number of discoveries than any of his predecessors or contemporaries; and, by his individual efforts, has done as much for the advancement, rectification, and improvement of anatomy, as all the anatomists for nearly two hundred years after him had jointly effected. He had, indeed, rectified and improved the whole system of human anatomy so much, that, as is justly observed by Lauth, had the author himself lived to publish his delineations, anatomical knowledge would have attained the perfection of the 18th century two centuries earlier at least.

The imperfect form in which these figures were published by Lancisi, in 1714, induced Cajetan Petrioli, a Roman surgeon, to republish them in 1740. The confused manner in which this author added notes and explanations on previous notes and explanations, only shewed his incapacity for the task; and, after various detached comments had been made by Morgagni, Fantoni, and Winslow, a full and complete explanation, much abler than any heretofore, was given in 1744 by Albinus. Even after this commentary, however, Haller remarks, there are various unexplained topics in the plates on the nerves and blood-vessels. In 1755, the first Monro superintended in this city the publication of a series of posthumous commentaries by Dr

George Martine, who had studied the Eustachian tables in the edition of Lancisi, for the year 1720, and who had only relinquished the design of publishing them in 1740, by being sent on the public service to America. Though their publication was afterwards delayed on the announcement of the edition of Albinus, it was found, on the appearance of that work, that they were not superseded. The commentaries of George Martine constitute the most learned, acute, and critical treatise on the Eustachian Anatomy that has yet appeared; and, though the improved engravings of modern times have, to a great extent, superseded those of the Roman physician, they will always be perused with interest by all who study the literary history of anatomy.

(*To be continued.*)

Thoughts regarding the Influence of Rocks upon Native Vegetables. By Alexander Murray, M. D. & A. M. Aberdeen. Communicated by the Author.

A gentleman in this neighbourhood, who is in the habit of seeing Loudon's Magazine, some time ago directed my attention to one of the late numbers, on account of its containing a paper —wherein various interesting observations are to be found— under the title of "Remarks on the Relations subsisting between Strata and the Plants most frequently found in their superincumbent Soils. By W. Thomson." As he brings forward, in a prominent manner, certain observations of mine, published in Professor Jameson's Journal, I may be allowed to offer, on the same subject, the following remarks, tending to a different conclusion from that adopted by Mr Thomson—who believes that the vegetable productions are largely influenced, if not invariably determined, by the rocks.

It will be readily admitted, that the existence of an unvarying connexion between indigenous vegetables and the rocks over which they grow, would be viewed as a beautiful association, calculated to increase not a little the attractions both of geology and botany; but the interest which would be attached to the circumstance, though sometimes used apparently in place of an argument, has, it is very evident, no bearing upon the question itself, which is, *Whether or not vegetable species are regulated by the subjacent rocks?* or, in other words, *Whether native plants, or a majority of them, spring up and thrive upon all rocks indiscriminately, when other circumstances are favourable; or, if they do so, some only over one rock, and others only over another?* The interest belonging to the subject entitles it at least to consideration; and notwithstanding the formidable objections to the doctrine, there is undoubtedly, even on the part of individuals whose opinions deserve much respect, an increasing disposition to believe, that the indigenous vegetables are frequently capable of disclosing the nature of the rock that lies beneath them *.

An obvious difficulty presents itself in the consideration, that though relations of the kind alluded to did in reality exist, no one can hope ever to be able to specify in words the nature of the connexion. This is certainly true, provided mineral masses be viewed through the medium of the present systems; wherein the same name is often given, and perhaps of necessity, to substances widely different in structure and composition; and wherein rocks are arranged and distinguished according to position and connexions, rather than according to qualities by which vegetables are likely to be influenced; these qualities being the nature of the component parts of the rock, together with its tendency to be converted into soil. Thus granite, it is well known, at one time completely resists the weather for ages, while at another it readily furnishes an abundant soil. Basalt, too, is occasionally of the most obdurate description, though in general it is copiously converted into one of our most fertile earths. It is almost unnecessary to add, that in the case of sandstones, conglomerates, breccias, and of amygdaloids, it must be impossible to discover any unvarying relation between vegetables

* It has been also thought, that the native vegetation may indicate the qualities of soils; and, indeed, attempts have been made to draw from the same source several curious inferences. Of these, one of the most interesting has been noticed by Clarke, the traveller, respecting *Arundo Phragmites*, a plant not uncommon in this country, and other parts of Europe; and the observation may be here mentioned, though not strictly connected with the present object. "Another criterion," says he, "of the sources of mephitic exhalation, is the appearance of *Arundo Phragmites.* This plant in warm countries may be reckoned a warning buoy."

and the rocks bearing those names, because in different instances each differs entirely from itself.

Not only does the same rock differ materially; but, on the other hand, rocks whose geological and mineralogical characters are dissimilar, may furnish a soil essentially the same. Thus, the following branches of the primitive series: granite, gneiss, mica-slate, clay-slate, when converted into soil, all usually give rise to a sandy clay; and, with respect to the secondary trap-rocks, they run into one another by insensible gradations, and each of them will probably produce a soil similar to that from any one of the rest.

In short, the varied forms of a particular rock may differ from one another, in respect of the circumstances likely to influence vegetation, more than certain rocks do from others, which are reckoned different in species,—a consideration which must occasion serious practical difficulties to him who attempts to connect plants with rocks. It might no doubt be alleged that this objection is more apparent than real, and that we must not class rocks together, which have little or no similarity but in name; but with a reference to the present object must reckon as the same those rocks only which have the same tendency to crumble down, or to be chemically decomposed, and which form soil of a similar description. Even with this modification, which cannot be adopted in practice, the doctrine here combated will be found to have no solid foundation.

In the first place, it cannot be denied that at the present day rocks usually lie at so great a depth, that the roots of most vegetables cannot come into contact with them; and it hence becomes probable that in general rocks have little influence upon the vegetables growing over them,—at least, except when they contribute materially to the superincumbent soil. Now, I believe, it will be admitted by all who have attended to the subject, that when an opportunity is afforded for making the observation, it is frequently apparent that the chief part of the mineral ingredients of the soil is not derived from the subjacent rock, but has been transported from some distance. These changes of situation, I scarcely need to say, are ascribed to the agency of water in various ways,—that is, rain and ice; to rivers particularly in a state of flood, from the deposites which take place in stagnant water; but most of all to that great revolution of the earth's surface, which we believe to have taken place at a remote period. The *causes*, however, concern not the present object. It is enough to know, that many of our plains, valleys, and the sides of mountains, are covered by a mass of sand and mud, not derived from the rock immediately beneath. The decay of vegetables, and the operations of agriculture, are gradually increasing the foreign matters upon the surface, and must be tending to separate the vegetable kingdom still farther from the rocks.

Let us next examine the cases, and they are not very numerous, wherein a considerable proportion of the soil is derived from the rock immediately below. It is, then, to be here mentioned, as an argument against the influence of rocks, even in those instances, that the mineral ingredients appear to perform a part which is far from being very important to the vegetable economy. Thus Giobert mixed together the earths usually found in fertile soils, and in this artificial compound were placed seeds of various kinds, which germinated indeed, but did not thrive, and soon perished. Let this experiment be viewed in connexion with others, wherein water alone was supplied. Du Hamel placed in moss or wet sponges beans and pease, which flourished and produced fruit; and Bennet, by treating vines in a similar manner, found that they produced excellent grapes. From these experiments, it might be inferred, that water by itself is as conducive to the nutrition of vegetables as pure mineral soil moistened with water. Is there a probability that the principal use of the mineral part of soil is to be a medium for conveying to plants moisture along with matter derived from animal and vegetable substances?

All the foregoing considerations militate much against the opinion that vegetable species are determined by the nature of the subjacent rock; and, indeed, they appear so strong as not to be overcome unless by strong facts on the other side. In other words, without strong facts the opinion appears to have no kind of footing. Were it to prove to be possessed of a good foundation, an interesting inquiry would be as to how the vegetable species are arranged, with relation to particular rocks,—whether they are mingled in a miscellaneous manner, or grouped together according to genera or to natural orders, or upon any other cognizable principle? No one, however, so far as I know, will venture to answer these questions, or to offer facts to connect more than a few plants with particular rocks, the best, even if fully admitted, not being comparatively more extensive than the usual exceptions to every rule. On the contrary, it will be found, that facts have an entirely opposite tendency.

There are various ways in which facts might be adduced to illustrate our subject. It appears, however, to be the most satisfactory plan, to select rocks differing from one another in structure and composition; but in other points, particularly in elevation and latitude, not materially dissimilar, and to compare their respective vegetations; for it is clear, that if the majority of plants, which are common upon a certain description of rocks, do also, *cæteris paribus*, grow and thrive upon a rock entirely different, this circumstance would go far to set the question at rest. I have therefore taken the native plants of a primitive district in Aberdeenshire, thirty or forty miles in circumference, composed mainly of granite and gneiss, and compared them with the vegetations of the secondary rocks around Edinburgh, and also with that of the still newer formation in the neighbourhood of Paris. These situations, in point of latitude, differ to a certain extent, but, upon the whole, they are for the present purpose very unexceptionable; as these respective rocks are, in the view of the chemist, mineralogist, and geologist, as different, I may say, as is possible. It is necessary to exclude plants depending upon local peculiarities, such as alpine and maritime species; since the fittest comparison is that which respects species growing over rocks, which differ in no material point unless their own nature.

A certain number of the more important genera and natural orders of botany have been selected, and the plants common in the Aberdeenshire district, belonging to those orders and genera, have been traced through the tract around Edinburgh, and throughout the environs of Paris. The following observations then have been made.

All the plants belonging to the order Compositæ, which can with propriety be called common in the Aberdeenshire district already alluded to, are these: *Sonchus arvensis*, *S. oleraceus*, *Leontodon Taraxacum, Apargia autumnalis, Hieracium Pilosella, H. sylvaticum, H. paludosum, Hippochæris radicata, Lapsana communis, Cnicus lanceolatus, C. palustris, C. arvensis, Artemisia vulgaris, Gnaphalium dioicum, G. rectum, G. uliginosum, Tussilago Farfara, Senecio vulgaris, S. sylvatica, S. Jacobæa, S. palustris, Bellis perennis, Pyrethrum inodorum, Achillæa Millefolium, A. Ptarmica, Centaurea nigra, C. Cyanus.* The above, I repeat, are all the common plants belonging to the order Compositæ found in the Aberdeenshire district. Now, of these every one is abundant around Edinburgh; and they are likewise all considered common in the vicinity of Paris, with the single exception of *Hieracium paludosum*, which is not there to be met with.

The following list comprehends all the plants of the order Labiatæ, which are decidedly common in the Aberdeenshire tract: *Ajuga reptans, Teucrium Scorodonia, Mentha hirsuta, M. arvensis, Lamium purpureum, L. amplexicaule, Galeopsis Tetrahit, G. versicolor, Stachys sylvatica, S. palustris, Thymus Serpyllum, Prunella vulgaris.* Of these plants, every one is common near Edinburgh; and, with the exception of *Galeopsis versicolor*, which is wanting, all of them appear to be abundant in the environs of Paris.

I shall next notice the important order Leguminosæ; but it is unnecessary to continue to set down names. It is enough to say, that all the Aberdeenshire species are common near Paris; and the same are met with abundantly in the vicinity of Edinburgh; unless *Genista Anglica*, which in that situation is rare.

The common plants in the Aberdeenshire district belonging to the orders Cruciferæ, Umbelliferæ, Asperifoliæ, Cyperaceæ, and Scrophularinæ, are all, with the single exception of *Carex binervis*, abundant around Edinburgh; and in the environs of Paris, they are also equally common, with the following exceptions: in that situation *Symphetum tuberosum* has not been found; and *Carex ampullacea, Chærophyllum sylvestre*, and *Ægopodium Padagraria*, appear to be rare. I am farther doubtful whether *Myosotis palustris* grows around Paris.

The following extensive genera not comprehended under the preceding Natural Orders, have likewise been examined, namely, Veronica, Viola, Juncus, Epilobium, Polygonum, Stellaria, Ranunculus, and Hypericum. It appears that all the truly common species in the Aberdeenshire district belonging to those genera are abundant near Edinburgh; excepting that *Polygonum viviparum*, *Juncus uliginosus*, and *Ranunculus hederaceus*, appear to be but sparingly distributed; and all are equally common in the environs of Paris, unless *Polygonum viviparum*, *Viola palustris*, and *Ranunculus hederaceus*. The first is not found; the others are uncommon.

These extensive examples, which I believe are quite accurate, and certainly they make a near approach to being so, may probably be taken as a fair representation of the similarity between the entire Floras of the regions referred to. In short, the mass of plants common in the Aberdeenshire district is equally so in the vicinity of Paris and of Edinburgh. The *plantæ rariores* of those places might likewise have been compared, but this plan would have been less useful than that which has been pursued; and the task, too, is one for which at present I have not convenience *.

It is not to be concealed, that around Edinburgh not a few plants are common which are wanting in the Aberdeenshire district so often referred to; and there are still more species abundant in the environs of Paris that do not belong to any part of Scotland; but this circumstance, when properly considered, has no material bearing upon the question here discussed, as it is probably unconnected with the nature of the rocks. It might be explained by the climate gradually becoming more favourable to vegetation as we approach the equator; though, perhaps,

* In connexion with these remarks, it may not be uninteresting to observe, that above three-fourths of the flowering plants of all Scotland grow also in the neighbourhood of Paris; and if from the plants found in Scotland, but not around Paris, the alpine, maritime, and rare species be extracted, few indeed remain. In short, there are scarcely in Scotland more than twenty truly common plants, which are not in the Flore des Environs de Paris. It may be worth adding, that the plants wherein the French tract appears more deficient, are Hieraciums and Saxifrages; and that the plants sometimes reckoned characteristic of Scotland, viz. our heaths, broom, and furze, are all found near Paris, where they appear to be common. I have also gathered, on the banks of the Seine, *Onopordum Acanthium*, the plant which in this country has occasionally a place in processions, from being considered that thistle which is emblematic of Scotland. Near Paris it is common, whereas in this country it is rare, appearing confined to a few stations in the south.

not a little of this difference in the number of species depends upon the fact, that the neighbourhood of great towns has been better explored than situations remote from the ordinary scenes of botanical research; while another part of the difference may arise from species not planted by the hand of Nature, having, from various causes, found a footing in the vicinity of towns. Considering the obvious result from the rudiments of a particular species not having had access to a certain spot, we ought not hastily to conclude, that the absence of a particular plant arises from the station being unfavourable to it. Thus, when we reflect upon the progress frequently made in the neighbourhood of gardens by plants which are not natives, it must be apparent that a certain region may be sufficiently congenial to various species never planted in it by the hand of Nature. It should likewise be recollected, that it is sometimes possible to detect, even in a limited space, a difference of vegetation without any appreciable alteration in the rock, soil, elevation, or exposure; on which account, when we meet with an example wherein two neighbouring rocks of different natures are clothed each with a vegetation differing from that which is found upon the other, we ought not to attribute this circumstance without hesitation to the dissimilarity of the rocks. Indeed it may be suspected that the apparently accidental circumstances which regulate the dispersion of seeds are, much more than the condition of the rocks, concerned with the manner in which plants are arranged.

Viewing, in connection, all the preceding facts and considerations, it must be impossible to maintain, that with respect to the great bulk of vegetables, particular species belong exclusively to particular rocks. The opinion has nothing to render it *a priori* probable, nor is it supported by any facts worthy of attention; whereas the view which it has been here attempted to establish, accords well both with reasoning and experience. It has appeared that the mass of vegetables common in a portion of the north of Scotland, are equally abundant in a southern part of the kingdom, and no less so in a district of France. The species, no doubt, increase in these two latter situations; but that circumstance, as already mentioned, ought to be imputed to considerations distinct from the rocks, particularly to the more genial climate. Climate, indeed, may be called the master regulator of vegetables. On this account, when impression of vegetables, with a tropical aspect, are met with in the south of Scotland, their dissimilarity to the species found at the present day in the same situation, is attributed, not to the difference of rock, but to the change which, in these latter times, our climate must have undergone. Let any change of place be made, short of that which is accompanied by a material alteration of climate, and the prevailing features of vegetable nature do not undergo a change. Every thing around us may have become different, while the native plants continue, in general, the same; and, more than any thing, bring back to memory the region which we have left. On the other hand, let us remove to a remote latitude, or even a different elevation, and however similar may be the rocks before us, a different creation of vegetables prevails. It is well known that the granite in the higher parts of the Alps is clothed with a vegetation different from that which covers the same rock in Cornwall; and no one will deny, that the plants growing upon the trap of St Kilda, are different from those which are found in a trap district of Hindostan.

In conclusion, it may be laid down as a general rule, that vegetable species are not limited and determined by the subjacent rocks; but to this there may be a few exceptions. Thus, it is certain that plants must be affected by rocks which influence the moisture of the soil; and, considering the peculiar and energetic properties of lime, it is not an improbable guess that it may be eventually established that certain plants are confined to the limestone rocks.

The title of this paper has been limited to the supposed influence of *rocks* upon native vegetables; as it is not intended to discuss, in any complete manner, the question as to relations subsisting between soils and plants—a subject far more difficult than the other to submit for examination, on account of the very great variety of combinations which the ingredients of soil are capable of forming. It may be permitted me, however, to say briefly, that, in all probability, the native plants of any given region will, when other circumstances are equal, grow and prosper in any soil, some exceptions being necessary, chiefly on the score of moistness. Depth, too, of soil ought to be taken into account; but that circumstance will be admitted to be of no vital moment by him who adverts to the admirable manner in which roots adapt themselves to existing circumstances. So marvellous sometimes is the manner wherein they do so, that he might almost be excused, who should ascribe to vegetables a power of observation and reflection.

The earths are absorbed by vegetables but seldom, and in very small quantities; and as the usual mineral constituents of soil, silica, alumina, magnesia, and lime, appear to exist every where over the earth's surface, it may be believed that every soil has as much of each of them as is necessary for the constitution of any vegetable. It is also clear that no soil can occur without a certain quantity of moisture and carbonaceous matter, the usual and necessary food of plants. In the next place, analogy, though far from being a safe guide, may be at least attended to. It is, therefore, to be mentioned, that the limiting of certain vegetables to certain soils, is favoured by no analogy which can be drawn from animals, who live and prosper in nearly all regions, and do so sometimes under circumstances which might be said to be opposed to the fundamental qualities of their natures *.

The preceding observations, whether relative to rocks or soils, regard only indigenous vegetables, and perhaps do not by any means apply to those which are in a state of culture. Vegetables are cultivated for the sake of particular parts, as the fruit, root, &c.; and it may be that luxuriance will be favoured by circumstances in the rock and soil which do not influence the simple existence and propagation of native species †.

Aberdeen, *19th January* 1831.

* It is mentioned by some authors, that in one or more of the Western Isles, the horse is occasionally fed on fishes.

† Vide Prof. Jameson's Memoir on soils, &c., in his Illustrations of Cuvier's Theory of the Earth.

*An Account of some Experiments made to determine the Thermal Expansion of Marble.** By Mr JOHN DUNN and Mr EDWARD SANG. Communicated by the Authors.

In the construction of clock movements and of metrical standards, we are constantly harassed by the expansion and contraction of the parts.

As soon as the fact that bodies expand by heat became known, the question must have arisen, "Does any substance exist which is not liable to this change of volume?" Many have been the experiments made to determine the rates of expansion of different bodies; but although some bodies have been found of which the elongation is exceedingly small, in none, as yet, has it been discovered to be awanting.

The construction, on the supposition that marble is inexpansile, of a marble clock pendulum for the Royal Society of Edinburgh, a description of which was read at our last meeting, and previously, we understand, before the Royal Society itself, can hardly have failed to have excited a considerable sensation among those who are practically acquainted with the many inconveniences which attend a change of temperature, or to have created some curiosity about the manner in which such a singular fact was arrived at.

The analogy from which the inexpansibility of marble was deduced, at first sight plausible, will not bear a rigid examination. Granting, though it has not been confirmed, that a regularly crystallized piece of calcareous spar changes its shape but not its volume on being subjected to a change of temperature; this only shows that, when disposed in a peculiar manner, the particles of carbonate of lime approach in one direction, and recede in others, so as to retain the same aggregate volume. We are by no means at liberty to infer, that irregularly disposed particles, or even crystals of this substance, are acted on in the same way; the very fact of their accidental distribution destroys of itself the force of the analogy. Particles of carbonate of lime, when regularly arranged, may obey one law, while, for any thing that we know, the intimate consti-

* Read before the Society of Arts for Scotland, March 30. 1831.

tution of matter, the same particles, when irregularly congregated, may follow a very different one. Such an analogy might have given rise to conjecture, and might have incited to experiment; but it should surely never have been regarded as justificative of an inference which militates against all experience, and gives to white marble so unique a place among solid bodies.

The appeal to direct observation can alone set the matter at rest. Induced by the high importance of the subject, we have made this appeal, and now propose to give an account of the results of our experiments.

The difficulty of making any very accurate measurements of the expansion of bodies by heat is best felt by those who have essayed them. When the rate of expansion of one substance is known, it is not a very difficult matter thence to determine the expansibilities of others: the first determination is that which is attended with the greatest difficulty. No substance is free from expansion by heat, so that we can have no permanent standard for measuring the magnitude of that submitted to observation, unless by keeping some slightly expansive material at a fixed temperature. Heat, however, is communicated with such rapidity through even the most slowly conducting media, that either the standard or the variable body changes temperature before the measurements can be effected. Berthoud's plan of lifting a heated bar and placing it upon the plate of a pyrometer, is altogether unfit for accurate purposes, nor is it easy to point out any method that may be entirely free from objections. The heating of the substance, as well as the retaining of it for a considerable time at a fixed temperature, is also attended with inconvenience; in fact, the sources of minute error are so involved, that no observer can be certain of the accuracy of his results, and that it becomes imperative on him to detail all the grounds on which he has proceeded, and all the precautions which he has taken to avoid error.

As we have already hinted, there are two methods according to which we may proceed in determining the expansion of a substance: we may either compare its lengths, when differently heated, with that of a body kept at a uniform temperature, or otherwise with those of a body of known expansion subjected to the same changes of temperature. The latter method is attended with comparative facility, and is worthy of the greatest reliance, if the expansibility of the standard substance has been well determined.

The tabulated expansions of few solid bodies can be relied on, on account of the great change in expansion caused by the smallest admixture of any foreign substance. Mercury, from its use in the construction of thermometers and barometers, has been examined with considerable care; yet, among the reported expansions of the fluid metal, there are great differences, mostly to be referred to inaccuracy in the determination of the glass vessels in which it was contained. That account of its variation in which we feel inclined to place the greatest reliance, is given by Laplace in his *Systeme du Monde*, where he states it to be 100 parts in 5412, or 18477 in a million, from the temperature of melting ice to that of boiling water.

The rod with which we compared the marble was of glass tube, the rate of whose expansion we determined in the following manner. Of a portion of the tube we formed a vessel with a capillary stem. This vessel we filled with recently distilled mercury, when at the temperature of melting ice: and afterwards subjected it to the heat of boiling water, carefully collecting all the expelled mercury. The weight of the mercury ejected was 66.9 grains, the weight of that remaining in the vessel being 4312.6 grains, giving for the excess of the expansion of mercury above that of glass .015513; whence the expansion of the glass is .002964 in bulk, or .000988 in length.

This result is rather above the expansion usually given in tables, and is liable to a previous error in determining the expansion of mercury. Yet a little reflection will convince any one, that the tendency of most of the errors of observation is to diminish the apparent expansions, so that an increased result seems to afford some proof of the care with which the expansion of mercury has been determined. The chance of error in the weighings was very small, so that, in all probability, the expansion named is very near the truth.

The glass rod was made to serve as beam to a beam-compass, and was subjected to the same change of temperature with two slabs, one of white Carrara, and the other of black or Lucullite marble. At the same time, to afford a check on the process, a wooden beam compass, kept as nearly as possible at one temperature, was likewise compared with the marbles.

In each slab, at the distance of 31.5 inches, were inserted two brass pins, one of which had a minute hole drilled in its centre, for the purpose of receiving one point of the compass, while the face of the other was smoothed, to allow of faint traces being made on it with the remaining point.

The slabs and the glass compass were placed in a tin trough, and surrounded with broken ice, a sufficient quantity of water being poured in to perfect the communication between the ice and the marble. At the end of an hour, when the marble might be supposed to have attained the temperature of melting ice, a sufficient space was cleared of icy fragments to allow of motion to the glass compass, without raising it above the surface of the surrounding fluid, and faint traces were made with both compasses on the smooth pins in each of the slabs.

The ice and water were then removed from the trough, and their place was supplied with hot water, which was kept boiling at 211° Fahr. for an hour. At the end of that time, traces were again made with each of the compasses, the glass compass having remained completely immersed in the boiling fluid, and the wooden one having been hastily brought from an adjoining apartment, whose temperature had not varied. However, on account of the short but unavoidable delay occasioned by the removal of the upper slab, the wooden beam must have suffered some slight increase of temperature and of length before the trace was made on the pin in the Carrara marble.

The distances between the traces were then examined with a microscope, and measured by means of a silver feather-edge, whose markings could be depended on to the 3000th part of an inch.

The total expansions given by the wooden compass were $\frac{33}{3000}$th of an inch for the Lucullite, and $\frac{79}{3000}$th for the Carrara marble, on a length of 31·5 inches, and for a change of temperature from 32° to 211° Fahr.; that is, for the entire change of 180°, an expansion in the black marble of ·000350, and in the white of ·000837.

On examining the traces made by the glass compass, it was found that the Lucullite marble had expanded less than had the glass by $\frac{53}{3000}$th of an inch, so that its absolute expansion must be ·000426; while the white marble had lengthened more than the glass had by $\frac{8}{3000}$th, so that its absolute expansion came out ·001072, or two and a quarter times that of the Lucullite marble.

Here it may be noticed, that both of the expansions as given by the glass are greater than those given by the wooden compass, and that the discrepancy is greatest on the Carrara marble; and we are, therefore, warranted in inferring, that during the time, short as it was, in which the wood was exposed to a moist and heated atmosphere, it had suffered a sensible expansion or twist.

The glass compass, having been furnished with two handles, was never removed from the fluid which surrounded the marble; its extreme lightness, when among water, and the shortness of the attached points, removed all risk of the error arising from bending; so that the results obtained by its means seem worthy of dependence, it being kept in mind that they are yet liable to a very small inaccuracy that may exist in the determination of the expansiveness of the glass itself.

The experiments just detailed formed the last of three series, the results of all of which gave very nearly the same expansions. We have given the last, not as made with greater care, but as having had the advantage of additional experience in conducting them. In one of the former experiments, we heated the water by means of two large choffers; yet, with all the assistance which two pairs of bellows could give, we were unable to sustain the temperature higher than at 197°. In the last experiment we used seven spirit-lamps, and were not a little surprised when, to restrain the too violent ebullition, we had to remove, successively, four of them, and found that three spirit-lamps kept up a brisk boiling in a trough whose dimensions were 37, 4, and $3\frac{1}{2}$ inches.

The difference between the expansions of black and of white marble is remarkable, considering the small difference which exists between their chemical compositions; but, on inquiry, we found that marble-cutters, aware not only of the expansion of marble in general, but of the superior expansiveness of the white varieties, are accustomed to guard against its effects in the construction of chimney-pieces.

In estimating the fitness of any substance for the construction of clock pendulums, other considerations than that of its thermal expansion must be taken. The variable buoyancy of the air, and the changeable resistance which it offers to a moving body, must also be attended to; and it is evident that, in regard to both of these, the dense has the advantage over the rare material. Taking the specific gravity of marble at 2.7,* it is 2268 times heavier than air; so that a variation of one inch in the barometer will make a change in the length of a beat of the $\frac{1}{136000}$th part, that is, of $\frac{5}{8}$ths of a second per day.

Estimating the expansion of white marble at .001, each degree of the Fahrenheit thermometer will cause a change in the clock's daily rate of $\frac{1}{4}$ of a second; so that the common deal-rod pendulum, with a leaden bob, must, both from its smaller elongation, and from the diminished hydrostatic influence and resistance of the air, be superior to the marble one.

We cannot conclude a paper on the expansion of such bodies, without pointing to the various expansibilities of the materials used in building. It would, indeed, be a useful and an interesting research to inquire into the actions of heat and moisture upon the materials of houses; since, to varieties in these, more perhaps than to chemical decomposition, the gradual dismemberment of edifices may be due. On marbles the effect of moisture in producing expansion was imperceptible, and from some incidental experiments, the Carrara marble was found to absorb only about the 1800th part of its weight of water. However small the expansions of such bodies may be, they are yet accompanied by enormous force, to prevent the effects of which it is in vain to heap together strength and matter; since just in proportion to the additional strength is increased also the destructive force.

EDINBURGH, *30th March* 1831.

* The white was 2.65, and the black 3.0.

On the Acidification of Iodine by means of Nitric Acid. By ARTHUR CONNELL, Esq. A. M. Communicated by the Author.

THE methods which have been hitherto followed for the oxidation of iodine with a view to the formation of iodic acid, may apparently be reduced to three: *first*, The action of alkaline solutions giving rise to the formation of a hydriodate and an iodate, from the latter of which the iodic acid may be separated by the original method of M. Gay-Lussac, and more perfectly by the recent processes of M. Serullas *; *secondly*, The action of euchlorine, as suggested by Sir H. Davy; and, *thirdly*, The action of water on the perchloride of iodine, and subsequent separation of iodic acid by means of alcohol, as also proposed by M. Serullas †. The agency of nitric acid, under certain management, offers another method, which I have been unable to observe noticed any where, and which, perhaps, will be found to equal in facility of execution any of the preceding processes.

This agency may be advantageously studied on the small scale. If a little iodine be boiled with a small quantity of nitric acid in a common test tube about five inches long, the iodine is dissolved, and a red solution formed. If the liquid be now farther boiled, and the orifice of the tube kept slightly stopped with a piece of cork, the iodine sublimes, and condenses on the sides of the tube. The iodine is then to be washed back again into the liquid by agitation; the liquid again boiled, and the sublimed iodine again washed back into the fluid; and this process is to be continued until no iodine any longer appears, and the liquid is colourless. If the boiling be then continued for a little, so as to increase the concentration of the liquid, it usually becomes milky; and if it be poured out and evaporated to dryness, a white mass is left, which is iodic acid, retaining a little nitric acid.

Having made these observations on the small scale, I pro-

* Annales de Chimie et de Physique, xliii. 127 & 217.

† Ibid. xlv. 63.

ceeded to try the process with larger quantities of the materials, with a view to its employment as a method for the preparation of iodic acid. The vessel I used was a rather large and tall flask, having a narrow orifice. In one trial I used twenty-five grains of iodine, and half an ounce measure of fuming nitric acid; and in another, I employed twice these quantities of the materials. After introducing the iodine and acid into the flask, the liquid was made to boil. As soon as any iodine sublimed and condensed on the sides of the vessel, it was washed back again into the liquid by agitation. After the process had been continued some time, a precipitation of white crystalline grains was observed to take place; and the operation of boiling and washing back the sublimed iodine was continued until the free iodine had to a great extent disappeared. The whole was then decanted into a shallow basin, and evaporated to dryness. Any free iodine which had remained was soon dissipated by the heat. The residue of the evaporation consisted of whitish crystalline grains, which were iodic acid, retaining a little nitric acid, from which they appeared to be freed by one or two solutions in water, and re-evaporations, when they lost much of their crystalline appearance, and became a whitish deliquescent mass, occasionally with a slight purplish tint, from a tendency to decomposition by the heat of evaporation.

The general properties of the matter thus obtained, sufficiently identified it with iodic acid. Exposed to a sufficient heat, it was decomposed, and iodine sublimed. Its solution in water gave a precipitate with nitrate of silver, soluble in ammonia. Saturated with potash, it gave by evaporation a salt composed of grouped cubical crystals, and deflagrating on hot charcoal.

The quantity of the acid obtained by this process, of course, must vary, according to the care taken to prevent the dissipation and loss of iodine. Where no particular precautions were taken to prevent its loss in the state of vapour, and where the process was not continued until the entire disappearance of iodine, the quantity of acid obtained approached that of the iodine employed. In operating with the relative proportions of iodine and acid which I have mentioned, I have no doubt that a farther addition of iodine might be made to the liquid, after the acidification of what had been at first introduced; and the process might then be farther continued, as before.

I find, conformably to the observation of M. Serullas, that iodic acid does not attack gold. Its solution seems to have no action on that metal even when aided by heat. It is equally inert in regard to platinum. Zinc is at first attacked by it with effervescence, especially when diluted; but the action ceases almost immediately, apparently from the formation of a sparingly soluble iodate; and when more zinc is added, the liquid becomes milky. No effervescence ensued when iron-filings were thrown into the solution of iodic acid, whether concentrated or diluted; but when the liquid was boiled, a white powder precipitated.

The solution of the acid reddened litmus paper permanently. The permanency of the colour may possibly be owing to a trace of nitric acid still adhering; as, according to Davy, the acid ultimately bleaches vegetable blues.

Observations on the Glaciers of the Alps. By Mr F. J. Hugi, Professor at Soleure. (Concluded from page 341 of preceding Volume.)

Observation has furnished proofs of the existence amongst the glaciers of the *second kind* of a progressive downward movement, which ranges from 20 to 60 feet per annum. We have evidence of this movement in the examination of the mineral debris belonging to a superior repository, embedded in the glacier, and gradually advancing even to the inferior extremity of this glacier. Some authors imagined that this descent might be attributed to the pressure exerted on the upper part by the avalanches detached from the glaciers of the *first kind.* Mr Hugi endeavours to combat this opinion, and relates, in reference to this, some curious observations concerning the meteorology of elevated regions. "Avalanches," says he, "take place only in low regions, at the limit of forests, and on the declivity of valleys, whence they are precipitated into the bottom, and often occasion terrible ravages. Elevated peaks are above the ordinary abode of mists. Moreover, at an elevation of from 10,000 to 13,000 feet above the level of the sea, the clouds are no longer discharged in great flakes of snow, as happens in an atmospheric region lower and more charged with vapours. The snow which falls in the high regions is always fine, dry, and crystalline. I have observed this every time I have been overtaken by snow, or found it newly fallen. In proportion as I redescended I saw the flakes, as also the mass of deposited snow, increase even to the limit of the woods where it terminated. We may also infer, from some indications, that the snow does not appear at this altitude but during spring and autumn, and not at all in winter. The greatest quantity is found, as I shall state, at the limit of the forests; thence it diminishes much more towards the higher than the lower regions. These are facts perfectly known to all the inhabitants of the mountains. Thence it happens, that the thickness of glaciers of the first kind, those which cover very high peaks, is so inconsiderable, although, from their undergoing but very slight changes from melting, they should increase enormously; hence it happens, that avalanches rarely or ever take place in high regions."

Other authors have endeavoured to explain this progressive movement of the glaciers by supposing, that the crevices or rents which traverse them are again filled with water, and that this water expanding, in the act of congelation, pushed forward the masses of ice. The simple inspection of the crevices demonstrates the futility of this hypothesis; they generally penetrate even to the soil, and consequently cannot contain water. Moreover, the movement takes place chiefly in the summer, that is to say, at a period when the crevices are perfectly open, and, besides, the crevices are far from extending from one border of the glacier to the other.

Others conjecture that the movement is caused by the expansion of the ice of the glacier itself; but a more attentive examination of the nature of the crevices, and of the different phenomena which accompany the movement, soon overthrows this explanation. It is the same respecting that hypothesis on which they account for the movement of the glaciers, by saying, that they melt at their under surface, and that their weight is sufficient to make them descend to the low regions. Entirely rejecting this idea, Mr Hugi delivers some interesting details regarding the melting of the glaciers, which we may now mention. "The fact," says he, "that the glaciers of the two kinds melt only at the lower surface, is a truth universally acknowledged, and concerning which no doubt exists; but it has been erroneously maintained, that in winter the glacier is attached or fixed to the soil by congelation. The progressive movement of glaciers during winter would alone suffice to negative this assertion, if the observation of the fact itself, and that of the heat of the soil at this depth, did not contradict it. It is proper to remark, that the nature and bearing of the strata of the mountain on which the glacier rests have a very great influence on the melting of the lower surface. Among the glaciers of the Uraz and of the Aar (superior) of Viesch and Gastern, I have succeeded in penetrating to a considerable depth below the mass of ice. Wherever a solid connected mass of rock was visible, the glacier rested securely upon it; the base of the glacier melted, when by the general progressive movement it had quitted the rock to descend upon the debris. The deeper and more solidly based the rock was, the larger were the bases of the glacier. Currents of warm air were observed issuing from the depths of the earth. But an observation which has surprised me more, and which I have often repeated, is, that during the day the temperature under the glacier was always a half lower than above, and that though the lower melted ten times more than the upper surface. Perhaps this difference is owing to this, that it is exposed each night to a fresh congelation, whilst the other is constantly exposed to a temperature a little above 32° Fahr. It may further probably be attributed to the action of the currents of air which pass from the bottom of the ravine to the surface, to re-establish the equilibrium; but observations are wanting on the last point. The fact is, that there exists under the glaciers an extraordinary humidity, by which they are moistened without receiving even a single drop of water. On the contrary, there exists at the upper a singular aridity, in consequence of which the ice tends to evaporate, and also to exhibit asperities and cavities. It rarely happens that the sun's rays act so powerfully on the glacier as to form accumulations of water on its surface. The streamlets of the glaciers generally proceed from newly fallen snow. From this contrast between the dry state of the upper and the moist state of the lower surface, results, in my opinion, the disproportion which exists in the melting of the two surfaces.

This, however, is the mode in which M. Hugi explains the progressive movement of the glaciers. According to him, a glacier of the second kind is produced under this form, not at the place where it is found, but in high regions, under a form of a glacier of the first kind; then, by the gradual development of its mass, it descends to the low regions, in which it attains the last state of its constitution, and terminates by decomposition. Let us pursue with our author the progress of this metamorphosis.

"The snow which falls in the elevated regions," says he, "is very different from that which falls below the limit of glaciers of the first kind, and which traverses an atmosphere denser and more surcharged with vapours, in a word, less pure than that of the high regions. This last snow appears to be in some degree more aqueous, while the first, more crystalline and purer, is of a dry and light nature. This, when the temperature rises, seems to evaporate rather than melt, which is owing to the presence of air in its composition, and above all, to the aridity and levity of the atmosphere in the regions where it is deposited. The truth is, that the remainder of the snow of the high regions, without becoming fluid, agglomerates under the form of grains; this agglomeration operates in a slow and irregular manner at the height of 13,000 feet; at 11,000 feet the grains are better formed; at 9000 feet they begin to be half melted. The granulated mass thus formed is exposed during the summer to continual changes of temperature. The very keen cold of the night renders it so firm that the foot does not make any impression on it, and that it follows the same laws of expansion as the ice properly so called; the intense heat of the day separates anew what the night has bound together. The grains are loosened, the rain penetrates into the interstices which are formed, and this water enlarges each grain by congealing around it. This alternate effect of day and night, and the modifications which result from it, reproduce themselves on a greater scale, and in a manner more conspicuous, by the succession of opposite seasons. The result is a state of increasing tension through the mass. Each year adds to the grains a new stratum; thence the increase of the whole mass, its rupture into crevices, and the observed expulsion of foreign bodies.

"In proportion as a glacier of the first kind (and not of the second) receives increase at its upper surface, it generally diminishes at its lower; yet it exhibits irregular periods of increase and extraordinary meltings. The inferior melting appears to follow a more uniform course than the superior increase.

"Whilst the mass is granulated, it does not form any crevice at its surface. The heat of the day, and of the summer, easily loosens all its parts without breaking them; but, by a long succession of contractions, moistenings, and expansions, the granular mass begins to crystallize together, each grain presents determinate faces, and encases itself between the grains which surround it: in a word, we perceive the formation of the system of interlacement of grains of which we have spoken above (see article on Glaciers in last Number), and which consolidates from that time more and more. The grains are no longer isolated, but conjoined into a compact mass, which forms the glacier. Afterwards the heat has no more the power of decomposing the mass into its grains, but of expanding it chiefly at its surface. The resistance opposed by this mass to the dilatation is soon violently overcome, and it rends.

"One day being on the inferior glacier of the Aar, during an intense heat, at three o'clock P. M., I heard a very peculiar noise. I advanced rapidly from 30 to 40 paces, from the side where the noise was heard; I felt the mass of the glacier shake by jolts under my feet, and I soon discovered the cause. A fissure was formed in an instant, the aperture was elongated from 12 to 20 feet, so that I was unable to follow its formation. Sometimes the operation seemed about to cease, and the mass separated itself very slowly; then again the fissure continued to open quickly, and by jolts. Many times I ran forward in time to see the separation taking place under my feet. I followed in this way the formation of the fissure over an extent of almost a quarter of a league, even to the border of the glacier, where it stopped. The fissure opened at first under the first concussion about an inch and a half, but afterwards it again contracted, so that its breadth did not attain to more than an inch. The interior of this fissure was rough and unequal; a part of the crystals were broken into two, and others, almost untouched, formed projections to which there were corresponding hollows in the opposite surface. I sounded the opening with my axe to a depth of 6 feet; the fissure extended to only 4 or 5 feet, and gradually diminished to this depth. Its examination clearly demonstrated the influence of the atmosphere, and the effect of a high temperature. At 11 feet distant a second fissure was formed in a direction exactly parallel to that of the first; I found it to be 6 feet deep. Afterwards I have often observed this phenomenon upon the glacier of Aletch, from the Elsenhorn to the lake Mörile. I have seen three fissures take place in an afternoon. Some of my guides had more than a hundred times witnessed this operation. The crevices are formed during warm days only; and generally previous to a change of weather. None of them are formed during the night, or in winter; but I have observed, on the contrary, that they contract during the night, and completely disappear in winter.

"During the whole period of my stay on the inferior glacier of the Aar, we were awoke every night, twice or thrice, by the subterranean noises which proceeded from the interior of the glacier. Twice the bed itself which we had dug in the glacier, and which was lined with slates and moss, was violently shaken by jolts analogous to those which I had observed during the formation of fissures; but the shaking appeared so deeply seated, that we could not for a moment entertain the idea that any rent or crevice would open at the surface. We heard and felt directly that the effect had taken place from below upwards. The noise was obtuse, of a particular nature, and was communicated to the atmosphere through the medium of the crystalline mass of the glacier. We have never found in the morning a new crevice completely opened. I have heard the same subterranean noises during the nights which I passed on the glacier of Grindelwald, and behind the Finsteraarhorn; but I have never heard any of these dull subterranean noises during the day, in my excursions on the glaciers. I have seen an inferior crevice when I penetrated under the glacier of the Viesch. It was at least 5 feet wide below, and appeared to wedge out above at a height of from 12 to 20 feet. I have never been able to discover in this place, at the upper surface of the glacier, any fissure which corresponded to this one. Moreover, it cannot be doubted that the lower crevices are rarer than the others; and they are seldom found but in glaciers of the first kind, of some extent. I have seen a great number in my last journey on the Finsteraarhorn.

"The upper fissures, that is to say, those formed by day, are always the widest at the surface, and terminate towards the bottom in an angular or wedge form. This form is equally observed in the case where the fissure reaches to the rock or to the soil, at least when an inferior fissure does not meet with a superior one. Among the elevated glaciers of the first kind, no upper or surface fissure can take place, because this mass is still imperfectly aggregated, and contains much air, so that the changes of temperature easily effect the separation of the grains from one another. Moreover, in years abounding in snow, no fissures are observed. It is only when the mass of these glaciers is deep, or when some time has elapsed without their having been again covered with new strata, that the fissures which are formed at the bottom during the night or winter, penetrate even to the superior surface. But to speak properly, the fissure itself does not penetrate higher than the third or fourth annual stratum of snow; and it is only when widened that the frozen ice which again covers it crumbles and falls into the opening, or is reduced to dust by the current of air which escapes from it. It is generally acknowledged, that in the elevated glaciers of the first kind, all the fissures widen towards the bottom, and contract towards the top; and also, that these fissures are much more dangerous than those of the lower glaciers which contract towards the bottom, because the inferior crevices of these glaciers do not close in winter. In agreement with these facts, it is, as we have already seen, that in a glacier of the first kind, its mass, on approaching the soil, where it is continually melting by means of the heat of the earth, develops itself, arranges itself and becomes more and more like in its texture to a glacier of the second kind."

We are entitled, from what precedes, to conclude, that the succession of the temperatures of day and night, summer and winter, constitutes the upper and under surfaces of the glaciers into opposite states. The reheating produced during summer, and by the periodical return of the heat of each day, determines in the upper surface a state of tension opposed to the state of the inferior surface; and the inverse effect results from the recooling which affects the upper surface during the winter and the night, whilst the temperature of the other remains always the same. Consequently, by this opposition, the upper fissures are formed during the day and during the summer, the lower crevices during the night and winter. Each fissure presents at the beginning but a small aperture formed in the upper or lower surface of the mass of ice, in a state of tension. Its enlargement is gradual, as the influence of the atmosphere and the course of the temperature in the interior of the glacier; it often finally traverses the glacier in its whole extent, and then it opens further, forming a wide and frightful fissure. There is still to remark concerning the course of fissures, that in the glaciers nearly horizontal and very long, such as the inferior glacier of the Aar and that of Aletsch, we never find them very wide. In proportion as the declivity of the glacier is steep, the fissure becomes wider. This appears to depend on the more or less great resistance which the glacier has to overcome in its progressive movement."

We shall terminate this article by relating some considerations of the author concerning the periods of progression and retrogression which he has observed in the glaciers, a subject which he proposes to study afterwards in a much more accurate manner. "Each glacier of the second kind," says he, "is, as we have seen, originally a glacier of the first kind; having arrived at its second state, it advances to dissolution. When, by a series of years abounding in snow, the glaciers of the first kind accumulate in an extraordinary manner, they produce equally towards their lower border glaciers of the second kind of great magnitude. These colossal masses, more extended in all their dimensions than they are in general, necessarily require a longer time to dissolve; and as their progressive movements continue, they advance also much further into the inhabited valleys. On the contrary, the glaciers of the first kind, which are not so thick, never produce large glaciers of the second kind; then those of less magnitude are dissolved before they reach the bottom of the valleys, and appear to contract themselves. Moreover, the general temperature of the year has doubtless some influence, but every thing demonstrates that this influence is altogether of secondary importance.

"It is probable that all the glaciers extend themselves downwards with nearly the same rapidity; if their velocity be known, we might be able to calculate beforehand their future progression or retrogression; which would be of great importance for the cultivation of the Alps. It is difficult to appreciate what would be necessary to allow in this calculation to the resistance which the movement of the nearly horizontal glaciers experiences. All the measures known to me of the progressive advance of the glaciers are false, because they are taken by the distances from the inferior extremity of the glacier to a determinate point, without taking into account the melting which has taken place at this extremity. Therefore, since we attribute in this manner to a glacier a progression of from 40 to 50 feet per annum, a more accurate measure would unquestionably give a much more considerable distance. The points to choose for this observation should be taken only on the glacier itself, and on its two borders."—*Bibliotheque Universelle*, 1830–1.

On the Geology of the Secondary Formation of the Meywar District. By JAMES HARDIE, Esq. Residency Surgeon, Oudeypore Meywar, Member of the Asiatic Society, of the Medical and Physical Society of Calcutta, &c. In a Letter to Professor JAMESON.

SIR,

THOUGH a long period of time has elapsed since you did me the honour to publish in the "Edinburgh New Philosophical Journal" the paper to which this letter refers, I have had no opportunity of perusing it in its printed form till very lately, when the state of my health led me to visit Calcutta. I should otherwise have long ere this made some reply to the queries contained in your editorial notes. Since drawing up the paper in question, I have had several opportunities of making new observations on the geology of Central India; and have thus been enabled to correct many inaccuracies into which I at first fell. I feel, however, that any thing I can communicate on this interesting subject must, to say the least, be vague and unsatisfactory. Situated as I have been, in a remote corner of Hindostan, I have been deprived of all means of reference to libraries, museums, &c. and, inexperienced as I am, I feel that I must have left much undone which even the opportunities of observation I have enjoyed might, if under more favourable auspices, have enabled me to perform. But enough of this.

I shall now reply in as distinct and brief a manner as I possibly can, to the queries and observations embodied in your notes. And, first, with regard to Note p. 334, Vol. VI. of your Journal. You seem inclined to believe that, in describing the quartz-bed near Bandeo, as being divided into *horizontal* strata, while the including clay-slate strata are arranged in a *vertical* position, I have confounded the natural joints which so frequently occur in quartz-rocks with the true planes of stratification. It may be so; and I have often wished for another opportunity of verifying my first observation, made while on a march with my corps through an enemy's country. This opportunity has as yet been denied me, and I am unwillingly compelled to leave the subject in its present unsettled state. I must, at the same time, remark, that with the jointed or fissured appearance described by Captain Dangerfield, as quoted by you, I am perfectly familiar. It is a most characteristic feature of the pure white quartz-rocks of this district; many of which are so traversed by cracks, that their original stratiform structure is completely obscured, and their whole mass resembles a congeries of angular and rhomboidal fragments closely packed together, but unconnected by any apparent cementing medium. The quartz-rock of the Bandeo bed does not belong to this variety; it has a schistose texture, and its stratiform structure is very distinctly marked, nor is it, generally speaking, characterized by the joints and fissures of the other. On the contrary, it is distinguished by the immense extent and continuity of its tabular masses, enormous slabs of which may be raised without difficulty, and these, in some parts of India, are used in place of beams in roofing, and are made to span from wall to wall, even in halls of large size, without risk from fracture.

This rock Captain Dangerfield sometimes describes as hornstone, sometimes as flinty slate; but, by whatever name it may be distinguished, it is, in its mineralogical characters, more nearly allied to quartz than to any other rock, and is most extensively distributed throughout Hindostan as a member of the clay-slate series. In many situations it is found passing into the pure white quartz-rock on one hand, and into the clay-slates on the other. The horizontal position of the strata near Bandeo appeared to me at the time to be very distinctly marked; and, at an after period, I requested a friend to visit the spot, and to favour me with his opinion on the subject. His observation entirely coincided with what I had previously supposed to be the fact, and he furnished me, at the same time, with a sketch of the appearances presented, which led to a similar conclusion. It is but fair to state, that my friend had not made geology his study, and in my own mind, I confess I am not perfectly satisfied on the subject. This hesitation on my part has arisen from after reflection; at the period when I wrote the account published in your Journal, I had not the slightest doubt of the correctness of my statement. I have since been sometimes inclined to believe that the bed in question was a peculiar modification of one of those numerous rectilinear quartz veins which traverse this country in all directions, and which may frequently be traced over a considerable stretch of surface, or forming the spines of the hill ranges. These very generally follow a direction parallel to the planes of stratification. In this last case, the rock in the vein might have been horizontally stratified, while the bounding clay-slates might have retained the general vertical position of the strata of the neighbourhood.

I would now offer a few words in reply to the observations contained in Note, p. 123. Vol. VII. And, in the first place, I must plead guilty to the charge of having been obscure and indistinct in describing the geology of the Cheetore Hill. The fact is, my ideas on the subject were at that time very vague and indefinite; and, in endeavouring to avoid being too precise on a point upon which I felt my own want of information, I have fallen into a contrary extreme, and have presented you with an account so indefinite as to render it utterly valueless. I shall now endeavour to remedy this evil, though I must say that the subject is still involved in much difficulty and obscurity.

The "clay-slates," or rather the sandstone slates and shales, upon which repose the waved quartose strata of Cheetore, belong apparently to that series of rocks which the late Dr Voyesy * proposed to distinguish by the general name of the "Clay-slate Formation;" a formation distinct from the *clay-slate* of Jameson (*Thonschiefer* of Werner). Captain Franklin †, however, has endeavoured to identify the rocks of this series with the new red sandstones of England, and his ideas have been very generally adopted in this country. The new red sandstone formation is now described as being one of the most extensively distributed surface formations of Hindostan; it consists of a series of shales, slate-clays, some of which it is impossible, as far as their mineralogical characters are concerned, to distinguish from the older slates, sandstones, sandstone-slates, with associated conglomerates and breccias. This series reposes, sometimes directly, upon granitic rocks, sometimes on the clay-slates, and sometimes upon rocks probably identical with the old red sandstones; while, in particular districts, it overlies the coal measures. It is characterized, in general, by the nearly horizontal position of its strata, by the absence or great scarcity of organic remains; and, to the west and north-west of Ajmeer, by associated deposites of rock-salt and gypsum; but these last have not, as yet, been discovered in Central India; nor have they been found in connexion with the vast sandstone tracts which form the southern and north-eastern barriers of the valley of the Ganges and Jumna, &c.

Saline efflorescences, indeed, consisting principally of muriate of soda, with associated sulphate of soda and carbonate of soda in small proportion, are every where observed in these districts, and the soil is also very generally impregnated to a great depth with a similar saline compound, which is extracted by lixiviation, and crystallized for common domestic purposes, under the name of *kharee Nimuk* (*i. e.* bitter salt); but such soils do not seem to be peculiar to the sandstone tracts, at least they have been observed in situations where it would be difficult indeed to trace any connexion between them and the occurrence of rocks of the formation under review. A less exceptionable argument might perhaps be derived from the fact, that brackish wells are frequently met with in the sandstone tracts, but even

* See Transactions of the Physical Class, Asiatic Society, Part I. p. 10.

† Ibid, p. 103, also p. 121.

these may have derived their saline properties from the soil; nor is their occurrence confined exclusively to such tracts. Many of the saline soils of the Gangetic provinces have undoubtedly been transported from a great distance.

It is not my object at this time to give a minute description of the Indian new red sandstone formation, or to point out all of the different forms in which the rocks composing it exist. It will be sufficient for my purpose to remark, that, interposed between the older and highly inclined strata, and a horizontally stratified limestone series, which is supposed to be the type of the lias of England, there occurs an immense sandstone deposite, which flanks, throughout the whole of India as yet examined, our great primitive districts, as well as our overlying trap-rocks, to which latter it is subjacent; and that to this great formation the hill of Cheetore, as well as the neighbouring boundary ranges between Meywar and Harvistee, belong. A common variety of this sandstone resembles, in its mineralogical characters, a nearly pure quartz-rock. It is hard, compact, and is almost entirely composed of quartz, having very little of the appearance of a re-united rock. Of this variety consist the waved strata, which form the summit of the Cheetore Hill, and a similar variety is observed topping the boundary ranges just alluded to, and is also extensively distributed throughout the whole of Harvistee, in which district it rises into low tabular hills and ranges, and in some one or other of its modifications, is spread over the greater portion of the plateau which this district exhibits. It is occasionally concealed from view by irregular patches of the lias limestone above alluded to.

The shales, sandstone-slates, slate-clays, &c., belong to the same era. In many instances, the inferior shales much resemble those of the coal-measures, and future observation may probably discover in some of them deposites analogous to those described in the Geological Transactions, as underlying the magnesian limestones of England, and which have been identified with several remarkable continental formations. This, however, is a point for after consideration; and, in the mean time, the whole series, including slates, sandstones, &c., we are in the habit of considering as the type of the *new red sandstone formation*, the phrase being understood in its most extended sense.

The strata of this great series are, generally speaking, conformable one to another, though partial exceptions to this rule may here and there be observed, more especially in the vicinity of the highly inclined strata of the primitive class. The waved appearance of the Cheetore strata is common throughout the whole of Harvistee, and is also occasionally observed in the north of Malwa, Meywar, &c. But the deflection from the usual horizontal position is trifling when considered on a large scale. The strata forming the rocky summit of Cheetore, as well as the slates of its base, both, I believe, exhibit this waved aspect. I had not, however, an opportunity of ascertaining the point in a perfectly satisfactory manner. Similar slates occur in the neighbourhood, arranged in a perfectly horizontal position.

The *old red sandstones* do not exist in this portion of the country, as a well marked and characteristic formation. There are many rocks, however, which future observation may probably identify with members of this series as it exists in England. There is a belt of quartzose rocks which flanks, a little to the westward of Cheetore, the newer sandstones, and which is interspersed between the latter and the primitive strata of Meywar. The rocks of this belt, consisting of alternations of a very compact quartzose rock of a whitish or greyish colour, with a kind of red felspathose porphyry of a crumbling nature, and occasionally somewhat conglomerated texture, dipping under an angle of upwards of 45° under the nearly horizontal strata of the north of Malwa, &c.; but their geology has not yet been minutely examined. A narrow linear range of hills (the Mokundura Hills), composed of a coarse-grained sandstone, the predominating colour of which is red, and which is arranged in strata inclined like the above at an angle of upwards of 45°, may be observed in the south of Harvistee, and separating that district from Malwa. This range, a branch of the Cheetore tabular chain, stretches in a direction NW. and SE. The strata composing it basset out from beneath the horizontally stratified rocks of the Harvistee plateau, and present a bold and bluff escarpment on the Malwa side, the level plains of which latter district abut against the range, and are, generally speaking, in this portion of the country, covered with a deep alluvium, protruding through which the newer sandstones and limestones are here and there observed, occasionally within a few yards of the basset edges of the inclined sandstone strata.

Outcroppings of a similar formation of older sandstones may also be traced in the ranges which bound Harvistee to the north; and here a narrow belt of these rocks would seem to be interposed between the newer series and the strata of the primitive district, which branches off from Ajmeer east towards Bhurtpoor. Similar appearances have been described as presenting themselves elsewhere; but, as surface rocks, the *old red sandstones* have a limited range, as contrasted with the other surface formations of this portion of India; though, perhaps, we may be entitled to conclude, from their occasional protrusion in situations so remote from each other, that there exists a great internal formation of rocks of this class.

The limestones which we are in the habit of describing as synonymous with the *lias limestones* of England over-lie the sandstones, and are arranged in horizontal, or nearly horizontal strata, which are separated from each other by loose calcareo-argillaceous partings. In their texture they are compact; they are characterized by their large conchoidal fracture. Their prevailing colour is bluish-grey, sometimes they are reddish, more frequently yellowish. They are very generally covered with beautiful dendritical delineations, and some varieties might be substituted for the Cotham marbles in ornamental architecture. They are argillaceous limestones, and may be raised in slabs of any size and breadth. They are remarkably free from veins, or fissures of any kind; the more compact varieties have been employed with success in *lithographic operations*, and as building stones they are invaluable.

The organic remains of these limestones are obscure and indistinct. This may perhaps be attributed to the compactness of the rock; at least, the best marked specimens are only discovered on the weathered surfaces of blocks which have long been exposed. They are rarely if ever found in the freshly quarried slabs. Protruding from the surface of the strata into the calcareo-argillaceous partings, are frequently observed numerous lobated and polymorphous bodies, apparently of an organic origin. Captain Franklin states (see his Geology of Bundelkhund, in Transactions of Phil. Class, Asiatic Society), that he discovered in the lias what appeared to him to be the fragment of a gryphite. The only well marked specimen of a shell which I have been enabled to procure, was a fragment of a bivalve, apparently nearly allied to the Pecten; but on this subject I shall not enlarge at present. It is sufficient to observe, that it is more from a consideration of their geological position and mineralogical characters, than from their contained organic remains, the inference has been drawn, that these limestones belong to a formation identical with the lias. The subject is still involved in much doubt and obscurity. Besides alumina and oxide of iron, these limestones contain a small proportion of carbonate of magnesia, associated with the carbonate of lime,—an association, however, which appears common to almost all the limestone formations of central India, from the primitive marbles or dolomites down to the imperfect rock formation known best by its local name of kunkur. A perfectly pure carbonate of lime I have not yet observed, though I have analyzed a considerable number of specimens of our finest marbles, as well as limestones from different parts of the country.

The formation under review is an extensively distributed one; it generally occupies plains and low lands through which protrude hills of sandstone. The depth of its beds would not appear, in any situation hitherto examined, to be great; and it has probably been subjected in a most destructive degree to the agency of those great denuding causes which are supposed to have exerted their energies with such amazing force over the whole surface of the globe. At least, this is the easiest way of accounting for the total disappearance of such limestones from many of our sandstone plateaus, and for the irregularity of the patches, often insulated and detached, in which they occur. *The limestone, as well as the sandstone strata, are occasionally much inclined in the neighbourhood of the primitive rocks, and in many situations have obviously been subjected to much violence and distortion.*

To Professor JAMESON.

Biography of the late Dugald Carmichael, *Esq. Captain 72d Regiment, Fellow of the Linnean Society*.*

While it is highly desirable that every country should have its just share of credit for the men of literature and science which it has produced, there is no individual, considered in himself, to whom the place of his birth has been less important in forming his character, than the naturalist, and with whom, therefore, it may be less necessary to record it. Not because his life reflects no honour on its natal soil, nor because he is himself insensible to the glow of patriotism; but because the sympathies of the naturalist extend beyond his own home, and Universal Nature claims his attention. Amidst the multitude of organized beings, the individuality of his own being is less to him than to others. His eye ranges from pole to pole, while his hand is stretched over mountain and valley, lake and wood, and the spot which has presented him with a new genus or a peculiar formation, becomes attractive to his thoughts as the dwelling-place of his fathers. His breath seems as if first drawn where he experienced the ecstacy that arises from the conviction of having discovered what had escaped the observation of others, and which stands hitherto recorded only in the annals of the Almighty in creation. The naturalist thus becomes the revealer, as it were, of a little world, wherein the divine power and wisdom are displayed in new relations; and, while accustoming his eye to behold in every object a particular manifestation of infinite intelligence, he sees in each law the operating hand of the Almighty; in each being the life of the Eternal; in each climate His unity; in every distant planet His ubiquity; in every provision the fulness of His mercy; and in the constancy of their action His truth; while in the struggle to grasp the whole in his own finite comprehension, the naturalist possibly forgets or loses sight of self.

The island of Lismore, in the county of Argyle, and one of

* In Dr Hooker's well known and excellent "Botanical Miscellany," there is a biography of our late excellent friend and pupil Carmichael, by our former pupil, the Rev. Colin Smith, minister of Inverary. We extract from Mr Smith's memoir some of the more interesting particulars.—Edit.

the Hebrides, was the birth-place of Dugald Carmichael, in 1772. Born of parents who were in easy circumstances, he was early designed for a learned profession; and, though the opportunities which the parochial school afforded might not perhaps be very great, nor calculated to enlarge the youthful mind, the eye of genius is ever open, and ready to avail itself of every advantage. While his schoolfellows were scattered over the play-ground, pursuing their own wild gambols, young Carmichael might be seen in some neighbouring field, gathering and examining the flowers which grew there, or searching in some fosse for the organic remains that were then plentifully scattered throughout the mosslands of Lismore. Thus do the amusements of the boy "cast their shadows before," and often exhibit an outline of the pursuits of the future man. He was regarded by other boys, generally, with contempt or astonishment; and, had not his habits of silence and retirement been occasionally broken by indications of spirit, which checked the insolent and awed the timid, while he was characterized by uniform gentleness and a more than ordinary capacity for learning the prescribed lessons, his schoolfellows would not have failed to consider him a fool.

This love of observation and experiment, which so far overcame bodily comfort, attended Mr Carmichael through life, accompanied with an equally strong mental characteristic, that stamped him as an individual who listened principally to the voice of experience, and made *fact* the ground of all his reasonings. From a very early age it was remarked of him, that he only believed what he could see positive evidence for, so that the fireside stories of apparitions and goblins that are firmly credited in the Highlands of Scotland, and which caused the hair of the aged natives to stand on end, only excited his laughter. He had never witnessed these appearances, and seeing no use in them, he did not believe in their existence. But this incredulity was sometimes not comfortable to others; for, acquainted with the spots that were famed as the haunts of fairies and other preternatural visitants, he would slip out alone in the evening, and carrying his violin, of which he was very fond, under his arm, and concealing himself behind some tree or rock that was celebrated for ghostly appearances, he would there await the return of the servants from the fold, and alarm them with sounds, which, being unexpected, induced the belief that they proceeded from some unearthly inhabitant of the spot.

In 1787, Mr Carmichael was sent by his parents to the University of Glasgow, to attend the literary classes, and he seems to have made a considerable proficiency in the Greek and Latin languages; but it is not surprising if the mysteries of metaphysical science should have but few charms for him, who looked to things more than to opinions; or that he should have turned his attention to medicine, as a study more congenial to his peculiar taste. What ardour he exhibited, or what progress he made during the years spent in attending these classes, cannot now be ascertained; but it is probable that he did not make any considerable acquisitions in science, in an university which at that time afforded few facilities, and no stimulants to the student of nature. To a much later period, Glasgow was almost exclusively a school for logic and metaphysics; and those who are now enabled, in an attendance there, to benefit by the instructions of some of the first teachers of natural science that this age can boast, will hardly conceive the difficulties under which the student laboured, who, a few years ago, might have finished his curriculum without a master to inform him even of the authors whom it was necessary for him to consult.

How detrimental this was to the progress of general knowledge cannot be estimated; but though Mr Carmichael went to Edinburgh to finish his studies, there is reason to believe that he deeply felt the disadvantage of not being earlier instructed in the first principles of natural science. Several years afterwards he writes,—" The plan adopted by several continental nations, particularly the French and the Swedish, of making natural history a branch of education in the public schools, possesses many advantages over the old Gothic system, to which we still cling so pertinaceously on the English side of the channel. To those young men who are destined to pass a great portion of their lives in regions far removed from their native land, the study of natural history affords intervals of pleasing recreation from the fatigues of professional duty. This study, aided by a knowledge of a few of the modern languages, is the surest passport to the best society. It occupies those idle hours which would otherwise lie heavy on the hands of the young, or incite, perhaps, to dangerous irregularities. It affords exercise to the mind, and frequently adds to the sum of human knowledge. It has also over every other study, this peculiar advantage, that whithersoever fortune may direct our footsteps, materials for it present themselves to our view. The pathless forest, the arid plain, the alpine rock, the desert island, tender by turns their varied and inexhaustible stores, and demand of us only exercise of body as the price at which they will furnish us with food for the mind. Even the boundless waste of ocean, which the common traveller views with an eye of apathy or apprehension, yields to the naturalist a rich harvest of amusement and instruction. A man possessed of a taste for natural history, has it in his power to amass a store of subjects, wherewith he can associate a train of agreeable recollections sufficient to afford him amusement during the remainder of his life; not to mention the pleasure he must feel in sharing his discoveries with those who have the same taste with himself, but who want the opportunity of indulging it.

"There is no denying that this branch of education may engender a host of unfledged philosophers, who will fancy, on their outset in life, that every thing must be new to others which appears so to ourselves; and when such undertake to visit remote countries, and communicate to the world the result of their observations, we must be prepared to meet with a little vanity and egotism, inflated language, extravagant theories, and deductions not always the most legitimate. With these drawbacks, however, the journal of a young traveller moderately skilled in natural history, will prove infinitely more interesting to the intelligent class of readers, than that of a person who is totally ignorant of that branch of science."

After taking his diploma as surgeon, in the University of Edinburgh, Mr Carmichael returned to reside with his father at Lismore, where, as may be imagined, he again applied to his favourite pursuits. But his circle of observation was limited, for this island does not abound in such productions as attract the eye of a young botanist. It is but little elevated above the level of the sea, and entirely formed of a bluish coloured limestone, more or less crystallized, which is occasionally traversed by *veins of greenstone*, and once only by a *vein of pitchstone*, scarcely an inch in thickness, and exceedingly friable. The soil barely coats the rocks, which put forth their bald foreheads in every portion of the best cultivated fields, giving to this fertile island the appearance of a heap of stones, and rendering the spade as necessary an implement of husbandry as the plough. The plants found on it are not numerous, consisting chiefly of a few *Orchideæ*, *Primulaceæ*, *Saxifragæ*, *Cruciferæ*, &c.; and though the neighbouring mainland presents a greater variety of soil and elevation, we cannot believe that Mr Carmichael would have made much progress in the knowledge of classification, far less have acquired his quick botanical eye, in a situation where he was excluded from the benefits to be obtained from books and sympathy, and where the list of native vegetables is by no means large. It is probable that his attention was at this time turned rather towards mineralogy, and that his sight was not indifferent to the majesty and beauty of the hills which form the great glen of Scotland, nor his mind inactive in speculating upon the manner of their formation. It was indeed a station calculated to arouse the slumbering spirit of the geologist into activity, and more callous observers than he who is the subject of this memoir might have their admiration excited by those mountains which enclose the island of Lismore, as in a mighty amphitheatre, and which present so many and such varied aspects.

In 1796, being appointed assistant-surgeon to the Argyleshire Fencibles, then stationed in Ireland, Mr Carmichael had an opportunity of extending his knowledge of the workings of Nature. Yet he has not left behind him anything which enables us to trace what progress he there made in science. When the advantages of scientific instruction are wanting in youth, years of after labour become necessary for the student, during which we may find him labouring assiduously to compass the first elements of knowledge, and carefully treading the paths which others have trodden before him, in order to ascertain what has been already done, and what yet remains to be effected. For nine years, during which he was stationed in Ireland, Mr Carmichael seems to have been preparing his mind for future discoveries, and, by a fortunate coincidence, Robert Brown, the first botanist of this age, held a similar appointment upon the same station. That the advantages arising from this circumstance were improved by Mr Carmichael, can hardly be doubted; and an intimacy was then formed between him and the great British botanist, which was renewed in after life, when each had risen to eminence in his respective line.

Whatever pleasure he may have received from society such as this, his eye could only rest upon objects that others had discovered long before, and so long as foreign lands lay untrodden and unexplored, Mr Carmichael could not but have a longing desire to visit them. He therefore gladly embraced the opportunity of entering the 72d regiment, in hopes of being sent to some foreign station; and whether it was that he deemed it most conducive to his interests to drop his profession as a surgeon, or, as is more probable, that he found his duties interfere too much with his favourite pursuits, he exchanged the lancet for the sword, and entered the 72d regiment as ensign. In 1805, his wishes were fully accomplished; the corps to which he belonged being one of those which formed the expedition under Sir David Baird against the Cape of Good Hope; and, from this period, he carefully noted whatever occurred to him that was deserving of remark, keeping a diary, in which, from time to time, he entered such observations on men, opinions, climate, plants, &c. as might be instructive to others, or amusing to himself. He was engaged in the action with the enemy which took place on landing at the Cape; and from the account which he gives of it, as well as from his general description of military movements and stations, we learn that he made his new profession his study, and that he was not contented merely with being an officer, but brought his talents to bear on his occupations, until he knew the general duties which he might have to perform, as well as the general rules of the military art. Colonel Grant, who then commanded the 72d, seemed to have duly estimated his merits, and desired his promotion; but, having been wounded in this engagement at the Cape, Carmichael lost, in consequence, an active friend. He always spoke of his profession with a warmth of a soldier, and of his brother officers with fondness; a fact, indeed, which also proves that his own deportment was such as commanded their regard.

Of this brave action which terminated so favourably for the British arms, we shall give the description in Captain Carmichael's own words.

"The expedition under the command of Sir David Baird, which was destined to act against the Cape of Good Hope, consisted of the 24th, 38th, and 83d regiments, commanded by Brigadier-General Beresford; and the 71st, 72d, and 93d, commanded by Brigadier-General Ferguson; three companies of the Royal Artillery under General Yorke; and two squadrons of the 20th Light Dragoons. To this force must be added the 59th regiment, embarked for the East Indies, which was ordered to co-operate with us in the reduction of the Cape. The naval force, commanded by Sir Home Popham, consisted of two 64 gun-ships, and one of 50 guns; two frigates, a sloop of war, and two gun-brigs.

"The expedition sailed from the Cove of Cork on the 2d day of September 1805, and, on the 4th of October, the fleet, amounting to about seventy sail, came to anchor in Funchal Roads, off the Island of Madeira. We weighed anchor again, and directed our course for St Salvador, on the coast of Brazil, where we arrived on the 12th of November, with the loss of the Britannia Indiaman, and the King George transport, with General Yorke on board, which were wrecked on the shoal called the Racers, off Cape St Augustine. Leaving St Salvador on the 26th of November, we made the Cape of Good Hope on the 3d of January 1806; and, on the evening of the 4th, the whole fleet came to an anchor in the channel, between Robin Island and the Blueberg.

"Early on the morning of the 5th of January, General Beresford's brigade made an attempt to land; but, on approaching the shore, the sea was found to break with such violence, that it was thought prudent to desist. As that part of the coast was known to be subject to a heavy surge, and the situation of the fleet was such as forbade any unnecessary delays, the Diomede, with the transports carrying the 38th regiment and General Beresford, was dispatched to Saldanha Bay, and the whole fleet would have followed next day, had not the Highland brigade been fortunate enough to effect a landing about six miles farther to the southward, in Sospiras Bay. The enemy's riflemen appeared lurking among the bushes, and showed a disposition to annoy us; but they were speedily dislodged by a few shots from the gun-brigs that covered our approach. The only serious accident that occurred was the loss of one of our boats, having on board about forty men of the 93d regiment, which was overset on a bank of shore-weed, and every soul lost.

"The 7th of January was employed in disembarking the remainder of the troops and the field artillery. Five hundred volunteers from the ships of war and Indiamen were also landed, for the purpose of dragging the guns, a service which they performed with their accustomed enthusiasm. At four o'clock, on the morning of the 8th, we moved from the sand hills along the road that leads over the shoulder of the Blueberg. When we arrived on the crest of the hill, we perceived the enemy drawn up on the other side. Our disposition was soon made. We were formed in echellons of brigades; the left, or Highland brigade, being about two hundred yards in advance of the other. In this relative position we advanced, sometimes in line, at others in file from the heads of companies, according to the nature of the ground. We no sooner arrived within the range of the enemy's artillery, than he opened his fire on us from twenty field-pieces, which were advanced considerably in front of his line. The action, on our side, was begun by the grenadiers of the 24th regiment, sent to dislodge a body of mounted riflemen, which occupied a rising ground on our right flank. This duty the grenadiers performed with great intrepidity, but not without serious loss: Captain Foster being killed on the spot, and fifteen men either killed or wounded.

"The line, in the mean time, continued to advance over a tract of ground where we were buried up to the middle in heath and prickly shrubs. Owing to some misconception of orders, we began firing before we had arrived within killing distance of the enemy; but this error was speedily corrected by the rapidity of our movement, which alarmed him so much, that, by the time we came within a hundred yards of his position, he began to retreat. This he effected in very good order; for, to tell the truth, we were in no condition to molest him. Fresh from the cool bracing climate of Ireland, then cooped up for five months on board of crowded transports, a march of six hours over the scorching sands of Africa, exhausted us to such a degree, that even the exhilarating sight of a flying enemy could not prevent immense numbers from escaping to the rear.

"Our force of every description in this action was about five thousand men; that of the enemy three thousand. The loss was nearly equal, being about three hundred in killed and wounded. After the engagement, we advanced as far as Reitt Valley, where we received from the fleet a supply of provisions and water. Next morning we marched on towards Cape Town, and had approached within a few miles of it, when we were met by a flag of truce, demanding a cessation of hostilities for forty-eight hours, in order to arrange terms of capitulation. Sir David Baird returned for answer that they should have six hours only, and that, if the place was not surrendered at the expiration of that period, he would enter it by storm in the course of the night. This menace had the desired effect, and the 59th regiment marched in that evening and took possession of the lines. The rest of the troops lay on their arms, at the mouth of the Salt River, until three o'clock P. M. next day, at which hour the British flag was hoisted on the castle, a royal salute was fired by the ships of war, and the Highland brigade marched to Wynberg.

"We thus, without much difficulty, got possession of the capital, but Jansen was still unsubdued. After the action at Blueberg, he had retired with his whole force to the pass of Hottentot's Holland Kloof, where he designed to establish himself in such a manner as should cut off the communication of Capetown with the interior. With a view to dislodge him from this stronghold, the Highland brigade and 59th regiment marched on the 12th to Stettenbock, and were followed, in a few days, by Sir David Baird in person. After some preliminary overtures between the two generals, a negociation was set on foot, which terminated in the formal cession of the whole colony to the British arms."

"The regiment being ordered to Capetown, Captain Carmichael has time to describe its remarkable features.

"The first thing which arrests the attention of a stranger, on his arrival at Capetown, is the wonderful diversity in the features, colour, and costume of the various descriptions of people who crowd the streets. He feels himself amazed at finding himself in a sort of Noah's Ark, where he meets with more varieties of one species than the patriarch had under his charge of the whole animal creation. Here he may see the pure spotless robe of the Hindoo rubbing against the painted kaross of the Caffre and the soot-stained sheepskin of the Hottentot; here the barefooted boor from the snow mountain stares at the polished boots of the London cockney: here he may contrast the crop of the Pennsylvanian with the pendant crown-lock of the Chinese: here the Brazilian may shake hands with the Malay, and the Guinea Negro with his brother from Madagascar. In the midst of this motley group, Europeans of every description, either as traders or prisoners of war, pass in review before him. The geographical position of the colony will account, in some measure, for the concurrence of these heterogeneous elements of population. The peculiar circumstances under which it was originally established, facilitate the emigration of people from all parts of Germany and the north of Europe. The revocation of the Edict of Nantz drove numbers of French Protestant families here for refuge; the practice of discharging soldiers in the settlement, after a certain period of service, few of whom ever returned to Europe; the extensive communication between Europe and India, in the course of which numberless adventurers were induced by hope, or forced by distress, to relinquish their prospects in the east, and settle in the colony; and, finally, the salubrity of the climate, inviting the martyrs to tropical diseases to repair hither for the re-establishment of their health: such are the lights of the picture; the shades are furnished from the coasts of Africa and the Indian Archipelago.

"In a society so constructed, the manners must be as varied as the materials of which it is composed; and ages must elapse ere they can amalgamate and assume a national form. This renders the colonists peculiarly prone to adopt the customs of strangers; and as these adoptions are oftener the fruit of caprice than of sound judgment, they are apt sometimes to excite a smile. Can there be conceived, for instance, a more awkward or more ludicrous object than a huge boor heaving up his ponderous shoulders in imitation of a Parisian, twisting his neck, and drawling out "Ilk wit neit," whilst his utmost endeavours cannot throw the corresponding expression into a countenance where the muscles are so deeply imbedded in blubber, that even the convulsions of death could not produce any visible derangement of features.

" No difference of ranks exists at the Cape; and, if the population be not occasionally reinforced from Europe, the distinction of colour will soon vanish. The intermixture of African with European blood can already be traced in some of the first-rate families in the colony; the hue of the skin and the lineaments of the countenance unequivocally betraying their origin. The abolition of the slave trade, and the facility with which the poorest inhabitants can, by ordinary activity and perseverance, obtain a competency, will accelerate this union, and it is probable that before two centuries shall have elapsed, all the colours will be blended in one.

" The complexion of the Cape ladies is, in general, fair, perhaps too fair. It is of that sickly delicate tint which indicates exclusion from the air and light. It is altogether deficient in the lively bloom which gentle exercise and exposure to the elements diffuse over the cheeks of the British fair. Great care is taken, while young and single, of their figures; they are accordingly then light and elegant in their form; but they are no sooner married than they begin to neglect their persons, and, by indulging in the pleasures of the table, acquire a degree of obesity that renders them objects of disgust. The habit of using vegetable acids as seasoning to every article of food, soon destroys the teeth. So universal, indeed, is this defect, that a fine set of teeth never enters as an item into the catalogue of female beauty; and the total neglect of the brush renders such as they have offensive to the sight of any person of delicacy.

" Almost every private house in Capetown is open for the accommodation of such strangers as have occasion to take lodgings for any time in the town. This custom supersedes the use of taverns; but, as it was originally the offspring of poverty and necessity, it will fall into disuse in proportion as the inhabitants become more opulent. The town may at present be aptly compared to a large inn on a well-frequented road. The same incessant routine of arrivals and departures; the same chaotic medley of characters; and the same insatiable thirst of gain, and disregard of reputation in the manner of acquiring it, are characteristic of both.

"I happened, some days ago, to step into one of the Venduties, or public sales, in Capetown, where, among other articles, I saw three or four slaves set up to sale. This was altogether a new sight to me. I could not without pain remark the anxiety with which those poor creatures regarded the persons who were bidding for them. It seemed as if they wished to trace the character of their future master in the lineaments of his countenance, and showed indications of joy or fear, according to the opinion they had formed of his disposition.

"Among the terrible reactions produced by the slave trade, none is perhaps more merited or more evident than the dissoluteness of morals and ferocity of disposition which it creates among the people who are concerned it. The cold-blooded calculator of profit and loss, the prime agent in this unhallowed traffic, feels its influence but in a remote and subordinate degree. It is when we cast a view on those who are placed immediately within the sphere of its action, that we perceive its deteriorating effects; their morals, their temper, their air, and their very features confessing its malignant influence. The softer sex, more especially, are transformed by it into cruel tyrants. When you mix in female society, you look in vain for that cheerful play of features which indicates a sweet disposition; in vain you listen for that harmonious tone of voice which is mellowed by the habit of associating with one's equals.

"The slaves at the Cape are composed of more various races than are to be met with in any other part of the world where the traffic in human flesh is sanctioned. The coast of Guinea, Mosambique, Madagascar, Malacca, and the islands of the east, have contributed in their turn to supply the colony; and from the intermixture of this heterogeneous group, aided by a dash of European and Hottentot blood, a mongrel race has sprung up, which exhibits an astonishing diversity of feature as well as of disposition. Of all the unadulterated race of slaves, the Malay bears the most marked character. He is cunning, active, and intelligent; but, at the same time, implacably revengeful. If a Malay commits a fault, and is punished for it, there the matter terminates; but if he is only threatened, and fancies the punishment still hanging over him, he will commit the most atrocious actions to put an end to the misery of suspense. Desperate under the influence of this impression, he works himself into a state of delirium by swallowing opium; then draws his kriss or dagger, and stabs the whole family, slaves and all. Having glutted his vengeance within doors, he sallies forth into the street, and, plunging his weapon into every living creature he meets, whether it be man or beast, he never ceases until he is shot, or is otherwise disabled from doing farther mischief.

" It is owing, in some measure, perhaps, to the dread of this savage retribution, that the slaves are treated beyond comparison better at the Cape than in any other European colony; though it must be allowed that the very high price at which they are usually valued, will prove, with most masters, a strong check on harsh and inhuman treatment. The law does not entrust the master with the infliction of corporeal punishment; but directs that the culprit shall be sent to the common trunk or prison, where he receives a certain number of stripes, according to the nature of his offence. It may readily be supposed, however, that this law is frequently evaded, even in the town, and under the very eyes of the magistrates; and in the remote parts of the country it necessarily goes for nothing; the distance from the seat of justice adding to the difficulty and expense of complying with its mandates, in the same ratio that it insures impunity in the transgression of them.

" Before the British got possession of the colony, slaves convicted of capital crimes were sometimes put to the torture, because an acknowledgment of guilt, either voluntary or compulsive, was necessary to authorise the magistrate to pass sentence of death on the criminal. But this inhuman practice has been abolished by the British government, and the sentence of death is executed now without any preliminary cruelties. The place of execution is at the base of the Lion's Rump, facing the Amsterdam Battery. Three pillars, erected in the form of a triangle, support as many beams placed across them, and from these beams the criminals are suspended. It was probably to a gallows of this construction that allusion is made in Schiller's play of the Robbers, in which somebody says, 'Maurice, beware of the beast that has got three legs.'"

(*To be continued.*)

Hunting the Cougar, or American Lion; and Deer Hunting. By John James Audubon, F.R.SS. L. & E. M.W.S., &c *.

1. *The Cougar, or American Lion* †.

There is an extensive swamp in the section of the state of Mississippi which lies partly in the Choctaw territory. It commences at the borders of the Mississippi, at no great distance from a Chicasaw village, situated near the mouth of a creek, known by the name of Vanconnah, and partly inundated by the swellings of several large bayous, the principal of which, crossing the swamp in its whole extent, discharges its waters not far from the mouth of the Yazoo River. This famous bayou is called False River. The swamp of which I am speaking follows the windings of the Yazoo, until the latter branches off to the north east, and at this point forms the stream named Cold Water River, below which the Yazoo receives the draining of another bayou, inclining towards the north-west, and intersecting that known by the name of False River, at a short distance from the place where the latter receives the waters of the Mississippi. This tedious account of the situation of the swamp is given with the view of pointing it out to all students of nature who may chance to go that way, and whom I would earnestly urge to visit its interior, as it abounds in rare and interesting productions, birds, quadrupeds, and reptiles, as well as moluscous animals, many of which, I am persuaded, have never been described.

In the course of one of my rambles I chanced to meet with a squatter's cabin on the banks of the Cold Water River. In

* It having been remarked, and rather sharply, that in our article on "Audubon's Ornithological Biography," we have overrated that gentleman's talents, we, in our own vindication, and as proofs of Audubon's descriptive powers, submit to the judgment of our readers the above sketches, taken at random from his work.

† Is the Felis concolor of Linnæus; the Felis puma of Trail, in vol. 4th of Wernerian Memoirs.

the owner of this hut, like most of those adventurous settlers in the uncultivated tracts of our frontier districts, I found a person well versed in the chase, and acquainted with the habits of some of the larger species of quadrupeds and birds. As he who is desirous of instruction ought not to disdain listening to any one who has knowledge to communicate, however humble may be his lot, or however limited his talents, I entered the squatter's cabin, and immediately opened a conversation with him respecting the situation of the swamp, and its natural productions. He told me he thought it the very place I ought to visit, spoke of the game which it contained, and pointed to some bear and deer skins, adding, that the individuals to which they had belonged formed but a small portion of the number of those animals which he had shot within it. My heart swelled with delight; and on asking if he would accompany me through the great morass, and allow me to become an inmate of his humble but hospitable mansion, I was gratified to find that he cordially assented to all my proposals. So I immediately unstrapped my drawing materials, laid up my gun, and sat down to partake of the homely but wholesome fare of the supper intended for the squatter, his wife, and his two sons.

The quietness of the evening seemed in perfect accordance with the gentle demeanour of the family. The wife and children, I more than once thought, seemed to look upon me as a strange sort of person, going about, as I told them I was, in search of birds and plants; and were I here to relate the many questions which they put to me in return for those which I addressed to them, the catalogue would occupy several pages. The husband, a native of Connecticut, had heard of the existence of such men as myself, both in our own country and abroad, and seemed greatly pleased to have me under his roof. Supper over, I asked my kind host what had induced him to remove to this wild and solitary spot: "The people are growing too numerous now to thrive in New England," was his answer. I thought of the state of some parts in Europe, and calculating the denseness of their population compared with that of New England, exclaimed to myself, "How much more difficult must it be for men to thrive in those populous countries!" The conversation then changed, and the squatter, his sons, and myself, spoke of hunting and fishing, until at length tired, we laid ourselves down on pallets of bear skins, and reposed in peace on the floor of the only apartment of which the hut consisted.

Day dawned, and the squatter's call to his hogs, which, being almost in a wild state, were suffered to seek the greater portion of their food in the woods, awakened me. Being ready dressed, I was not long in joining him. The hogs and their young came grunting at the well-known call of their owner, who threw them a few ears of corn, and counted them, but told me that for some weeks their number had been greatly diminished by the ravages committed upon them by a large panther, by which name the cougar is designated in America, and that the ravenous animal did not content himself with the flesh of his pigs, but now and then carried off one of his calves, notwithstanding the many attempts he had made to shoot it. The painter, as he sometimes called it, had on several occasions robbed him of a dead deer, and to these exploits the squatter added several remarkable feats of audacity which it had performed, to give me an idea of the formidable character of the beast. Delighted by his description, I offered to assist him in destroying the enemy, at which he was highly pleased, but assured me, that unless some of his neighbours should assist us with their dogs and his own, the attempt would prove fruitless. Soon after, mounting a horse, he went off to his neighbours, several of whom lived at a distance of some miles, and appointed a day of meeting.

The hunters accordingly made their appearance one fine morning at the door of the cabin, just as the sun was emerging from beneath the horizon. They were five in number, and fully equipped for the chase, being mounted on horses, which in some parts of Europe might appear sorry nags, but which in strength, speed, and bottom, are better fitted for pursuing a cougar or a bear through woods and morasses than any in that country. A pack of large ugly curs were already engaged in making acquaintance with those of the squatter. He and myself mounted his two best horses, whilst his sons were bestriding others of inferior quality.

Few words were uttered by the party till we had reached the edge of the swamp, where it was agreed that all should disperse and seek for the fresh track of the painter, it being previously settled that the discoverer should blow his horn, and remain on the spot until the rest should join him. In less than an hour the sound of the horn was clearly heard, and, sticking close to the squatter, off we went through the thick woods, guided only by the now and then repeated call of the distant huntsmen. We soon reached the spot, and in a short time the rest of the party came up. The best dog was sent forward to track the cougar, and in a few moments the whole pack were observed diligently trailing, and bearing in their course for the interior of the swamp. The rifles were immediately put in trim, and the party followed the dogs at separate distances, but in sight of each other, determined to shoot at no other game than the panther.

The dogs soon began to mouth, and suddenly quickened their pace. My companion concluded that the beast was on the ground, and putting our horses to a gentle gallop, we followed the curs, guided by their voices. The noise of the dogs increased, when all of a sudden their mode of barking became altered, and the squatter, urging me to push on, told me that the beast was treed, by which he meant that it had got upon some low branch of a large tree to rest for a few moments, and that should we not succeed in shooting him when thus situated, we might expect a long chase of it. As we approached the spot, we all by degrees united into a body, but on seeing the dogs at the foot of a large tree, separated again, and galloped off to surround it.

Each hunter now moved with caution, holding his gun ready, and allowing the bridle to dangle on the neck of his horse, as it advanced slowly towards the dogs. A shot from one of the party was heard, on which the cougar was seen to leap to the ground, and bound off with such velocity as to shew that he was very unwilling to stand our fire longer. The dogs set off in pursuit with great eagerness, and a deafening cry. The hunter who had fired came up, and said that his ball had hit the monster, and had probably broken one of his fore-legs near the shoulder, the only place at which he could aim. A slight trail of blood was discovered on the ground, but the curs proceeded at such a rate that we merely noticed this, and put spurs to our horses, which galloped on towards the centre of the swamp. One bayou was crossed, then another still larger and more muddy; but the dogs were brushing forward, and as the horses began to pant at a furious rate, we judged it expedient to leave them and advance on foot. These determined hunters knew that the cougar being wounded, would shortly ascend another tree, where in all probability he would remain for a considerable time, and that it would be easy to follow the track of the dogs. We dismounted, took off the saddles, set the bells attached to the horses' necks at liberty to jingle, hoppled the animals, and left them to shift for themselves.

Now, kind reader, follow the group marching through the swamp, crossing muddy pools, and making the best of their way over fallen trees and amongst the tangled rushes that now and then covered acres of ground. If you are a hunter yourself, all this will appear nothing to you; but if crowded assemblies of "beauty and fashion," or the quiet enjoyments of your "pleasure grounds," alone delight you, I must mend my pen before I attempt to give you an idea of the pleasure felt on such an expedition.

After marching for a couple of hours, we again heard the dogs. Each of us pressed forward, elated at the thought of terminating the career of the cougar. Some of the dogs were heard whining, although the greater number barked vehemently. We felt assured that the cougar was treed, and that he would rest for some time to recover from his fatigue. As we came up to the dogs, we discovered the ferocious animal lying across a large branch, close to the trunk of a cotton-wood tree. His broad breast lay towards us; his eyes were at one time bent on us, and again on the dogs beneath and around him; one of his fore-legs hung loosely by his side, and he lay crouched with his ears lowered close to his head, as if he thought that he might remain undiscovered. Three balls were fired at him, at a given signal, on which he sprang a few feet from the branch, and tumbled headlong to the ground. Attacked on all sides by the enraged curs, the infuriated cougar fought with desperate valour; but the squatter advancing in front of the party, and almost in the midst of the dogs, shot him immediately behind and beneath the left shoulder. The cougar writhed for a moment in agony, and in another lay dead.

The sun was now sinking in the west. Two of the hunters separated from the rest, to procure venison, whilst the squatter's sons were ordered to make the best of their way home, to be ready to feed the hogs in the morning. The rest of the party agreed to camp on the spot. The cougar was despoiled of its skin, and its carcass left to the hungry dogs. Whilst engaged in preparing our camp, we heard the report of a gun, and soon after one of our hunters returned with a small deer. A fire was lighted, and each hunter displayed his pone of bread, along with a flask of whisky. The deer was skinned in a trice, and slices placed on sticks before the fire. These materials afforded us an excellent meal, and as the night grew darker, stories and songs went round, until my companions, fatigued, laid themselves down, close under the smoke of the fire, and soon fell asleep.

I walked for some minutes round the camp, to contemplate the beauties of that nature, from which I have certainly derived my greatest pleasures. I thought of the occurrences of the day, and glancing my eye around, remarked the singular effects produced by the phosphorescent qualities of the large decayed trunks which lay in all directions around me. How easy, I thought, would it be for the confused and agitated mind of a person bewildered in a swamp like this, to imagine in each of these luminous masses some wondrous and fearful being, the very sight of which might make the hair stand erect on his head. The thought of being myself placed in such a predicament, burst over my mind, and I hastened to join my companions, beside whom I laid me down and slept, assured that no enemy could approach us without first rousing the dogs, which were growling in fierce dispute over the remains of the cougar.

At day-break we left our camp, the squatter bearing on his shoulder the skin of the late destroyer of his stock, and retraced our steps until we found our horses, which had not strayed far from the place where we had left them. These we soon saddled, and jogging along, in a direct course, guided by the sun, congratulating each other on the destruction of so formidable a neighbour as the panther had been, we soon arrived at my host's cabin. The five neighbours partook of such refreshment as the house could afford, and dispersing, returned to their houses, me to follow my favourite pursuits.

2. *Deer-Hunting.*

The different modes of destroying deer are probably too well understood, and too successfully practised in the United States; for, notwithstanding the almost incredible number of these beautiful animals in our forests and prairies, such havoc is carried on amongst them, that, in a few centuries, they will probably be as scarce in America, as the great bustard now is in Britain.

We have three modes of hunting deer, each varying in some slight degree, in the different states and districts. The first is termed still-hunting, and is by far the most destructive. The second is called fire-light hunting, and is next in its exterminating effects. The third, which may be looked upon as a mere amusement, is named driving. Although many deer are destroyed by this latter method, it is not by any means so pernicious as the others. These methods I shall describe separately.

Still-hunting is followed as a kind of trade by most of our frontier men. To be practised with success, it requires great activity, an expert management of the rifle, and a thorough knowledge of the forest, together with an intimate acquaintance with the habits of the deer, not only at different seasons of the year, but also at every hour of the day, as the hunter must be aware of the situation which the game prefers, and in which it is most likely to be found at any particular time. I might here present you with a full account of the habits of our deer, were it not my intention to lay before you, at some future period, in the form of a distinct work, the observations which I have made on the various quadrupeds of our extensive territories.

Illustrations of any kind require to be presented in the best possible light. We shall therefore suppose that we are now about to follow the true hunter, as the still-hunter is also called, through the interior of the tangled woods, across morasses, ravines, and such places where the game may prove more or less plentiful, even should none be found there in the first instance. We shall allow our hunter all the agility, patience, and care, which his occupation requires, and will march in his rear, as if we were spies, watching all his motions.

His dress, you observe, consists of a leather hunting-shirt, and a pair of trowsers of the same material. His feet are well moccassined; he wears a belt round his waist; his heavy rifle is resting on his brawny shoulder; on one side hangs his ball-pouch, surmounted by the horn of an ancient buffalo, once the terror of the herd, but now containing a pound of the best gun-powder; his butcher-knife is scabbarded in the same strap; and behind is a tomahawk, the handle of which has been thrust through his girdle. He walks with so rapid a step that, probably, few men besides ourselves, that is myself and my kind reader, could follow him, unless for a short distance, in their anxiety to witness his ruthless deeds. He stops, looks at the flint of his gun, its priming, and the leather cover of the lock, then glances his eye towards the sky, to judge of the course most likely to lead him to the game.

The heavens are clear, the red glare of the morning sun gleams through the lower branches of the lofty trees, the dew hangs in pearly drops at the tip of every leaf. Already has the emerald hue of the foliage been converted into the more glowing tints of our autumnal months. A slight frost appears on the fence-rails of his little corn-fields. As he proceeds he looks to the dead foliage under his feet, in search of the well known traces of a buck's hoof. Now he bends toward the ground, on which something has attracted his attention. See! he alters his course, increases his speed, and will soon reach the opposite hill. Now, he moves with caution, stops at almost every tree, and peeps forward, as if already within shooting distance of the game. He advances again, but how very slowly! He has reached the declivity upon which the sun shines in all its growing splendour;—but mark him! he takes the gun from his shoulder, has already thrown aside the leathern cover of the lock, and is wiping the edge of his flint with his tongue. Now he stands like a monumental figure, perhaps measuring the distance that lies between him and the game which he has in view. His rifle is slowly raised, the report follows, and he runs. Let us run also. Shall I speak to him, and ask him the result of his first essay? Assuredly, reader, for I know him well.

"Pray, friend, what have you killed?" for to say, "what have you shot at?" might imply the possibility of his having missed, and so might hurt his feelings. "Nothing but a buck." "And where is it?" "Oh! it has taken a jump or so, but I settled it, and will soon be with it. My ball struck, and must have gone through his heart." We arrive at the spot where the animal had laid itself down among the grass in a thicket of grape-vines, sumachs, and spruce bushes, where it intended to repose during the middle of the day. The place is covered with blood, the hoofs of the deer have left deep prints in the ground, as it bounced in the agonies produced by its wound; but the blood that has gushed from its side discloses the course which it has taken. We soon reach the spot. There lies the buck, its tongue out, its eye dim, its breath exhausted —it is dead. The hunter draws his knife, cuts the buck's throat almost asunder, and prepares to skin it. For this purpose he hangs it upon the branch of a tree. When the skin is removed he cuts off the hams, and, abandoning the rest of the carcass to the wolves and vultures, reloads his gun, flings the venison, enclosed by the skin, upon his back, secures it with a strap, and walks off in search of more game, well knowing that, in the immediate neighbourhood, another at least is to be found.

Had the weather been warmer, the hunter would have sought for the buck along the shadowy side of the hills. Had it been the spring season, he would have led us through some thick cane brake, to the margin of some remote lake, where you would have seen the deer immersed to his head in the water, to save his body from the tormenting attacks of moschettoes. Had winter overspread the earth with a covering of snow, he would have searched the low damp woods, where the mosses and lichens, on which at that period the deer feeds, abound, the trees being generally crusted with them for several feet from the ground. At one time, he might have marked the places where the deer clears the velvet from his horns by rubbing them against the low stems of bushes, and where he frequently scrapes the earth with his fore hoofs; at another, he would have betaken himself to places where persimons and crab apples abound, as beneath these trees it frequently stops to munch their fruits. During early spring our hunter would imitate the bleating of the doe, and thus frequently obtain both her and the fawn; or, like some tribes of Indians, he would prepare a deer's head, placed on a stick, and creeping with it amongst the tall grass of the prairies, would decoy the deer within reach of his rifle. But kind reader, you have seen enough of the still-hunter. Let it suffice for me to add, that by the mode pursued by him, thousands of deer are annually killed, many individuals shooting these animals merely for the skin, not caring for even the most valuable portions of the flesh, unless hunger, or a near market, induce them to carry off the hams.

The mode of destroying deer by fire light, or, as it is named in some parts of the country, forest light, never fails to produce a very singular feeling in him who witnesses it for the first time. There is something in it which at times appears awfully grand. At other times, a certain degree of fear creeps over the mind, and even affects the physical powers of him who follows the hunter through the thick under-growth of our woods, having to leap his horse over hundreds of huge fallen trunks; at one time impeded by a straggling grape-vine crossing his path, at another squeezed between two stubborn saplings, whilst their twigs come smack in his face, as his companion has forced his way through them. Again, he every now and then runs the risk of breaking his neck, by being suddenly pitched headlong on the ground, as his horse sinks into a hole covered over with moss. But I must proceed in a more regular manner, and leave you, kind reader, to judge whether such a mode of hunting would suit your taste or not.

The hunter has returned to his camp or his house, has rested and eaten of his game. He waits impatiently for the return of night. He has procured a quantity of pine knots, filled with resinous matter, and has an old frying-pan, that, for aught I know to the contrary, may have been used by his great grand-mother, in which the pine knots are to be placed when lighted. The horses stand saddled at the door. The hunter comes forth, his rifle slung on his shoulder, and springs upon one of them, while his son, or a servant, mounts the other, with the frying-pan and the pine knots. Thus accoutred, they proceed towards the interior of the forest. When they have arrived at the spot where the hunt is to begin, they strike fire with a flint and steel, and kindle the resinous wood. The person who carries the fire moves in the direction judged to be the best. The blaze illuminates the near objects, but the distant parts seem involved in deepest obscurity. The hunter who bears the gun keeps immediately in front, and after a while discovers before him two feeble lights, which are produced by the reflection of the pine fire from the eyes of an animal of the deer or wolf kind. The animal stands quite still. To one unacquainted with this strange mode of hunting, the glare from its eyes might bring to his imagination some lost hobgoblin that had strayed from its usual haunts. The hunter, however, nowise intimidated, approaches the object, sometimes so near as to discern its form, when, raising the rifle to his shoulder, he fires and kills it on the spot. He then dismounts, secures the skin, and such portions of the flesh as he may want, in the manner already described, and continues his search through the greater part of the night, sometimes until the dawn of day, shooting from five to ten deer, should these animals be plentiful. This kind of hunting proves fatal, not to the deer alone, but also sometimes to wolves, and now and then to a horse or a cow which may have straggled far into the woods.

Now, kind reader, prepare to mount a generous full blood Virginian hunter. See that your gun is in complete order, for, hark to the sound of the bugle and horn, and the mingled clamour of a pack of harriers! Your friends are waiting you under the shade of the wood, and we must together go driving the light-footed deer. The distance over which one has to travel is seldom felt, when pleasure is anticipated as the result; so, galloping we go pell-mell through the woods to some well-known place, where many a fine buck has drooped its antlers under the ball of the hunter's rifle. The servants, who are called the drivers, have already begun their search. Their voices are heard exciting the hounds, and unless we put spurs to our steeds, we may be too late at our stand, and thus lose the first opportunity of shooting the fleeting game as it passes by. Hark again! The dogs are in chase, the horn sounds louder and more clearly. Hurry, hurry on, or we shall be sadly behind.

Here we are at last! Dismount, fasten your horse to this tree, place yourself by the side of that large yellow poplar, and mind you do not shoot me! The deer is fast approaching; I will to my own stand, and he who shoots him dead wins the prize.

The deer is heard coming. It has inadvertently cracked a dead stick with its hoof, and the dogs are now so near it that it will pass in a moment. There it comes! How beautifully it bounds over the ground! What a splendid head of horns! How easy its attitudes, depending, as it seems to do, on its own swiftness for safety! All is in vain, however, a gun is fired, the animal plunges and doubles with incomparable speed. There he goes! He passes another stand, from which a second shot, better directed than the first, brings him to the ground. The dogs, the servants, the sportsmen, are now rushing forward to the spot. The hunter who has shot it is congratulated on his skill or good luck, and the chase begins again in some other part of the woods.

A few lines of explanation may be required to convey a clear idea of this mode of hunting. Deer are fond of following and retracing the paths which they have formerly pursued, and continue to do so even after they have been shot at more than once. These tracts are discovered by persons on horseback in the woods, or a deer is observed crossing a road, a field, or a small stream. When this has been noticed twice, the deer may be shot from the places called stands, by the sportsman who is stationed there, and waits for it, a line of stands being generally formed so as to cross the path which the game will follow. The person who ascertains the usual pass of the game, or discovers the parts where the animal feeds or lies down during the day, gives intimation to his friends, who then prepare for the chase. The servants start the deer with the hounds, and, by good management, generally succeed in making it run the course that will soonest bring it to its death. But, should the deer be cautious, and take another course, the hunters, mounted on swift horses, gallop through the woods to intercept it, guided by the sound of the horns and the cry of the dogs, and frequently succeed in shooting it. This sport is extremely agreeable, and proves successful on almost every occasion.

Hoping that this account will be sufficient to induce you, kind reader, to go driving in our western and southern woods, I now conclude my chapter on deer-hunting, by informing you, that the species referred to above, is the Virginian deer, Cervus Virginianus; and that, until I be able to present you with a full account of its habits and history, you may consult, for information respecting it, the excellent Fauna Americana of my esteemed friend Dr Harlan of Philadelphia.

Analysis of the Compact Ferruginous Marl of Salisbury Craigs, and the Limestone of Red Burn, near to Seafield Tower, Fifeshire. By William Gregory, M. D.

1. *Compact Feruginous Marl of Salisbury Craigs.*

Silica, - - - - -	14.52
Alumina, - - - -	9.42
Peroxide of Iron, - -	10.23
Oxide of Manganese, - -	1.54
Carbonate of Lime, - -	50.46
Carbonate of Magnesia, -	2.20
Water, - - - -	10.34
	98.71

Owing to the quantity of water present, which is perhaps only mechanically combined, the mineral decrepitates violently in the fire.

2. *Magnesian Limestone of Red Burn, near to Seafield Tower, coast of Fife.*

Carbonate of Lime, - -	68.73
Carbonate of Magnesia, -	24.16
Alumina, - - - - -	2.05
Oxide of Iron, - - -	1.47
Oxide of Manganese, - -	0.80
Carbonaceous Matter, - -	0.75
Silica, - - - - - -	A trace.
	97.96

This limestone, which is of a grey colour and granular foliated, occurs in contact with *greenstone.* Geologists conjecture it may have derived its granular structure and magnesian contents from the Plutonian trap-rock.

Account of a Human Body, in a singular Costume, found in a high state of preservation in a Bog on the Lands of Gallagh, in the County of Galway. By George Petrie, Esq.

In the summer of 1821, as stated in the Dublin Journal of Science, the body of a man was found in a bog on the lands of Galagh, now Newton-Bellew, the seat of C. D. Bellew, Esq. in the county of Galway. The bog was about ten feet and a half deep, and the body lay about nine feet below its surface. It had all the appearance of recent death when first discovered, excepting that the abdomen was quite collapsed, but on exposure to the atmosphere it decayed rapidly. The face was that of a young man of handsome features and foreign aspect, and his hair, which was long and black, hung loosely over his shoulders. The head, legs, and feet, were without covering, but the body was clothed in a tight dress, covering also the limbs as far as the knees and elbows. This dress was composed of the skin of some animal, laced in front with thongs of the same material, and having the hairy side inwards; and it is not improbable that it might have been that of the Moose-deer. He had no weapon; but near him, at each side of the body, was found a long staff or pole, which it was supposed he had used for the purpose of bounding over streams; and as the body was found near a rivulet, it was further conjectured by the peasantry, that the man had met his death accidentally in some such manner.

The antiseptic power of bogs is well known, and the frequent discovery of human bodies in a high state of preservation, in those of Ireland, has been already recorded. (See Gough's edition of Camden's Britannia.) The finding of this body would not therefore deserve particular notice, nor would it probably have excited much attention at the time, but for the singularity of the costume. And this notice is the more necessary, as the dress no longer exists, having been buried with the body—an instance of ignorance and barbarism that could hardly have occurred out of Ireland, and of which we may well feel ashamed.

The antiquity of these remains is shewn by the great depth of bog under which they lay; but as the growth of bog must depend on various circumstances, as situation, humidity, soil, &c., that fact alone can give us no certain criterion of their age. On this point, perhaps, the rude dress in which the body was clothed, is likely to afford more satisfactory ground for conjecture.

That it belonged to a period antecedent to the arrival of the English, may be concluded from the evidence of Gerald Barry, who says, the Irish were but lightly clad in woollen garments, barbarously shaped, and for the most part black, because the sheep of the country were usually of that colour: and from the spirit of that author's work, we have little reason to suppose, that if any portion of the Irish in his time had been clothed in skins in his time, he would have failed to notice it.

If we credit the early annals of our native writers, we would believe that among the Irish, so far back as the reign of *Tighernmas*, in the year of the world 2815, the various ranks of persons, from the king to the peasant, were distinguished by the number of colours striped in their garments; and so barren are our ancient chronicles of any notice of skins being used for dress, that Mr Walker (the ingenious author of an Essay on the Dress of the Irish), expresses his belief, that the art of manufacturing woollen garments, and the fashions into which they were shaped, were brought into this country by the Milesian colony. Few, however, will give implicit credit to these authorities; and we may well doubt the truth of accounts that make the Irish so much more civilized than the Gauls and Belgic Britons, even at a later period. From Tacitus, it appears, that the Germans, and from Cæsar and Diodorus that the Belgæ, wore the skins of some beast; the Braceæ, or party-coloured woollen garments, being apparently confined to the higher orders. In these customs, we may suppose the Belgic inhabitants of Ireland, called Fir-bolg, agreed; and it was in a district unquestionably inhabited by that colony, that the body here noticed was found (see O'Flaherty's Ogygia). But we must not conclude that such a luxury was common to all the British and Irish. We are told by Dion Cassius, and Herodian, that the inhabitants of the northern parts of Britain went entirely naked; and it appears from numerous ancient monuments still existing, that the Celtic tribes of the Irish for many centuries later were dressed as Gildas describes the Scots and Caledonians in the sixth century, that is, simply with a covering or *Celt* round their middle, and occasionally a mantle across their shoulders. And it is an interesting and important fact, not hitherto noticed, that the names by which these two grand races in Ireland, the Celtæ and Belgæ, were known, were also used to designate the characteristic articles of dress by which they were distinguished. Thus *Celt* means a small petticoat, and *Fir-bolg* (literally a breeched or bagged man) signified breeches (see O'Clery's old vocabulary MS.).

The skin dress of the Gauls and Britons called *Sac*, from whence the *Sagum* of the Romans is derived by Varro, is generally thought to have been worn originally as a mantle, and that the name was retained in after times to designate the woollen garment of the same form. But the dress on the body here described gives reason to believe that supposition erroneous, and that the *Sac* originally was a close dress, somewhat resembling a bag, in which sense the word was used in the Hebrew and Greek, and is still retained not only in all the Teutonic languages, but also in the Welsh and Irish. Perhaps in its original signification it simply meant *racan* or skin.

This subject would admit of much illustration; but it must suffice to remark, that the long staffs found with this body will remind the reader of the description of the *Silures* as given by Tacitus, and the flowing hair with which the head was adorned of the usage of the *Suevi* and other Gothic tribes, as noticed by the same writer. The custom of wearing the hair long, in despite of penal statutes, continued almost to our own times, in some of the western parts of Ireland.

On the present Erroneous and Expensive Systems of Life Assurance. By Mr W. Fraser, Edinburgh.

WHILE the great utility of Life Assurance has now become very generally known, and begun to be duly appreciated by all classes of the community, the late Parliamentary investigations regarding Friendly Societies, and the Government Annuitants, have produced a great improvement in the details of the science.

Most of the uncertainty and difficulty by which it has hitherto been supposed to be attended have been cleared away, and Life Assurance transactions may now be calculated and managed with nearly the same accuracy and simplicity as those of any common mercantile concern.

The case was very different in the earlier periods of Life Assurance. Its principles were but very imperfectly understood: and from this cause, as well as from the defective tables of mortality in use, several institutions were founded upon very erroneous calculations, and have been since carried on upon any thing but equitable or scientific principles, and others more recently established have, with slight modifications, followed the same plan. By all of these the premiums required for sums payable at death are uniformly much higher than necessary. In proprietory companies, the excess of funds thus occasioned is a complete loss to the assured, as the proprietors appropriate it exclusively to themselves; while in mutual guarantee associations, there arise much trouble and expense, and a great inequality in the adjustment, from the necessity of periodically apportioning to each individual a share of the large aggregate surpluses.

Two reasons are usually assigned for still exacting such excessive premiums. The proprietory companies allege, that, as they guarantee the assured in payment of their policies by a large subscribed capital, and for a long period after outset run a great risk of loss, so, on the other hand, they are entitled to be recompensed by the assured for such obligations. The mutual guarantee associations, again, acknowledge that their premiums are too high, but assert that this signifies little to the members, or rather is beneficial to all concerned, because, while the institution is thereby rendered more secure, the accumulated surplus is periodically added, under the name of bonuses, to the policies of the subscribers.

Both of these reasons, however, are quite fallacious. The risk at first is next to nothing. The chances are only about 100 to 1 against an ordinary life of thirty years of age failing in one year; 100 times 100, or 10,000 to 1, against two named lives of that age both failing within the year; and 100 times 10,000, or a million to 1 against three of that age dying in the year. But if among ordinary lives the chances are so small, as every institution begins with select lives the odds are still greater against rapid mortality during the first few years of an establishment. The celebrated Dr Price long ago stated, " that it is not to be expected that any Society can meet with difficulties in its infancy;" and experience has since amply demonstrated, that of all undertakings, a Life Assurance association, from the premiums being paid in advance, and from there being no risk of bad debts, has the least occasion for capital at the commencement; and, in proof of this, it may be affirmed, that no instance can be given of any such institution, under proper management, ever requiring any part of a subscribed capital to make good the policies of the assured.

For Mutual Assurance associations, the only preliminary precautions are, that the lives be select, and that the extent of the individual risks at first be proportioned to the number and ages of the members, so that their collective annual premiums may of themselves, in one or two years at most, form a sufficient fund for meeting every probable demand. With regard to the requisite premiums, it is certainly proper that these should be always made such as fully to cover the risks assured, and to defray the expenses of management; but it is difficult to conceive why they should be 40 or 50 per cent. more than necessary. The value of the prospective claims against Life Assurance Companies may now be calculated with very great accuracy (as even the periodical computation of a surplus necessarily implies); and hence there is no necessity for taxing the members to accumulate a large surplus fund, merely for the purpose of being again divided and distributed among them under the name of bonuses.

Besides, the bonus system is any thing but a just or equitable one. The surpluses have chiefly arisen from fewer deaths occurring among the members of the middle and younger ages than were calculated to happen by the mortality tables hitherto in use, as in the more advanced ages these tables are pretty nearly correct, and, consequently, little or no surplus then arises from the contributions of the older members. Such being the case, the latter should then also cease to derive any additional benefit from a subsequent extra accumulation of capital; whereas the practice is for all, after a certain period of contribution, to participate alike, in proportion to the sums assured, but without any regard to their ages. Hence it follows, that the first or youngest class of entrants secure to themselves all the benefit of their own surpluses; but while the excess from their premiums must always continue to decrease, and, after a certain age, cease altogether, still they continue to participate in the surpluses of every succeeding class of members. Thus the first class gain at the expense of the second; the first and second at the expense of the third; the first, second, and third, at that of the fourth, and so on—the surpluses accruing to the last or youngest class of entrants being always diminished in proportion to the number and ages of those who had entered before them. Young and good lives, therefore, can have no inducement to enter such a society.

It is usual for institutions of this kind to refer the public to the large sums of bonuses which have been added to the policies of the original members; but it will be perceived that it by no means follows that similar additions will continue to be made to the policies of all future members. So long as institutions upon this principle can obtain an increasing number of young entrants, the surpluses may at one or two successive investigations appear to be of the same or perhaps even of an increased amount; but should the number become stationary or decrease, or the ages of the entrants be higher, while the ages, and consequently the mortality, of the existing members increase, the surpluses would soon begin to diminish, and ultimately cease altogether. It will then be found by all but the first and second class of entrants, that the additions to their policies will by no means be a recompense for the heavy extra premiums to which they are subjected through life.

But there is still another strong objection to the usual mode of dividing the surpluses. To the sum specified in the policies, at whatever time the death may happen, the representatives of the assured are justly entitled, because that is the nature and object of the contract; and the aggregate premiums of the long and the short lived, should, if properly calculated, be made fully adequate to the policies of both classes in the long run. But the right to participate in a surplus fund depends on a very different principle. Whether the excess of capital arise from a low rate of mortality, from profitable investments of capital, or from forfeitures, it is obvious that no part of such surplus can in equity belong to any member till such time as his premiums, with the accumulation of interest, exceed the sum to be paid at his death. All those who die previous to this period evidently create a loss to those who live beyond it; and as it is from the contributions of the latter class that a surplus has actually arisen, it is only but fair that they should have the benefit of it, instead of sharing it with the representatives of those who may have died before paying perhaps one-fourth of the specific sums assured by their policies.

In short, it is now universally admitted, that the awkward and expensive system of superfluous exaction and subsequent increase of policies is highly objectionable, and wholly unnecessary in the present improved state of the science of Life Assurance. "My view in all cases is," said the very eminent mathematician Mr Babbage, in his evidence before a Select Committee of the House of Commons, "let us get as nearly as we can the law of mortality of the class for which we want to calculate, and add to the prices computed from it some proportional part, sufficient to insure the safety of the establishment which uses them. I strongly object to using tables giving a greater mortality than is expected to take place, a course which has sometimes been defended on the ground of safety to the establishment. Safety is much more certainly secured by judging as nearly as possible the true risk, and adding an additional sum for security. If tables not representing the mortality of the class for whom they are designed are employed, every step in the reasonings which are deduced from them is liable to increased error; and if the calculations are at all complicated, the errors so introduced may not improbably act on the opposite side to that which they were introduced to favour."

The primary object of every class of life assurers should be to ascertain—from the most accurate tables of mortality, and from the best authorities as to the probable rate of interest that will be obtained for capital—the lowest premiums at which any specified benefit at death can be safely secured, at the same time adding a sufficient sum to the premium for safety and management. As the Northampton Table of mortality is now universally acknowledged to be unfit for the purposes of Life Assurance, the Government Annuity Tables may be safely taken as a guide, these having been very recently constructed, with the utmost care, and from the best data. Besides, as they have been deduced from the rate of mortality found to prevail for a long period among the State Annuitants, they will represent the mortality likely to occur among a select class of Life Assurers more accurately than any tables calculated from that of the community at large. These tables, too, must very speedily become the standard for all calculations connected with life contingencies in Britain; and should it be alleged that they represent human life as of too short duration, they must still on that account be held the safer for Life Assurance.

The two Tables of Premiums annexed have been calculated by an eminent actuary from the Government Annuity Tables, 10 per cent. having been added to the one for males, and 15 to that for females, as an additional guarantee, and for defraying the expenses of management. These tables we would with perfect confidence recommend to any new Life Assurance association, to be conducted with ordinary prudence and economy; but this being the lowest rate of premium, consistent with security to the assured, the public should by no means be led to expect large returns in the shape of bonuses; while at the same time, should a surplus capital eventually arise, as there may be reason to expect, from the addition which has been made to the requisite premiums, it should be apportioned periodically among the members on whose contributions it has arisen,—and among them alone. In this way no entrant would be told, that his representatives would in the first place be entitled to a certain sum should he die before the first period of investigation subsequent to his entry, and, in all probability, to an additional sum should he survive to another period, and to a still farther sum should he live to a third period, &c., while it is impossible to specify the amount of such additions, as they are, in truth, extremely contingent, and very distant at the best. But every one would here at once be told the utmost sum which he could reasonably expect for his premium, whether he died sooner or later; at the same time, should he live long, and a surplus be found to have actually arisen from his premiums and those of others of the same standing, there would be no chance of its being in a great measure carried off on account of those who died early. Still farther to prevent individual loss, should any one, after being some time a member, find it inconvenient to pay the full amount of his original premiums, or even to remain at all in the institution, either the sum assured should be reduced, so as to admit of a corresponding reduction in his annual payments, or his interest in the capital at the time should be ascertained, and a due proportion of it returned to him, in the case of his withdrawing altogether from the society.

To whatever extent the premiums are found to be less in the subjoined Tables than in those of the present institutions, the difference may be said to be just so much saved to the assured, and upon premiums for large sums, it would afford at once a considerable addition to the policies. The difference upon the premiums of Females in particular will be found to be no trifle, from the greater longevity known to prevail among them than among males—a fact which has been long ascertained, but which has been very seldom taken into view in calculations for Life Assurance.

It needs only farther be noticed, that in commencing a Life Assurance Society, a large number of members, or high individual assurances, are by no means indispensable. A limited number, for sums from L. 100 to L. 500, should be only expected in the first instance, and whose premiums might be made payable either annually, half-yearly, or quarterly. Both of these would without doubt be very speedily increased; but in such an institution, as indeed in any other concern, it is safer to proceed upon a small scale at first, and advance gradually, than to undertake high individual risks before a sufficient number of policies be issued to cover them.

The following Tables shew the value, both in single payments and in yearly premiums paid in advance, of L. 100 to be received six months after the death of a male and also of a female; according to the Government Tables, interest 4 per cent.; including the per-centage before mentioned for charges, and additional security to the assured.

TABLE I.—*Shewing the Single and Annual Premiums for* £100 *at Death.*

MALES.

Age.	Single Payment.			Annual Premium.			Age.	Single Payment.			Annual Premium.		
	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.
18	31	11	10	1	14	1	40	42	16	9	2	14	0
19	32	2	7	1	14	11	41	43	13	1	2	15	8
20	32	12	0	1	15	8	42	44	10	6	2	17	6
21	33	0	1	1	16	3	43	45	8	8	2	19	7
22	33	5	10	1	16	9	44	46	7	10	3	1	9
23	33	11	2	1	17	2	45	47	7	11	3	4	1
24	33	16	5	1	17	7	46	48	9	0	3	6	7
25	34	2	0	1	18	0	47	49	11	7	3	9	5
26	34	8	2	1	18	6	48	50	15	0	3	12	6
27	34	16	1	1	19	2	49	51	19	1	3	15	9
28	35	4	9	1	19	11	50	53	3	8	3	19	2
29	35	14	1	2	0	8	51	54	8	3	4	2	10
30	36	4	0	2	1	6	52	55	12	1	4	6	6
31	36	14	6	2	2	5	53	56	15	8	4	10	3
32	37	5	5	2	3	4	54	57	18	9	4	14	2
33	37	17	2	2	4	5	55	59	1	3	4	18	1
34	38	9	7	2	5	6	56	60	3	8	5	2	3
35	39	2	9	2	6	9	57	61	5	8	5	6	5
36	39	16	8	2	8	0	58	62	7	8	5	10	10
37	40	11	0	2	9	5	59	63	10	0	5	15	10
38	41	5	10	2	10	10	60	64	12	10	6	0	7
39	42	1	0	2	12	4							

EXAMPLE.

A Male aged 30, may secure L. 100, payable six months after his death, whenever it may happen, either by a single payment of L. 36, 4s., or by an annual premium during life of L. 2 : 1 : 6.

TABLE II.—*Shewing the Single and Annual Premiums for* £100 *at Death.*

FEMALES.

Age.	Single Payment.			Annual Premium.			Age.	Single Payment.			Annual Premium.		
	£	*s.*	*d.*	£	*s.*	*d.*		£	*s.*	*d.*	£	*s.*	*d.*
18	27	10	3	1	7	10	40	39	2	4	2	5	7
19	27	17	8	1	8	4	41	39	16	9	2	6	11
20	28	5	0	1	8	10	42	40	11	10	2	8	3
21	28	13	0	1	9	4	43	41	7	6	2	9	9
22	29	1	2	1	9	11	44	42	3	9	2	11	3
23	29	9	9	1	10	6	45	43	0	10	2	12	11
24	29	18	9	1	11	2	46	43	18	9	2	14	8
25	30	8	0	1	11	9	47	44	17	6	2	16	7
26	30	17	8	1	12	6	48	45	17	1	2	18	8
27	31	7	9	1	13	2	49	46	17	6	3	0	11
28	31	18	0	1	14	0	50	47	18	10	3	3	3
29	32	8	7	1	14	9	51	49	1	5	3	5	10
30	32	19	5	1	15	7	52	50	4	10	3	8	8
31	33	10	9	1	16	5	53	51	9	2	3	11	8
32	34	2	5	1	17	5	54	52	14	4	3	14	10
33	34	14	2	1	18	3	55	54	0	1	3	18	4
34	35	6	2	1	19	2	56	55	6	2	4	2	0
35	35	18	4	2	0	2	57	56	12	9	4	5	10
36	36	10	4	2	1	2	58	57	19	10	4	10	0
37	37	2	8	2	2	2	59	59	7	3	4	14	5
38	37	15	4	2	3	3	60	60	15	5	4	19	2
39	38	8	8	2	4	5							

EXAMPLE.

A Female aged 30, may secure L. 100, payable six months after her death, whenever it may happen, either by a single payment of L. 32, 19s. 5d., or by an annual premium during life of L. 1 : 15 : 7.

It has been considered unnecessary to enter at present into any detail regarding the late investigations into the law of mortality in this country, or the rate of interest most likely to be obtained for money. These subjects were formerly fully considered in the Numbers of this Journal for January and April 1828, and the views therein given have been since completely confirmed, both by two legislative enactments regarding Friendly Societies and the Government Annuitants, and by the institution of several Friendly Societies, under high patronage, upon the principles recommended in the series of papers of which the above two Numbers formed a part. To these papers, and to the rules of these Societies *, we would therefore refer for such an elementary or practical knowledge of the science of Health and Life Assurance, as will enable any one to judge how far the foregoing brief remarks and tables may be relied on, and how far the public should continue to credit the contradictory and fallacious statements in excuse for high premiums, contained in the innumerable advertisements and reports of the present Life Assurance Companies.

[We understand that a number of individuals, to whom this article has been shewn in proof-sheet, have already resolved to form themselves immediately into an association for Mutual Life Assurance. The tables of premiums here given are to be adopted, and the Society is to be conducted upon the most economical and popular plan. From the practical knowledge which some of these individuals have already acquired in the formation and management of several properly constituted Friendly Societies, we are inclined to augur very favourably of the success of the *Scottish Economic Life Assurance Society;* and, the better to secure the confidence of the public, we would strongly recommend that every facility should be given to the members in general, for understanding the pecuniary and other details of management. Much dissatisfaction and misconception have long existed, owing to the closeness with which Life Assurance matters have been hitherto managed; but this is now obviated in regard to Friendly Societies, by the statute making it imperative upon them to publish periodical statements of their pecuniary transactions, and we certainly do think that similar publicity would be equally beneficial and satisfactory to the higher classes of Life Assurers.]

* Among other Societies here alluded to, may be mentioned the Edinburgh Compositors' Society, and the Edinburgh School of Arts Society,—the Rules and Tables of the former may be safely taken as a guide for Societies of a limited number of members, and those of the latter for Societies on a large scale.

Improvements in the Navigation of the Mississippi. By J. J. Audubon, Esq., F. R. S S. & E., &c.

I have so frequently spoken of the Mississippi, that an account of the progress of navigation on that extraordinary stream may be interesting even to the student of nature. I shall commence with the year 1808, at which time a great portion of the western country and the banks of the Mississippi river, from above the city of Natchez particularly, were little more than a waste, or, to use words better suited to my feelings, remained in their natural state. To ascend the great stream against a powerful current, rendered still stronger wherever islands occurred, together with the thousands of sand banks, as liable to changes and shiftings as the alluvial shores themselves, which at every deep curve or bend were seen giving way, as if crushed down by the weight of the great forests that every where reached to the very edge of the water, and falling and sinking in the muddy stream, by acres at a time, was an adventure of no small difficulty and risk, and which was rendered more so by the innumerable logs, called sawyers and planters, that every where raised their heads above the water, as if bidding defiance to all intruders. Few white inhabitants had yet marched towards its shores, and these few were of a class little able to assist the navigator. Here and there a solitary encampment of native Indians might be seen; but its inmates were as likely to become foes as friends, having from their birth been made keenly sensible of the encroachment of white men upon their lands.

Such was then the nature of the Mississippi and its shores. That river was navigated principally in the direction of the current, in small canoes, pirogues, keel-boats, some flat-boats, and a few barges. The canoes and pirogues being generally laden with furs from the different heads of streams that feed the great river, were of little worth after reaching the market of New Orleans, and seldom reascended, the owners making their way home through the woods amidst innumerable difficulties. The flat-boats were demolished, and used as fire wood. The keel-boats and barges were employed in conveying produce of different kinds besides furs, such as lead, flour, pork, and other articles. These returned laden with sugar, coffee, and dry goods, suited for the markets of Genevieve and St Louis on the Upper Mississippi, or branched off and ascended the Ohio to the foot of the falls, near Louisville, in Kentucky. But, reader, follow their movements, and judge for yourself of the fatigues, troubles, and risks of the men employed in that navigation. A keel-boat was generally manned by ten hands, principally Canadian, French, and a patroon or master. These boats seldom carried more than from twenty to thirty tons. The barges had frequently forty or fifty men, with a patroon, and carried fifty or sixty tons. Both these kinds of vessels were provided with a mast, a square sail, and coils of cordage, known by the name of cordelles. Each boat or barge carried its own provisions. We shall suppose one of these boats under way, and, having passed Natchez, entering upon what were called the difficulties of their ascent. Wherever a point projected, so as to render the course or bend below it of some magnitude, there was an eddy, the returning current of which was sometimes as strong as that of the middle of the great stream. The bargemen, therefore, rowed up pretty close under the bank, and had merely to keep watch in the bow, lest the boat should run against a planter or sawyer. But the boat has reached the point, and there the current is to all appearance of double strength, and right against it. The men, who have all rested a few minutes, are ordered to take their stations, and lay hold of their oars, for the river must be crossed, it being seldom possible to double such a point, and proceed along the same shore. The boat is crossing, its head slanting to the current, which is, however, too strong for the rowers, and when the other side of the river has been reached, it has drifted perhaps a quarter of a mile. The men are by this time exhausted, and, as we shall suppose it to be twelve o'clock, fasten the boat to the shore, or to a tree. A small glass of whisky is given to each, when they cook and eat their dinner, and, after repairing their fatigue by an hour's repose, recommence their labours. The boat is again seen slowly advancing against the stream. It has reached the lower end of a large sand bar, along the edge of which it is propelled by means of long poles, if the bottom be hard. Two men, called bowsmen, remain at the prow, to assist, in concert with the steersman, in managing the boat, and keeping its head right against the current. The rest place themselves on the land-side of the foot-way of the vessel, put one end of their poles on the ground, the other against their shoulders, and push with all their might. As each of the men reaches the stern, he crosses to the other side, runs along it, and comes again to the landward side of the bow, when he recommences operations. The barge in the mean time is ascending at the rate not exceeding one mile in the hour.

The bar is at length passed; and as the shore in sight is straight on both sides of the river, and the current uniformly strong, the poles are laid aside, and the men being equally divided, those on the river-side take to their oars, while those on the land-side lay hold of the branches of willows, or other trees, and thus slowly propel the boat. Here and there, however, the trunk of a fallen tree, partly lying on the bank, and partly projecting beyond it, impedes their progress, and requires to be doubled. This is performed by striking it with the iron points of the poles and gaff-hooks. The sun is now quite low, and the barge is again secured in the best harbour within reach. The navigators cook their suppers, and betake themselves to their blankets or bears'-skins to rest, or perhaps light a large fire on the shore, under the smoke of which they repose, in order to avoid the persecutions of the myriads of moschettoes which occur during the whole summer along the river. Perhaps, from dawn to sunset, the boat may have advanced fifteen miles. If so, it has done well. The next day the wind proves favourable, the sail is set, the boat takes all advantages, and meeting with no accident, has ascended thirty miles,—perhaps double that distance. The next day comes with a very different aspect. The wind is right a-head; the shores are without trees of any kind, and the canes on the banks are so thick and stout, that not even the cordelles can be used. This occasions a halt. The time is not altogether lost, as most of the men, being provided with rifles, betake themselves to the woods, and search for the deer, the bears, or the turkeys that are generally abundant there. Three days may pass before the wind changes, and the advantages gained on the previous fine day are forgotten. Again the boat proceeds, but in passing over a shallow place runs on a log, swings with the current, but hangs fast, with her lea-side almost under water. Now for the poles! all hands are on deck, bustling and pushing. At length, towards sunset, the boat is once more afloat, and is again taken to the shore, where the wearied crew pass another night.

I shall not continue this account of difficulties, it having already become painful in the extreme. I could tell you of the crew abandoning the boat and cargo, and of numberless accidents and perils; but be it enough to say, that, advancing in this tardy manner, the boat that left New Orleans on the 1st of March, often did not reach the falls of the Ohio until the month of July,—nay, sometimes not until October; and, after all this immense trouble, it brought only a few bags of coffee, and at most 100 hogsheads of sugar. Such was the state of things in 1808. The number of barges at that period did not amount to more than 25 or 30, and the largest probably did not exceed 100 tons burden. To make the best of this fatiguing navigation, I may conclude by saying, that a barge which came up in three months had done wonders, for I believe few voyages were performed in that time.

If I am not mistaken, the first steam-boat that went down out of the Ohio to New Orleans was named the "Orleans," and, if I remember right, was commanded by Captain Ogden. This voyage, I believe, was performed in the spring of 1810. It was, as you may suppose, looked upon as the *ne plus ultra* of enterprise. Soon after, another vessel came from Pittsburgh; and, before many years elapsed, to see a vessel so propelled, became a common occurrence. In 1826, after a lapse of time that proved sufficient to double the population of the United States of America, the navigation of the Mississippi had so improved, both in respect to facility and quickness, that I know no better way of giving you an idea of it, than by presenting you with an extract of a letter from my eldest son, which was taken from the books of N. Berthoud, Esq., with whom he at that time resided.

"You ask me, in your last letter, for a list of the arrivals and departures here. I give you an extract from our list of 1826, showing the number of boats which plied each year, their tonage, the trips which they performed, and the quantity of goods landed here from New Orleans and intermediate places.

					Tons.	Trips.	Tons.
" 1823, from Jan.	1. to	Dec. 31. . .	42 boats, measuring		7,860	98	19,453
1824, ditto	1.	Nov. 25. . .	36	ditto	6,393	118	20,291
1825, ditto	1.	Aug. 15. . .	42	ditto	7,484	140	24,102
1826, ditto	1.	Dec. 31. . .	51	ditto	9,388	182	28,914

" The amount for the present year will be much greater than any of the above. The number of flat-boats and keels is beyond calculation. The number of steam-boats above the falls I cannot say much about, except that one or two arrive at and leave Louisville every day. Their passage from Cincinnati is commonly 14 or 16 hours. The Tecumseh, a boat which runs between this place and New Orleans, and which measures 210 tons, arrived here on the 10th instant, in 9 days 7 hours, from port to port; and the Philadelphia of 300 tons made the passage in 9 days 9½ hours, the computed distance being 1650 miles. These are the quickest trips made. There are now in operation on the waters west of the Alleghany mountains, 140 or 145 boats. We had last spring (1826), a very high freshet, which came 4½ feet deep in the counting-room. The rise was 57 feet 3 inches perpendicular."

The whole of the steam-boats of which you have an account did not perform voyages to New Orleans only, but to all points on the Mississippi, and other rivers which fall into it. I am certain, that since the above date, the number has increased, but to what extent I cannot at present say.

When steam-boats first plied between Shipping-port and New Orleans, the cabin passage was 100 dollars, and 150 dollars on the upward voyage. In 1829, I went down to Natchez from Shipping-port for 25 dollars, and ascended from New Orleans, on board the Philadelphia, in the beginning of January 1830, for 60 dollars, having taken two state-rooms for my wife and myself. On that voyage we met with a trifling accident, which protracted it to 14 days; the computed distance being, as mentioned above, 1650 miles, although the real distance is probably less. I do not remember to have spent a day without meeting with a steam-boat, and some days we met several. I might here be tempted to give you a description of one of these steamers of the western waters, but the picture having been often drawn by abler hands, I shall desist.

Thermometer and Barometer Tables.

In perusing foreign scientific works, many of our readers must no doubt have experienced considerable trouble in reducing the degrees of the scales of Reaumur and Celsius or the centigrade, which are generally used in continental works, to degrees in Fahrenheit's scale, which has been universally adopted in this country. Similar difficulties will also have been experienced in reducing barometrical measurements in the French measure to equivalent measurements in the English scale. With the view, therefore, of obviating these difficulties, we have been induced to present our readers with three Tables, by which any given degree in the scales of Reaumur or the Centigrade may be reduced to corresponding degrees in Fahrenheit's scale, or *vice versa*, by simple inspection. The other three Tables are for reducing French barometrical measurement to English measure, or the reverse.

Directions for using the Tables.

I. THERMOMETER TABLES.

1. If it be required to convert a whole number of degrees of any one of the three scales into each of the others, it is done at once by simple inspection of that Table in which the proposed scale to be converted stands in the first column. Thus, to convert —20° of Reaumur into degrees of Fahrenheit, also of the Centigrade scale;—by inspection of Table I. we find, that

—20° Reaum. = —13°.0 Fahr. = —25°.0 Centigr.

Again, to convert + 36° of Fahrenheit into degrees of the other two scales, we see in Table II. that

+ 36° Fahr. = + 1°.8 R. = + 2°.2 Cent.

Lastly, to convert —28° Centigrade into degrees of Fahrenheit and Reaumur, we find, by Table III. that

—28° Cent. = —22°.4 R. = —18°.4 Fahr.

2. If there be tenths in addition to the whole number of degrees to be converted; these must be changed by the supplementary Tables of Proportional Parts, and added, observing the rule for the addition of quantities with like or unlike signs: that is, when the signs are like, the sum is to be taken, and the common sign prefixed; but when unlike, their difference, and the sign of the greater prefixed.

Note.—The increments or decrements for the decimal parts have always the same sign in all the three scales.

Examp. I. Convert + 37°.7 R. into degrees of Fahr. and also of Cent.

By Table I.	+ 37°.0 R. =	+ 115°.2 Fahr. =	+ 46°.2 Cent.
	+ 0.7 =	+ 1.6 =	+ 0.9
The answer is,	+ 37°.7 R. =	+ 116°.8 Fahr. =	+ 47°.1 Cent.

Examp. II. Convert — 10°.6 R. into degrees of Fahr., also of Cent.

By Table I.	— 10°.0 R. =	+ 9°.5 Fahr. =	— 12°5 Cent.
	— 0.6 =	— 1.3 =	— 0.7
	— 10°.6 R. =	+ 8°.2 Fahr. =	— 13°.2 Cent.

Here, to find the degrees of Fahr. we subtract 1°.3 from 9°.5, because they have opposite signs, one being + and the other —: In the other two cases, we add, because the signs are alike, being both —.

EXAMP. III. Convert + 13°.2 Fahr. into degrees of R. and Cent.

By Table II.	+ 13°.0 Fahr.	= — 8°.4 R.	= — 10°.6 Cent.
	+ 0.2	= + 0.1 R.	= + 0.1
	+ 13°.2 Fahr.	= — 8°.3 R.	= — 10°.5 Cent.

EXAMP. IV. Find the degrees of R. and of F. corresponding to — 6°.8 Cent.

By Table III.	— 6°.0 Cent.	= — 4°.8 R.	= + 21°.2 Fahr.
	— 0.8	= — 0.7	= — 1.4
	— 6°.8	= — 5°.5	= + 19°8 Fahr.

EXAMP. V. Find the degrees of R. and F. corresponding to + 6°.8 Cent.

+ 6°.0 Cent.	= + 4°.8 R.	= + 42°.8 Fahr.
+ 0.8	= + 0.7	= + 1.4
+ 6°.8 Cent.	= + 5°.5 R.	= + 44°.2 Fahr.

II. BAROMETER TABLES.

TABLE IV. p. 139.

1. It is required to express in metres and English measure the given height 27 inches 3.5 lines Paris measure, of the mercury in the barometer. We look in the first column, Paris measure, for 27 in. 3.5 lines, and find opposite, in the column metres, and English measure, the equivalents, which are 0.739 metres, and 29 in. 1.0 lines English measure.

2. If tenth parts of Paris lines are given, that do not occur in the Table, the surplus above 0 tenth or 5 tenth is added to the English line. For the metre, on the contrary, we take the number immediately preceding the Paris line given. Thus, for example, we obtain for 319.2 Paris lines, in the first place, in the column English measure, for 319 Paris lines,

	28 in. 3.9 lines.
the surplus is	+ 0.2
	28 in. 4.1 lines English measure, which is equivalent to 319 lines Paris measure.

Next we obtain from the column metres, for the number that immediately precedes 319.2, viz. 319.0 = 0.728 metres.

TABLE V. p. 140.

If it is required to give the barometric height of 0.740 metres in Paris and English measure, we look in the column metres for 0.740, and in the corresponding columns Paris and English measure, we find 27 in. 4.0 lines Paris measure, and 29 in. 1.6 lines English measure.

TABLE VI. p. 141.

1. If it is required to give the mean barometer height of 356 English lines in metres and Paris measure, we look in the column of lines of English measure, and will find the numbers 356.0, and opposite it in the columns Paris measure and metres, 27 in. 10.1 lines Paris, and 0.753 metres.

2. If tenths of a line English measure are given, that do not occur in the Table, we proceed as in 2. under Table IV.—Suppose it is required to give the metres and Paris measure corresponding to 28 in. 3.8 lines of English measure; we look first for 28 in. 3.5 lines in the column English measure, and opposite, in the column Paris measure, is 26 in. 6.6 lines,

the surplus, ...	+ 0.3
	26 in. 6.9 lines Paris measure, which is equal to 28 in. 3.8 lines English measure.

Secondly, 3.8 is near 4.0. We therefore, for 28 in. 4 lines English measure, find opposite in the column of metres 0.720.

TABLE I.

Reaum.	Fahren.	Centigr.	Reaum.	Fahren.	Centigr.	Reaum.	Fahren.	Centigr.
—30°	—35.5°	—37.5°	+ 7°	+47.7°	+ 8.7°	+ 44°	+131.0°	+55.0°
29	33.2	36.2	8	50.0	10.0	45	133.2	56.2
28	31.0	35.0	9	52.2	11.2	46	135.5	57.5
27	28.7	33.7	10	54.5	12.5	47	137.7	58.7
26	26.5	32.5	11	56.7	13.7	48	140.0	60.0
25	24.2	31.2	12	59.0	15.0	49	142.2	61.2
24	22.0	30.0	13	61.2	16.2	50	144.5	62.5
23	19.7	28.7	14	62.5	17.5	51	146.7	63.7
22	17.5	27.5	15	65.1	18.2	52	149.0	65.0
21	15.2	26.2	16	68.0	20.0	53	151.2	66.2
20	13.0	25.0	17	70.2	21.2	54	153.5	67.5
19	10.7	23.7	18	72.5	22.5	55	155.7	68.7
18	8.5	22.5	19	74.7	23.7	56	158.0	70.0
17	6.2	21.2	20	77.0	25.0	57	160.2	71.2
16	4.0	20.0	21	79.2	26.2	58	162.5	72.5
15	1.7	18.7	22	81.5	27.5	59	164.7	73.7
14	+ 0.5	17.5	23	83.7	28.7	60	167.0	75.0
13	2.7	16.2	24	86.0	30.0	61	169.2	76.2
12	5.0	15.0	25	88.2	31.2	62	171.5	77.5
11	7.2	13.7	26	90.5	32.5	63	173.7	78.7
10	9.5	12.5	27	92.7	33.7	64	176.0	80.0
9	11.7	11.2	28	95.0	35.0	65	178.2	81.2
8	14.0	10.0	29	97.2	36.2	66	180.5	82.5
7	16.2	8.7	30	99.5	37.5	67	182.7	83.7
6	18.5	7.5	31	101.7	38.7	68	185.0	85.0
5	20.7	6.2	32	104.0	40.0	69	187.2	86.2
4	23.0	5.0	33	106.2	41.2	70	189.5	87.5
3	25.2	3.7	34	108.5	42.5	71	191.7	88.7
2	27.5	2.5	35	110.7	43.7	72	194.0	90.0
1	29.7	1.2	36	113.0	45.0	73	196.2	91.2
0	32.0	0.0	37	115.2	46.2	74	198.5	92.5
+ 1	34.2	+ 1.2	38	117.5	47.5	75	200.7	93.7
2	36.5	2.5	39	119.7	48.7	76	203.0	95.0
3	38.7	3.7	40	122.0	50.0	77	205.2	96.2
4	41.0	5.0	41	124.2	51.2	78	207.5	97.5
5	43.2	6.2	42	126.5	52.5	79	209.7	98.7
6	45.5	7.5	43	128.7	53.7	80	212.0	100.0

PROPORTIONAL PARTS TO TABLE I.

Reaumur.	Fahrenheit.	Centigrade.
0.1°	0.2°	0.1°
0.2	0.4	0.2
0.3	0.7	0.4
0.4	0.9	0.5
0.5	1.1	0.6
0.6	1.3	0.7
0.7	1.6	0.9
0.8	1.9	1.0
0.9	2.0	1.1

TABLE II.

Fahren.	Reaum.	Centigr.	Fahren.	Reaum.	Centigr.	Fahren.	Reaum.	Centigr.
—36°	—30.2°	—37.8°	+17°	—6.6°	8.4°	—70°	+16.9°	21.1°
35	29.7	37.3	18	6.2	7.8	71	17.3	21.6
34	29.3	36.7	19	5.7	7.3	72	17.8	22.2
33	28.8	36.2	20	5.3	6.7	73	18.2	22.7
32	28.4	35.6	21	4.8	6.2	74	18.7	23.3
31	28.0	35.1	22	4.4	5.6	75	19.1	23.8
30	27.6	34.4	23	4.0	5.0	76	19.6	24.4
29	27.2	33.9	24	3.6	4.4	77	20.0	24.9
28	26.7	33.3	25	3.1	3.9	78	20.4	25.6
27	26.2	32.8	26	2.7	3.3	79	20.8	26.1
26	25.8	32.2	27	1.2	2.8	80	21.3	26.7
25	25.4	31.7	28	1.8	2.2	81	21.7	27.2
24	24.9	31.1	29	1.3	1.7	82	22.2	27.8
23	24.4	30.6	30	0.9	1.1	83	22.6	28.3
22	24.0	30.0	31	0.4	0.6	84	23.1	28.9
21	23.6	29.5	32	0.0	0.0	85	23.5	29.4
20	23.1	28.9	33	+ 0.4	+ 0.5	86	24.0	30.0
19	22.6	28.4	34	0.9	1.1	87	24.4	30.5
18	22.2	27.8	35	1.3	1.6	88	24.9	31.1
17	21.7	27.3	36	1.8	2.2	89	25.3	31.6
16	21.3	26.7	37	2.2	2.7	90	25.8	32.2
15	20.8	26.2	38	2.7	3.3	91	26.2	32.7
14	20.4	25.6	39	3.1	3.8	92	26.7	33.3
13	20.0	25.0	40	3.6	4.4	93	27.1	33.8
12	19.6	24.4	41	4.0	5.0	94	27.6	34.4
11	19.1	23.9	42	4.4	5.6	95	28.0	34.9
10	18.7	23.3	43	4.8	6.1	96	28.4	35.5
9	18.2	22.8	44	5.3	6.7	97	28.8	36.1
8	17.8	22.2	45	5.7	7.2	98	29.3	36.7
7	17.3	21.7	46	6.2	7.8	99	29.7	37.2
6	16.9	21.1	47	6.6	8.3	100	30.2	37.8
5	16.4	20.6	48	7.1	8.9	101	39.6	38.3
4	16.0	20.0	49	7.5	9.4	102	31.1	38.9
3	15.5	19.5	50	8.0	10.0	103	31.5	39.4
2	15.1	18.9	51	8.4	10.5	104	32.0	40.0
1	14.6	18.4	52	8.9	11.1	105	32.4	40.5
0	14.2	17.8	53	9.3	11.6	106	32.9	41.1
+ 1	13.7	17.3	54	9.8	12.2	107	33.3	41.6
2	13.3	16.7	55	10.2	12.7	108	33.8	42.2
3	12.8	16.2	56	10.7	13.3	109	34.2	42.7
4	12.4	15.6	57	11.1	13.8	110	34.7	43.3
5	12.0	15.0	58	11.6	14.4	111	35.1	43.8
6	11.6	14.4	59	12.0	15.0	112	35.6	44.4
7	11.1	13.9	60	12.4	15.6	113	36.0	44.9
8	10.7	13.3	61	12.8	16.1	114	36.4	45.6
9	10.2	12.8	62	13.3	16.7	115	36.8	46.1
10	9.8	12.2	63	13.7	17.2	116	37.3	46.7
11	9.3	11.7	64	14.2	17.8	117	37.7	47.2
12	8.9	11.1	65	14.6	18.3	118	38.2	47.8
13	8.4	10.6	66	15.1	18.9	119	38.6	48.3
14	8.0	10.0	67	15.5	19.4	120	39.1	48.9
15	7.5	9.5	68	16.0	20.0	121	39.5	49.4
16	7.1	8.9	69	16.4	20.5	122	40.0	50.0

TABLE II.—*continued.*

Fahren.	Reaum.	Centigr.	Fahren.	Reaum.	Centigr.	Fahren.	Reaum.	Centigr.
+ 123°	+ 40.4°	+ 50.5°	+ 153°	+ 53.7°	+ 67.2°	+ 183°	+ 67.1°	+ 83.8°
124	40.9	51.1	154	54.2	67.8	184	67.6	84.4
125	41.3	51.6	155	54.6	68.3	185	68.0	85.0
126	41.8	52.2	156	55.1	68.9	186	68.4	85.6
127	42.2	52.7	157	55.5	69.4	187	68.8	86.1
128	42.7	53.3	158	56.0	70.0	188	69.3	86.7
129	43.1	53.8	159	56.4	70.5	189	69.7	87.2
130	43.6	54.4	160	56.9	71.1	190	70.2	87.8
131	44.0	55.0	161	57.3	71.6	191	70.6	88.3
132	44.4	55.6	162	57.8	72.2	192	71.1	88.9
133	44.8	56.1	163	58.2	72.7	193	71.5	89.4
134	45.3	56.7	164	58.7	73.3	194	72.0	90.0
135	45.7	57.2	165	59.1	73.8	195	72.4	90.5
136	46.2	57.8	166	59.6	74.4	196	72.9	91.1
137	46.6	58.3	167	60.0	75.0	197	73.3	91.6
138	47.1	58.9	168	60.4	75.6	198	73.8	92.2
139	47.5	59.4	169	60.8	76.1	199	74.2	92.7
140	48.0	60.0	170	61.3	76.7	200	74.7	93.3
141	48.4	60.5	171	61.7	77.2	201	75.1	93.8
142	48.9	61.1	172	62.2	77.8	202	75.6	94.4
143	49.3	61.6	173	62.6	78.3	203	76.0	95.0
144	49.8	62.2	174	63.1	78.9	204	76.4	95.6
145	50.2	62.7	175	63.5	79.4	205	76.8	96.1
146	50.7	63.3	176	64.0	80.0	206	77.3	96.7
147	51.1	63.8	177	64.4	80.5	207	77.7	97.2
148	51.6	64.4	178	64.9	81.1	208	78.2	97.8
149	52.0	65.0	179	65.3	81.6	209	78.6	98.3
150	52.4	65.6	180	65.8	82.2	210	79.1	98.9
151	52.8	66.1	181	66.2	82.7	211	79.5	99.4
152	53.3	66.7	182	66.7	83.3	212	80.0	100.0

PROPORTIONAL PARTS TO TABLE II.

Fahrenheit.	Reaumur.	Centigrade.
0.1°	0.0°	0.1°
0.2	0.1	0.1
0.3	0.1	0.2
0.4	0.2	0.2
0.5	0.2	0.3
0.6	0.3	0.3
0.7	0.3	0.4
0.8	0.4	0.4
0.9	0.4	0.5

TABLE III.

Centigr.	Reaum.	Fahren.	Centigr.	Reaum.	Fahren.	Centigr.	Reaum.	Fahren.
— 39°	— 31.2°	— 38.2°	+ 8°	+ 6.4°	+ 46.4°	+ 55°	+ 44.0°	+ 131.0°
38	30.4	36.4	9	7.2	48.2	56	44.8	132.8
37	29.6	34.6	10	8.0	50.0	57	45.6	134.6
36	28.8	32.8	11	8.8	51.8	58	46.4	136.4
35	28.0	31.0	12	9.6	53.6	59	47.2	138.2
34	27.2	29.2	13	10.4	55.4	60	48.0	140.0
33	26.4	27.4	14	11.2	57.2	61	48.8	141.8
32	25.6	25.6	15	12.0	59.0	62	49.6	143.6
31	24.8	23.8	16	12.8	60.8	63	50.4	145.4
30	24.0	22.0	17	13.6	62.6	64	51.2	147.2
29	23.2	20.2	18	14.4	64.4	65	52.0	149.0
28	22.4	18.4	19	15.2	66.2	66	52.8	150.8
27	21.6	16.6	20	16.0	68.0	67	53.6	152.6
26	20.8	14.8	21	16.8	69.8	68	54.4	154.4
25	20.0	13.0	22	17.6	71.6	69	55.2	156.2
24	19.2	11.2	23	18.4	73.4	70	56.0	158.0
23	18.4	9.4	24	19.2	75.2	71	56.8	159.8
22	17.6	7.6	25	20.0	77.0	72	57.6	161.6
21	16.8	5.8	26	20.8	78.8	73	58.4	163.4
20	16.0	4.0	27	21.6	80.6	74	59.2	165.2
19	15.2	2.2	28	22.4	82.4	75	60.0	167.0
18	14.4	0.4	29	23.2	84.2	76	60.8	168.8
17	13.6	+ 1.4	30	24.0	86.0	77	61.6	170.6
16	12.8	3.2	31	24.8	87.8	78	62.4	172.4
15	12.0	5.0	32	25.6	89.6	79	63.2	174.2
14	11.2	6.8	33	26.4	91.4	80	64.0	176.0
13	10.4	8.6	34	27.2	93.2	81	64.8	177.8
12	9.6	10.4	35	28.0	95.0	82	65.6	179.6
11	8.8	12.2	36	28.8	96.8	83	66.4	181.4
10	8.0	14.0	37	29.6	98.6	84	67.2	183.2
9	7.2	15.8	38	30.4	100.4	85	68.0	185.0
8	6.4	17.6	39	31.2	102.2	86	68.8	186.8
7	5.6	19.4	40	32.0	104.0	87	69.6	188.6
6	4.8	21.2	41	32.8	105.8	88	70.4	190.4
5	4.0	23.0	42	33.6	107.6	89	71.2	192.2
4	3.2	24.8	43	34.4	109.4	90	72.0	194.0
3	2.4	26.6	44	35.2	111.2	91	72.8	195.8
2	1.6	28.4	45	36.0	113.0	92	73.6	197.6
1	0.8	30.2	46	36.8	114.8	93	74.4	199.4
0	0.0	32.0	47	37.6	116.6	94	75.2	201.2
+ 1	+ 0.8	33.8	48	38.4	118.4	95	76.0	203.0
2	1.6	35.6	49	39.2	120.2	96	76.8	204.8
3	2.4	37.4	50	40.0	122.0	97	77.6	206.6
4	3.2	39.2	51	40.8	123.8	98	78.4	208.4
5	4.0	41.0	52	41.6	125.6	99	79.2	210.2
6	4.8	42.8	53	42.4	127.4	100	80.0	212.0
7	5.6	44.6	54	43.2	129.2			

PROPORTIONAL PARTS TO TABLE III.

Centigrade.	Reaumur.	Fahrenheit.	Centigrade.	Reaumur.	Fahrenheit.
0.1°	0.1°	0.2°	0.6°	0.5°	1.1°
0.2	0.2	0.4	0.7	0.6	1.3
0.3	0.2	0.5	0.8	0.7	1.4
0.4	0.3	0.7	0.9	0.8	1.6
0.5	0.4	0.9			

TABLE IV.

Paris measure.			Metres.	English measure.		Paris measure.			Metres.	English measure.	
Inch.	lin.	Lines.		Inch.	lin.	Inch.	lin.	Lines.		Inch.	lin.
26	0.0	312.0	0.704	27	8.5	27	6.0	330.0	0.744	29	3.7
	0.5	312.5	0.705		9.0		6.5	330.5	0.745		4.2
	1.0	313.0	0.706		9.6		7.0	331.0	0.747		4.7
	1.5	313.5	0.707		10.1		7.5	331.5	0.748		5.2
	2.0	314.0	0.708		10.6		8.0	332.0	0.749		5.8
	2.5	314.5	0.709		11.1		8.5	332.5	0.750		6.3
	3.0	315.0	0.711		11.7		9.0	333.0	0.751		6.8
	3.5	315.5	0.712	28	0.2		9.5	333.5	0.752		7.3
	4.0	316.0	0.713		0.8		10.0	334.0	0.753		7.9
	4.5	316.5	0.714		1.3		10.5	334.5	0.754		8.4
	5.0	317.0	0.715		1.8		11.0	335.0	0.756		8.9
	5.5	317.5	0.716		2.3		11.5	335.5	0.757		9.5
	6.0	318.0	0.717		2.9	28	0.0	336.0	0.758		10.1
	6.5	318.5	0.718		3.4		0.5	336.5	0.759		10.6
	7.0	319.0	0.720		3.9		1.0	337.0	0.760		11.2
	7.5	319.5	0.721		4.4		1.5	337.5	0.761		11.7
	8.0	320.0	0.722		5.0		2.0	338.0	0.762	30	0.3
	8.5	320.5	0.723		5.6		2.5	338.5	0.763		0.8
	9.0	321.0	0.724		6.1		3.0	339.0	0.765		1.3
	9.5	321.5	0.725		6.6		3.5	339.5	0.766		1.8
	10.0	322.0	0.726		7.2		4.0	340.0	0.767		2.4
	10.5	322.5	0.727		7.7		4.5	340.5	0.768		2.9
	11.0	323.0	0.729		8.2		5.0	341.0	0.769		3.4
	11.5	323.5	0.730		8.7		5.5	341.5	0.770		3.9
27	0.0	324.0	0.731		9.3		6.0	342.0	0.771		4.5
	0.5	324.5	0.732		9.8		6.5	342.5	0.772		5.0
	1.0	325.0	0.733		10.3		7.0	343.0	0.774		5.5
	1.5	325 5	0.734		10.8		7.5	343.5	0.775		6.0
	2.0	326.0	0.735		11.4		8.0	344.0	0.776		6.6
	2.5	326.5	0.736		11.9		8.5	344.5	0.777		7.1
	3.0	327.0	0.738	29	0.5		9.0	345.0	0.778		7.7
	3.5	327.5	0.739		1.0		9.5	345.5	0.779		8.2
	4.0	328.0	0.740		1.6		10.0	346.0	0.781		8.8
	4.5	328.5	0.741		2.1		10.5	346.5	0.782		9.3
	5.0	329.0	0.742		2.6		11.0	347.0	0.783		9.8
	5.5	329.5	0.743		3.1		11.5	347.5	0.784		10.3
						29	0.0	348.0	0.785		10.9

TABLE V.

Metres.	Paris measure.		English measure.		Metres.	Paris measure.		English measure.	
	Inch.	lin.	Inch.	lin.		Inch.	lin.	Inch.	lin.
0.700	25	10.3	27	6.6	0.751	27	8.9	29	6.7
0.701		10.7		7.0	0.752		9.4		7.2
0.702		11.2		7.5	0.753		9.8		7.7
0.703		11.6		8.0	0.754		10.2		8.1
0.704	26	0.1		8.5	0.755		10.7		8.6
0.705		0.5		9.0	0.756		11.1		9.0
0.706		1.0		9.6	0.757		11.6		9.6
0.707		1.4		10.0	0.758	28	0.0		10.1
0.708		1.8		10.5	0.759		0.5		10.6
0.709		2.3		10 9	0.760		0.9		11.1
0.710		2.7		11.4	0.761		1.3		11.5
0.711		3.2		11.9	0.762		1.8	30	0.1
0.712		3.6	28	0.4	0.763		2.2		0.5
0.713		4.1		0.9	0.764		2.7		1.0
0.714		4.5		1.3	0.765		3.1		1.4
0.715		5.0		1.8	0.766		3.6		2.0
0.716		5.4		2.2	0.767		4.0		2.4
0.717		5.8		2.7	0.768		4.5		2.9
0.718		6.3		3.2	0.769		4.9		3.3
0.719		6.7		3.6	0.770		5.3		3.7
0.720		7.2		4.1	0.771		5.8		4.3
0.721		7.6		4.6	0.772		6.2		4.7
0.722		8.1		5.1	0.773		6.7		5.2
0.723		8.5		5.6	0.774		7.1		5.6
0.724		8.9		6.0	0.775		7.5		6.0
0.725		9.4		6.5	0.776		8.0		6.6
0.726		9.8		7.0	0.777		8.4		7.0
0.727		10.3		7.5	0.778		8.9		7.6
0.728		10.7		7.9	0.779		9.3		8.0
0.729		11.2		8.4	0.780		9.8		8.6
0.730		11.6		8.9	0.781		10.2		9.0
0.731	27	0.0		9.3	0.782		10.7		9.5
0.732		0.5		9.8	0.783		11.1		9.9
0.733		0.9		10.2	0.784		11.6		10.5
0.734		1.4		10.7	0.785	29	0.0		10.9
0.735		1.8		11.2	0.786		0.4		11.5
0.736		2.3		11.7	0.787		0.9	31	0.0
0.737		2.7	29	0.2	0.788		1.3		0.4
0.738		3.2		0.7	0.789		1.8		0.9
0.739		3.6		1.2	0.790		2.2		1.4
0.740		4.0		1.6	0.791		2.6		1.9
0.741		4.5		2.1	0.792		3.1		2.4
0.742		4.9		2.5	0.793		3.5		2.8
0.743		5.4		3.0	0.794		4.0		3.3
0.744		5.8		3.5	0.795		4.4		3.8
0.745		6.3		4.0	0.796		4.8		4.3
0.746		6.7		4.4	0.797		5.3		4.8
0.747		7.1		4.8	0.798		5.7		5.2
0.748		7.6		5.4	0.799		6.2		5.7
0.749		8.0		5.8	0.800		6.6		6.2
0.750		8.5		6.3					

TABLE VI.

English measure.			Paris measure.		Metres.	English measure.			Paris measure.		Metres.
Inch.	lin.	Lines.	Inch.	lin.		Inch.	lin.	Lines.	Inch.	lin.	
27	9.0	333.0	26	0.5	0.705	29	3.0	351.0	27	5.4	0.743
	9.5	333.5		0.9	0.706		3.5	351.5		5.8	0.744
	10.0	334.0		1.4	0.707		4.0	352.0		6.3	0.745
	10.5	334.5		1.9	0.708		4.5	352.5		6.8	0.746
	11.0	335.0		2.4	0.709		5.0	353.0		7.3	0.747
	11.5	335.5		2.8	0.710		5.5	353.5		7.7	0.748
28	0.0	336.0		3.3	0.711		6.0	354.0		8.2	0.749
	0.5	336.5		3.7	0.712		6.5	354.5		8.7	0.750
	1.0	337.0		4.2	0.713		7.0	355.0		9.2	0.751
	1.5	337.5		4.7	0.714		7.5	355.5		9.6	0.752
	2.0	338.0		5.2	0.715		8.0	356.0		10.1	0.753
	2.5	338.5		5.6	0.716		8.5	356.5		10.6	0.754
	3.0	339.0		6.1	0.717		9.0	357.0		11.1	0.756
	3.5	339.5		6.6	0.719		9.5	357.5		11.5	0.757
	4.0	340.0		7.1	0.720		10.0	358.0		11.9	0.758
	4.5	340.5		7.5	0.721		10.5	358.5	28	0.4	0.759
	5.0	341.0		8.0	0.722		11.0	359.0		0.8	0.760
	5.5	341.5		8.4	0.723		11.5	359.5		1.3	0.761
	6.0	342.0		8.9	0.724	30	0.0	360.0		1.7	0.762
	6.5	342.5		9.4	0.725		0.5	360.5		2.2	0.763
	7.0	343.0		9.8	0.726		1.0	361.0		2.7	0.764
	7.5	343.5		10.3	0.727		1.5	361.5		3.2	0.765
	8.0	344.0		10.8	0.728		2.0	362.0		3.6	0.766
	8 5	344.5		11.3	0.729		2.5	362.5		4.1	0.767
	9.0	345.0		11.7	0.730		3.0	363.0		4.6	0.768
	9.5	345.5	27	0.2	0.731		3.5	363.5		5.1	0.769
	10.0	346.0		0.7	0.732		4.0	364.0		5.5	0.770
	10.5	346.5		1.2	0.733		4.5	364.5		6.0	0.771
	11.0	347.0		1.6	0.734		5.0	365 0		6.5	0.772
	11.5	347.5		2.1	0.735		5.5	365.5		7.0	0.774
29	0.0	348.0		2.5	0.737		6.0	366.0		7.5	0.775
	0.5	348.5		3.0	0.738		6.5	366.5		7.9	0.776
	1.0	349.0		3.5	0.739		7.0	367.0		8.4	0.777
	1.5	349.5		3.9	0.740		7.5	367.5		8.8	0.778
	2.0	350.0		4.4	0.741		8.0	368.0		9.3	0.779
	2.5	350.5		4.9	0.742		8.5	368.5		9.7	0.780
							9.0	369.0		10.2	0.781

The Agricultural and Horticultural Society of India.

Notwithstanding the fertility, in some degree historical, of the borders of the Ganges, and the numerous cottages of the indigenous population, surrounded by verdure, which give to Bengal the aspect of a garden, it appears that agriculture is still very little advanced in that country, and that it has much to gain from the judicious influence of Europeans. "To overthrow," says De Candolle, "a blind routine, founded in the ignorance of the Indians and their division into castes; to shew them that they can cultivate otherwise than they have done during 2000 or 3000 years; to engage the principal among them to occupy themselves with agriculture, which they despise; to introduce more perfect agricultural instruments, and species and varieties of useful plants, with which they are unacquainted:"—such are the objects that the Society of Agriculture and Horticulture, founded some years ago at Calcutta, propose, and whose first volume of Memoirs is now before us *.

This Society, patronized by the preceding Governor-General, the Marquis of Hastings, as well as by his successor Lord Amherst, is composed of British residents at Bengal, and of natives of rank. The total number of the members in the first of July 1828 was ninety-seven, and it has probably increased since that period. However barbarous such names as these may be to our ears, Prusunnukoomur Thakoor, or Ubhuyachurun Bariojya, which figure in the list of members, we mention them with pleasure, for they augur well concerning the future influence of the society on the native population.

In an Introductory Discourse by the President, he points out the utility of societies in general, and their influence on English agriculture. He represents the Indian Agriculture as much inferior to what it was in England two centuries ago; and the instruments employed by the natives as miserable. They have done nothing, he says, towards the cultivation of different and abundant species of plants which might be cultivated with pro-

* Transactions of the Agricultural and Horticultural Society of India, Vol. I. 8vo. Serampore, 1829.

fit; they neglect the forests; they could convert into pastures the jungles of long grass, which only afford them at present materials for covering their houses; in the winter they could have crops of wheat, barley, flax, mustard, and different kinds of pulse, in the immense districts which they altogether neglect, because they are inundated during the rainy season. Even the grasses that cover them, namely *Andropogon muricatus* and two or three kinds of *Saccharum*, would make a valuable hay, if mowed in the spring. In cultivating these districts, they would drive away the dangerous animals with which they are infested *, and which at present prevent their amelioration. The President shows himself adverse to the proposed establishment of experimental farms and horticultural gardens, being convinced that the society would be obliged to support them, and that the operations carried on there would not be applicable at present to India. He wishes that they could engage the principal proprietors to make experiments on agriculture, at their own expense; and he believes that their example would be profitable in the end. This opinion we consider a sound one. The following passage of his discourse has struck us as applicable to the amelioration of agriculture in Europe as well as that in India. " Conviction respecting the most obvious things, must, however, be expected to make but a slow progress among a people who are the slaves of custom, and whose want of curiosity and energy are such as to prevent their inquiry into the advantages and disadvantages of any new thing proposed to them, and which operate so powerfully as to keep them in a state of stupid contentment with their present miserable condition. The Society must not, therefore, expect too much at first; but must patiently labour in hope. It must not be discouraged by disappointments, but reiterate and increase its efforts; and, when the effects of its labours once begin to appear, it may be reasonably expected that the adoption of the means recommended will proceed with a gradually accelerated force, until the result shall finally exceed the expectations of its most zealous friends."

* Tigers, which abound in the jungles, humid districts, covered with coarse grass and shrubs, in the environs of Calcutta.

The introductory discourse of the President is followed by a number of interesting memoirs.

Dr Tytler, established at Allahabad, has studied the different diseases that attack barley and rice; among others, one which changes the latter salubrious grain into a true poison. It is a blight, analogous to that of wheat, produced, as it appears, by a superabundance of water in the rivers.

The society had communicated to its members a series of questions concerning the climate, the statistics, and agriculture of the different provinces. Dr Tytler sent detailed answers concerning the district of Allahabad; Mr Stirling concerning those in the vicinity of Nurmuda; Mr C. H. Blake concerning that of Poornea, where he has kept a regular journal of all the operations of agriculture during a year. Detailed descriptions of the agriculture of the twenty-four Purgunnas, of Silhut, and the neighbouring districts, have been communicated by Baboo-Radha-Kanta-Deva. General Hardwick communicated a note concerning a species of very nutritive wheat, which is cultivated in the districts annually inundated on the borders of the Jumna. Details concerning certain varieties of rice, a dwarf pea, originally of Patna, and ropes fabricated with fibres of different palms, are communicated by the President. Mr H. Piddington has a short memoir on the hemp of Manilla, furnished by the *Musa textilis;* Mr G. Ballard one concerning the culture of the grape-vine at Bombay; on the cultivation of the sugar-cane in different districts; and on an improved plough. Dr Wallich has communicated notices concerning the colony of Prince Edward's Isle, of the price of opium in that establishment, as well as concerning the employment of lime as a manure, and on the arborescent cabbage sent to the botanic garden of Calcutta by Professor de Candolle of Geneva. D. Scott, Esq. has given a summary of observations made during 22 years, as to the succession of the seasons at Bengal. The same gentleman has directed the attention of the society to the obtaining grains from Europe, by taking care to preserve them from humidity and the rapid changes of temperature, by putting them into glass phials with parched bran or burnt charcoal.

We observe in this volume the translation of an Indian book on horticulture, which, although it may contain some useful directions, shews the low condition of this interesting art in the East. In it we are told that there are trees which bring good luck, and others that bring bad; how we ought not to sow and plant but on certain days of the week and month; how we may change the nature of the fruits of Mango, by putting grains into the fat of the rabbit for the space of a month, &c. They moreover recommend to rub and to prick the roots with different substances, in order that they may carry fruit a longer time. To the memoir is appended a list of names of plants in Hindoo and Persian, corresponding to the botanical names.

A description of the gardens and the fruit-trees of Kashmeer, by Mr Moorcroft, contains many interesting details. The fruits of this country are those of the south of Europe, such as apples, pears, peaches, quinces, apricots, plums, cherries, walnuts, pomegranates, almonds, &c.; but there are many varieties of these fruits, and it appears that some are superior to those that have been obtained in Europe. The author thinks that advantage might be taken of the vicinity of this country for introducing many of them into British India. In the kingdom of Kashmeer, where there are many lakes, they construct floating gardens, in which they cultivate a great quantity of melons and cucumbers.

Mr Moorcroft, during his sojourning in Thibet, also inquired as to the culture of the forage named *Prangos* *, a forage very much sought after by sheep, and from which important results are anticipated, if it could be naturalized in Europe, or at the Cape of Good Hope. Packets of grains and roots of this umbelliferous plant have been sent to different persons, and, in particular, to Dr Wallich at Calcutta, but we are ignorant of the results of this communication. The President found a new mode of grafting in use in a western district of Bengal, which he thus describes: "In the season of the year when the bark easily separates from the wood, having previously cut off the end of a small branch which was considered unripe, about a quarter of an inch above an eligible bud, he would then make an annular cut round the bark about half an inch below the bud,

* This plant is the *Prangos pabularia*, described by Mr Lindley in the Journal of Science of the Royal Institution of London, 1825. No. 37. p. 7.

and then with a cloth in his hand, would forcibly pull off the ring of bark, taking care not to injure the bud; after which, he would proceed in the same way with the buds below. Having collected a sufficient number, and kept them fresh in the hollow of a leaf with a little water, he would proceed to the stocks to be engrafted, and having cut off the head, where the stock appeared of a proper size, he would strip the bark in small shreds all round to a sufficient depth, until a ring of the bark being applied, very exactly fitted. The shreds were then collected over the ring of bark and tied above, and bound together by a little moist hay, taking care not to press upon the bud. This perhaps combines the advantages of being the most successful, the most easy, and most simple mode of engrafting or budding."

The Society of Agriculture and Horticulture of Calcutta has imported from Europe many varieties of fruits and pulse, which it has distributed among the native gardeners; it has also awarded prizes for successful culture. "We cannot," says M. de Candolle, "sufficiently praise the zeal and prudence that distinguish its efforts for the improvement of Indian agriculture; and we must also remark how much in this point of view the English dominion, compared to that of preceding possessors, is a fortunate circumstance for this vast country. We must not forget that the impulse given to agriculture comes above all from the government of the country, for the Botanic Garden of Calcutta is the place where they make all kinds of experiments, and whence a number of seeds and useful plants are distributed among private individuals, and in the provincial gardens throughout British India. This magnificent establishment has enjoyed, during many years, an annual revenue of L. 5000 (125,000 fr. de France), which has enabled them to cultivate a very large tract of ground, to pay travellers to the interior of India, to correspond liberally with the gardens of Europe, and to give a comfortable salary to a skilful botanist charged with the direction of it. The particular circumstances of the India Company have forced it to diminish the income of the gardens; but we trust this system will not be pushed too far, for, without speaking of the utility of the garden of Calcutta in a sense purely scientific, it cannot be denied that it has rendered great services, whether by introducing into India all the best fruits of the equatorial regions, such as Mango, Litchee, Loquat, the Alligator pear, &c., or in procuring the best varieties of potatoes of which Bengal was formerly destitute; or, finally, by furnishing fresh seeds of coffee, which they now cultivate in many parts, and great quantities of the Teak wood, so valuable for the mariner."

Although the liberality of the India Company, in regard to botany, is highly praiseworthy, we confess ourselves unable to comprehend how the science of plants of all the branches of natural history should be the one selected for exclusive patronage by the Lords of our Eastern Empire. We now, however, know so much on this subject, as to be entitled to say that when our Indian affairs are finally arranged, this *exclusive* patronage of one branch of knowledge will be entirely done away with, and that Geology (in its most comprehensive sense), Mineralogy, and Zoology, will also be brought forward in a manner worthy the munificence of this great and liberal commercial company.

Account of the Arbusculites argentea, from the Carboniferous Limestone of Innerteil, near to Kirkcaldy, in Fifeshire. By P. Murray, M. D. of Scarborough. Communicated by the Author.

In the carboniferous limestone of the extensive quarries near Kirkcaldy, in Fife, may be observed, mingled with crinoidal remains, very delicate vermiform bodies, in fragments of different lengths, shining with metallic lustre, neither articulated nor cellular, and resembling broken bits of silver wire. Very short and minute pieces had been noticed among the coralloid fossils of this limestone, collected by myself many years ago, when a medical student at Edinburgh. But this winter, I have been, through the kindness of Mr Murray of Edinburgh, supplied with a specimen so much more perfect, as to induce me to call the attention of geologists to it, as a fossil animal hitherto undescribed, and not exactly reducible to any known group.

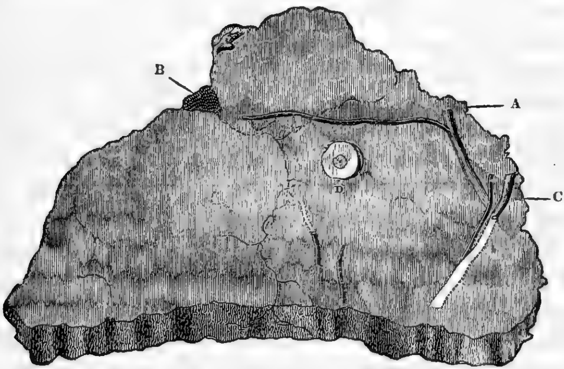
It would appear to have been an attached Mollusca, dichotomous at first, but afterwards sending out lateral branches, moderately tapering, and with very distant and obscure (if any) articulations, grooved longitudinally, and composed of a bright silvery cortical *case*, and a solid axis of carbonate of lime, frequently crystallized. It differs decidedly from the crinoidal animals, which are regularly articulated; and varies nearly in the same degree from the corallines, &c. by not displaying the cellular structure characteristic of that family, from which I should at once have separated this fossil, were I not fully aware of the extreme minuteness of those cells, and that occasionally they are lost to observation by the denuding of the cortical integument, or shrinking of the polypus itself. Besides, the fossilized objects under consideration are so rare and so imperfect, that it would be premature, nay presumptuous, as yet to remove them from all the known classes, until we shall be justified by careful and repeated examination of other and more perfect specimens. I would therefore, for the present, prefer placing it among the corallines, under the third order of the first class of Lamouroux, which are "Polypida plant-like, tubular, simple or branched, never articulated; of a horny or membranous substance, but sometimes slightly covered with a calcareous layer, neither cellular nor porous. Polypida situated at the extremity of the stems."

But as our Fifeshire fossil assuredly does not belong to any of the genera of Lamouroux, we must class it as a new one, and may give it the generic appellation of *Arbusculites*, from its shrub-like appearance; and, for a trivial name, *argentea*, from its singularly metallic and silvery aspect.

It occurs, as has before been remarked, in the mountain limestone of the coal formation at Kirkcaldy, in Fife, and is repeatedly crossed by sections of encrinital stems and arms, which abound in that locality. Indeed, I do not recollect ever to have seen entrochinal fragments, &c. in greater abundance than in the grey carboniferous limestone of Innerteil, near Kirkcaldy. I have said *fragments* of crinoideæ; for stems of any length, or shewing side-arms, are but rarely there to be met with. However, various shells of the genera Producta and Spirifera, characteristic of the formation, are very plentiful, with Caryophyllites; and occasionally a very delicate Retepora, which is beautifully crystalline, and white, and finely displayed upon the dark grey coloured limestone.

As far as can be ascertained by microscopical observation, the structure of this animal has been of the most simple description; and probably it was attached, for security, to some solid heavy substance, as a stone or shell; and also from the analogy of some species of Actinia and Hydra, we may conjecture it to have possessed a retractile power; and, under certain circumstances, it might occasionally have presented merely a very shortened nacrous stem, or fasciculus of branches.

Probably, too, this zoophyte may be so far interesting to the general naturalist, as offering another link of connexion in the vast chain of nature; and may be that which runs between the jointed Crinoideæ and the Porous Corals, or between them and the Annulosa.



References to the Drawing.

A, The Stem.

B, The Side-arm, in botanical language, arising decurrent from the stem.

C, An imperfect stem, bifurcated from the first division, under which the stem A passes, and is lost in the mass.

D, Section of an encrinite.

Table of the General State of the Weather in the Isle of Man, commencing Jan. 1. 1824, *and ending* 31*st December* 1830. By Colonel Stewart. (Communicated by Principal Baird.)

[Fahrenheit's Thermometer, situated on a northern exposure, always out, taken at 9 o'clock A. M. and at 11 o'clock P. M.—With reference to the "Wind," the prevailing Point for the day is taken: if any Rain, Snow, or Sleet during the day, not considered Fair.]

Years.	Medium of Thermometer.		Wind. Number of Days.				Weather. Number of Days.			Rain Fallen.	
	A. M.	P. M.	N.	S.	E.	W.	Rain.	Snow.	Fair.	Inch.	100th
1824.											
January,	40½°	40½°	15	4	1	11	8	2	21	2	47
February,	41½	40	2	8	12	7	9	...	20	1	52
March,	41	39½	9	...	7	15	14	3	14	3	43
April,	45½	41½	7	8	8	7	7	2	21	1	86
May,	52½	48	9	4	13	5	7	1	23	...	62
June,	57	55	2	7	18	3	12	...	18	2	42
July,	57	59	4	6	3	18	12	...	19	1	37
August,	59	56	1	8	10	12	17	...	14	2	45
September,	53	51	7	4	5	14	10	2	18	5	36
October,	48	46	12	5	12	2	20	...	11	6	58
November,	45½	45½	11	5	3	11	18	2	10	5	93
December,	42½	42½	14	2	...	15	16	3	12	6	74
Gen. Medium,	49¾	49¾	93	61	92	120	150	15	201	40	75
1825.											
January,	46	43	8	4	3	16	11	...	20	3	80
February,	39	40	11	7	4	6	11	2	15	2	67
March,	44½	41	5	8	12	6	7	1	23	2	11
April,	47½	45½	...	1	16	13	9	...	21	1	22
May,	53½	48½	5	3	17	6	10	...	21	2	7
June,	58	54½	9	8	5	8	12	...	18	2	20
July,	64½	59	6	6	11	8	2	...	29	...	57
August,	64	59	5	1	7	18	15	...	16	3	71
September,	63	59	1	8	12	9	16	...	14	3	38
October,	52	52½	7	7	2	15	20	1	10	6	52
November,	43½	43	12	3	3	12	19	1	10	7	67
December,	40	38	11	6	5	9	13	2	16	2	76
Gen. Medium,	51¾	48½	80	62	97	126	145	7	213	38	68
1826.											
January,	39	35½	7	11	8	5	7	1	23	...	79
February,	44½	43	4	13	1	10	17	2	9	4	75
March,	43	44½	6	5	14	6	6	3	22	1	79
April,	48	43	11	4	2	13	10	1	19	2	59
May,	53½	50	6	2	19	4	3	...	28	...	52
June,	60	55	11	9	7	3	3	...	27	...	4
July,	66½	63	6	11	4	10	10	...	21	1	30
August,	67½	62½	1	11	1	18	14	...	17	2	35
September,	58½	53	4	8	12	6	11	...	19	2	4
October,	55½	49½	8	5	4	14	17	...	14	3	55
November,	43½	42	10	...	11	9	11	4	15	3	5[illegible]
December,	44½	44	8	7	4	12	17	1	13	6	2[illegible]
Gen. Medium,	53¼	49¼	82	86	87	110	126	12	227	29	52

Years.	Medium of Thermometer.		Wind. Number of Days.				Weather. Number of Days.			Rain Fallen.	
	A. M.	P. M.	N.	S.	E.	W.	Rain.	Snow.	Fair.	Inch.	100th
1827.											
January, ...	39°	38½°	12	4	7	8	13	5	13	4	58
February, ...	39	37	9	4	14	1	5	1	22	2	12
March, ...	42	41	9	2	2	18	15	5	11	5	65
April, ...	47	45	5	5	13	7	9	2	19	2	41
May, ...	52	49	4	17	7	3	14	...	17	1	76
June, ...	57	53	8	12	6	4	11	...	19	2	79
July, ...	60	55	11	8	8	4	10	...	21	2	65
August, ...	58	55	11	6	12	2	11	...	20	4	58
September, ...	59	55	5	12	10	3	12	...	18	2	12
October, ...	54	52	8	11	12	...	15	...	16	3	50
November, ...	48	48	16	6	5	3	16	1	13	4	33
December, ...	46	45	7	6	6	12	21	1	9	6	92
Gen. Medium,	50	48	105	93	102	65	152	15	198	43	41
1828.											
January, ...	43	42	6	8	12	5	11	2	18	3	47
February, ...	41	42	7	12	6	4	13	2	14	2	56
March, ...	41	43	14	5	6	6	7	3	21	1	80
April, ...	47	44	6	11	8	5	15	1	14	4	38
May, ...	54	51	3	3	17	8	10	...	21	2	5
June, ...	58	55	2	10	8	10	10	...	20	1	63
July, ...	58	59	...	18	3	10	12	...	19	3	33
August, ...	61	58	4	8	11	8	9	...	22	2	9
September, ...	59	56	2	12	14	2	10	...	20	2	50
October, ...	53	51	6	10	7	8	14	...	17	2	31
November, ...	50	48	8	4	11	7	17	1	12	4	72
December, ...	49	48	8	10	4	9	19	...	12	5	6
Gen. Medium,	51	49	64	113	107	82	147	9	210	35	90
1829.											
January, ...	36	41	12	2	17	...	4	7	20	...	87
February, ...	43	43	6	2	12	8	9	1	18	1	58
March, ...	41	40	3	6	22	...	4	...	27	1	...
April, ...	46	42	6	8	11	5	15	2	13	3	10
May, ...	53	50	4	15	7	5	5	...	26	1	53
June, ...	60	54	8	8	6	8	11	...	19	1	77
July, ...	60	55	9	15	4	3	18	...	13	2	86
August, ...	57	54	18	3	3	7	17	...	14	5	80
September, ...	52	49	13	8	2	7	17	...	13	3	65
October, ...	49	47	12	6	7	6	15	...	16	6	10
November, ...	44	45	6	4	8	12	14	1	15	3	81
December, ...	40	39	5	14	11	1	6	2	23	1	82
Gen. Medium,	48	46	102	91	110	62	135	13	217	33	89

Year.	Medium of Thermometer.		Wind. Number of Days				Weather. Number of Days			Rain Fallen.	
	A. M.	P. M.	N.	S.	E.	W.	Rain.	Snow.	Fair.	Inch.	100th
1830.											
January, ...	39½°	37°	17	7	5	2	5	4	22	...	73
February, ...	38	37	5	11	5	7	8	7	13	2	40
March, ...	44½	47	5	7	6	13	12	...	19	1	95
April, ...	47	45	4	8	7	11	14	2	14	3	72
May, ...	52	49	2	11	13	5	19	...	12	3	94
June, ...	55	53	7	10	3	10	22	...	8	2	67
July, ...	56	57	5	15	4	7	17	...	14	3	61
August, ...	58	52	6	7	8	10	12	...	19	2	67
September, ...	54	52	3	10	3	14	17	...	13	6	83
October, ...	52	49	8	4	12	7	15	...	16	3	42
November, ...	49	45	5	7	11	7	14	...	16	3	74
December, ...	39	38	16	7	7	1	12	2	17	2	87
Gen. Medium,	48.8	46.9	83	104	84	94	167	15	183	38	55

Year		A. M.	P. M.
1824,	Highest state of Thermometer, ...	68°	64°
	Lowest, ...	32	32
1825,	Highest state of Thermometer, ...	72	68
	Lowest, ...	30	28
1826,	Highest state of Thermometer, ...	75	70
	Lowest, ...	30	24
1827,	Highest state of Thermometer, ...	70	64
	Lowest, ...	29	25
1828,	Highest state of Thermometer, ...	67	64
	Lowest, ...	33	32
1829,	Highest state of Thermometer, ...	65	62
	Lowest, ...	28	27
1830,	Highest state of Thermometer, ...	66	67
	Lowest, ...	25	26
Highest state of Thermometer during these seven years,		75	70
Lowest state of ditto during ditto, ...		25	24

GENERAL AVERAGE FOR THE SEVEN YEARS.

Years.	Medium of Thermometer.		Wind. Number of Days				Weather. Number of Days			Rain Fallen.	
	A. M.	P. M.	N.	S.	E.	W.	Rain.	Snow.	Fair.	Inch.	100th
1824, ...	49.9°	49.9°	93	61	92	120	150	15	201	40	75
1825, ...	51.9	48.6	80	62	97	126	145	7	213	38	68
1826, ...	53.3	49.3	82	86	87	110	126	12	227	29	52
1827, ...	50	48	105	93	102	65	152	15	198	43	41
1828, ...	51	49	64	113	107	82	147	9	210	35	90
1829, ...	48	46	102	91	110	62	135	13	217	33	89
1830, ...	48.8	46.9	83	104	84	94	167	15	183	38	55
Medium for Seven Years,	50.5	48.3	87	87.1	97	94.1	144.4	12.2	207	35	81.3

Table, shewing the Mean Temperature at Aberdeen for each Month of the last Eight years,—Mean Height of Barometer for 1830,*—and Rain fallen at Marischall College Observatory during the last Two Years.* By Mr George Innes, Astronomical Calculator, Aberdeen.

Months.	Mean Temperature at Aberdeen for each Month of the last Eight Years.							
	1823.	1824.	1825.	1826.	1827.	1828.	1829.	1830.
January, ...	36° 69	40° 14	37° 95	34° 29	35° 43	40° 00	34° 40	36° 49
February, ...	35 03	38 32	37 54	40 59	34 91	41 43	38 69	35 83
March, ...	40 41	36 69	39 88	40 04	39 06	42 87	41 60	44 47
April, ...	44 56	44 13	44 42	45 32	45 17	45 57	43 25	45 56
May, ...	51 33	48 73	48 50	63 27	50 98	52 07	51 85	51 39
June, ...	54 19	54 76	56 10	62 65	57 45	58 95	56 43	52 91
July, ...	56 24	60 51	60 50	51 48	62 05	60 55	58 56	60 22
August, ...	56 88	58 63	59 83	60 34	57 49	60 30	56 49	53 95
September, .	54 08	53 47	57 56	55 25	56 34	55 94	51 57	52 83
October, ...	48 27	45 47	50 45	49 56	51 88	48 74	46 45	48 40
November, ...	47 81	38 89	40 14	38 41	41 59	46 18	41 01	43 00
December, ...	39 94	36 13	39 37	40 23	41 89	43 15	39 14	36 70
Mean, ...	47 12	46 32	47 69	48 45	47 85	49 65	46 62	46 81

The Thermometer is fixed outside of a window which looks nearly east, being always in the shade before 8 a. m.: the bulb is 16½ feet above the level of the ground. The nearest building eastward is 70 feet distant; and there is no building to the northward for a considerable distance.

Months.	Mean Height of Barometer.	Rain fallen at Marischal College Observatory.	
	1830.	1829.	1830.
	Inches.	Inches.	Inches.
January, ...	30 147	3 48	1 51
February, ...	29 807	0 99	1 34
March, ...	29 900	3 12	0 73
April, ...	29 700	2 74	1 84
May, ...	29 935	0 66	1 62
June, ...	29 866	1 54	2 82
July, ...	29 894	1 92	5 36
August, ...	29 875	4 35	3 90
September, ...	29 681	2 35	3 33
October, ...	30 165	2 72	0 61
November, ...	29 735	2 34	3 62
December, ...	29 695	2 45	3 87
Mean, ...	29 783	28 66	30 60

The Rain-Gauge, with the results of which I am favoured, is fixed on the roof of the Tower of Marischal College, 74 feet above the level of the ground. The height of the basin of the barometer above the level of the sea, at *half flood*, is 50 feet. G. I.

On the Utility of fixing Lightning Conductors in Ships. By W. S. Harris, Esq. Member of the Plymouth Institution.

1. A THUNDER-STORM is the result of a great natural action subsisting between an extensive stratum of cloud, and a corresponding portion of the earth's surface, together with the intervening atmosphere; and is the result of some powerful agency, the nature of which is as yet undiscovered.

2. The active principle of a thunder-storm, however, may be considered as an extremely subtle species of matter universally pervading nature, and distributed in bodies, in quantities proportionate to their capacities for it, so that when accumulated in and about certain bodies, and abstracted at the same time from other bodies, a tendency to regain the previous state of proportionate distribution is marked by a certain train of phenomena; thus, a concentrated action is frequently set up between the overcharged and undercharged bodies, which produces all the effects of a violent and terrific expansive force, for the original state of proportionate distribution is often restored by a rapid explosion, at which instant the most compact bodies are broken; whilst, at the same time, there is such an evolution of heat, that substances directly in the line of action are sometimes inflamed, fused, and ignited.

3. This easy and elementary view of electrical action may not be altogether useless; for to investigate any branch of physical science with success, it is always advantageous to arrange our ideas in some determinate order, by means of which the details assume a clear and connected form; for although it must be admitted, that every theory is merely a way of picturing to ourselves the course of nature, it may be always sufficient, and admissible, so long as it is consistent with the observed phenomena, and not contradicted by any known fact.

4. In the progress of electrical inquiries, it has been found, that some substances oppose but comparatively little resistance to the passage of the electrical agency, whilst, on the contrary, other substances seem to arrest its course altogether; a fact which induced electricians to consider bodies as possessed of these peculiar properties, and to classify them in relation to this *con-*

ducting or *non-conducting* power. Substances which oppose but comparatively little resistance to an electrical explosion, have therefore been termed *conductors*, whilst those which offer resistance to its progress, have been termed *non-conductors*, or, occasionally, from the same cause, *insulators.* In the conducting class, we find, all the metals, concentrated acids, water, well burnt charcoal, wood, diluted acids, and saline fluids, most earths and stones, flame, smoke and steam. If any of these substances resting on the ground, be put into contact with an electrical machine, whilst a current of sparks is passing from it, the sparks will immediately cease; in consequence of the electric matter being transmitted by them to the earth:—an easy and striking experiment. Non-conductors of electricity, or insulators, are all vitreous and resinous substances;—dry, permanently elastic fluids, such as air; baked wood, silk, pure carbon, and most precious stones, oils, dry vegetable substances, as also, dry marble, chalk, and lime, wool, hair, feathers, dry paper, parchment, and leather. If, whilst a current of sparks is passing from the electrical machine, any of these bodies be put into contact with it, and rest as in the former instance on the earth, little or no difference will be perceived, the sparks wil continue.

5. Although for general purposes, the various bodies in nature may be considered as belonging to one or the other of these classes, a gradation of effect is observable from one class to the other; so that the conducting or insulating power of some substances, compared with that of others, may be considered as imperfect: hence has arisen a third class, which consists of the remote extremes of the other two, and which may be considered in the power of arresting or transmitting certain electrical actions as appertaining to either. Thus wood, hemp, stone, and the like, may become insulators to a state of low electrical action, and conductors to a high one.

6. The manner in which accumulations of atmospheric electricity proceed, may be referred to the following principle: When two substances of the conducting class are directly opposed to each other, and are separated by a substance of the non-conducting or *insulating* class, leaving the one free and the other insulated, the proportionate state of electrical distribution may

become deranged to the greatest possible extent. Now, in nature, the conditions of such an experiment are found in the relative situations of the sea and clouds, and intervening air; so that when, from any cause, an evolution of natural electricity takes place, and heavy masses of vapour are present in the atmosphere, we have immediately an insulated conductor (a cloud), directly opposed to a conductor in a free state (the sea or land), and an intervening non-conducting or insulating medium, the air; hence results a charged battery of enormous power: the attraction of the opposite electrical states, therefore, may become at length so powerful, that the electric matter breaks down the intervening resisting air, with a terrific and dense explosion—an effect perfectly analogous to the explosion which frequently occurs at the time of conveying a high charge to an electrical battery, and which is attended by a peculiar fracture of the interposed glass *.

7. The year 1752, which marks an important era in electrical science, from the celebrated discovery of the principle just mentioned, under the form of the Leyden jar, gave to the natural philosopher an easy method of concentrating large quantities of electricity produced by artificial means, so as to discharge it upon or through bodies with an instantaneous and violent explosion. From the time, therefore, that the cause of lightning became *identified* with that of ordinary electricity, and that the gigantic attempt of Dr Franklin and other philosophers, of actually drawing down the matter of lightning from the clouds, was fully accomplished, the effects produced on bodies by these minor electrical discharges with their mode of action, acquired a new interest; and many important experimental researches into the laws and operation of the great natural action, were successfully carried on by means of the ordinary artificial one.

8. Amongst the many important results arrived at by such inquiries, are the following:—

First, In every case of electrical explosion, there are universally two points of action, one *from* which the electric matter

* An explanation of some of the phenomena of thunder-storms on this principle will be found in my printed letter to Sir T. B. Martin, K.C.B. Comptroller of his Majesty's Navy.

may be supposed to proceed, and another *towards* which it may be considered as determined.

Secondly, At the instant before which an explosion takes place, the stream of electricity moving to restore the equilibrium of natural disposition, seems by a wonderful influence to feel its way, and mark out as it were, in advance, the course it is about to follow; which course is *invariably determined through the line or lines of least resistance* between the points of action.

A few illustrations from experience of damage by lightning, may serve to render these facts evident.

(*a*.) The brig Belisle, of Liverpool, in November 1811, was lying afloat, abreast of Mr Evan's yard, at Bideford, when a vivid flash of lightning shivered her fore-top-mast and fore-mast, tore up the forecastle deck, and struck a hole through her starboard-side, starting several butts in the bends, whence it passed into the sea.

(*b*.) The French ship Coquin, at anchor in the bay of Naples, was struck by lightning in the afternoon of Christmas day 1820. The electric matter passed, in this case, close to the main hatchway, upon a spare anchor, and from thence through her bottom a little below the water's edge on the larboard-side. The boats of the squadron in Naples Bay, assisted to slip her cables and run her ashore in the mole.

(*c*.) The United States ship Amphion, Blone master, of and thirteen days from New York, bound to Rio, was struck by lightning on the 21st of September 1822. The lightning descended by her mizen-mast, destroyed the compasses and cabin furniture, splintered and tore to pieces the ceiling, bulk-heads, and rudder trunks, shivered two hold beams, and passed out through the quarter into the sea, tearing off part of the sheathing in its course *.

(*d*.) His Majesty's frigate Palma, commanded by Captain Worth, was struck by lightning in 1814, in the harbour of Carthagena, Spanish America. The fore-top-mast was knocked over the side, the lightning guttered or scooped its way, two inches deep, and one inch and a-half wide, under the hoops of

* Extracted from the log of the brig Mirabiles, and given to Mr Lockyer, Comptroller of the Customs at Plymouth.

the mast, without injuring them, as far as the main deck. Here it fell upon the wet cable which had been just shortened in, and was lying against the after-beam ; it knocked out a piece of the beam, and passed by the wet cable out of the hawse hole, the lead of which bore evident marks of the explosion. It was perfectly calm at the time, and the lightning, besides striking the ship, *struck also down upon the sea* several times, and within a short distance of the ship.

(*e.*) The packet ship New York, in her passage from New York to Liverpool, was struck by lightning twice in the same day, April 19. 1827. The first explosion shattered the main-royal-mast and mast-head, penetrated the deck, and demolished the bulk-heads and fittings in the store-rooms below,—then dividing, one part fell upon a lead tube, which it traversed as far as the side of the ship, and passed out into the sea, starting the ends of three four-inch planks; another portion passed into one of the cabins, and shivered to atoms the plate of a large mirror, without hurting the frame; after this, it fell upon a piano-forte, which it touched with no very delicate hand, and left it dismounted and out of tune; from thence it passed through the whole length of the cabin floor, which was damp at the time, and out of the stern windows into the sea.

(*f.*) The operation of the second explosion was very different from this;—it fell upon a spike at the mast-head, and from thence passed down a small metallic chain, which it disjointed and partly fused, into the sea, without doing any damage to the vessel *.

(*g.*) His Majesty's ship Bellerophon, under the command of Captain Rotheram, was struck by lightning at sea in August 1807. A violent explosion took place in several parts of the ship at the same time; the main-top-gallant-mast totally disappeared, except the heel; the rigging of it was cut and burned in pieces; main-top-mast shivered in splinters from head to heel; main-mast damaged, and thirteen feet of the fish on the fore-part disappeared. The explosion also fell on the mizen-top-mast, which it likewise shivered; it descended down the mizen-mast in a spiral direction, broke the hoops, and damaged the

* This conducting chain had been set up immediately after the first explosion happened.

mast; it passed through the coat of the mizen-mast on the larboard-side, and through one of the poop beams on the other side; it passed into the ward-room, into one of the officer's cabins, started the butt end of a plank in the ship's side, and split a rider underneath on the lower deck. The electric matter on the larboard-hand went close into the ship's side, in a perpendicular direction, and through the main and lower decks; it cut the clamp of the main-deck beams, entered the steward's room, where it ripped up the tin lining, and then passed through the orlop-deck into the butter room. The vessel was not damaged in the final escape of the electric matter into the sea.

(*h.*) In January 1830, H. M. S. Etna, under the command of Captain Lushington, was struck by lightning, in the Corfu Channel, in the Adriatic, at the time of coming to anchor. In this instance three tremendous explosions came down a metallic chain, attached to the main-mast, and passed into the sea, without damage to the mast; the ship at the time seemed covered with sparks.

9. It may be observed by an attentive examination of these few cases, 1st, That the points *to* and *from* which the electric matter is eventually determined, are out of the ship; and, according with what has been stated in 1, 2, 6, are in the clouds and sea, so that the vessel is merely, as it were, an intervening object; the only action, therefore, which can be conceived to belong exclusively to the ship, is that which may be required to neutralize the opposite electrical state, induced upon the whole mass of the vessel, as being a point of the great surface opposed to the electrified clouds, and which is very small and of little consequence, compared with the capacity of the surrounding sea. Cases *a*, *b*, *c*, *d*, *e*, *f*, more particularly shew this. 2dly, That the points through which the explosion is determined, are invariably in the line or lines of least resistance between the points of action—that is, through the best conductors. Cases *d*, *f*, *h*, clearly illustrate this; and the same may be traced in all the others.

10. It may be also observed in these, as in every other case of damage from lightning, more especially on ship-board, that the greatest mischief occurs where good conductors cease; the

electric matter being then enabled to produce all the disastrous effects of an expansive force, as if, whilst in the conducting body, it was in a diffused and low state, and again condensed and brought into a narrow focus, at the moment of leaving it. The damage, therefore, may be in this case considered to happen, not where the best conductors *are*, but where they *are* not; so that the mariner has to contend with a constantly exploding principle, which continues its devastations in all those points where it ceases to be transmitted; thus determining for itself a passage between the points of action through such line or lines as may, upon the whole, oppose to it the least resistance.

11. Such effects being constantly observed not only on ship-board, but on shore, it became a grand question of scientific consideration, how far it would be prudent to provide for the electric matter an efficient conducting line, between the highest points of a ship and the sea, so as to offer the least resistance to the progress of such a powerful agency, and transmit it in a state of low tension between the points of action; on the same principle that persons, dreading an inundation, would provide a channel to carry off the water as easily as possible; an idea, as is well known, first suggested by the celebrated Dr Franklin, and since carried into practice with considerable success; the conducting line having the name of Lightning-Conductor or Lightning-Rod.

12. Although the application of lightning-conductors to buildings on shore is always judicious, and their advantages very apparent, yet on ship-board, where the effects of lightning are most to be dreaded, the introduction of this means of defence has been slow and imperfect. The conductor hitherto employed at sea consists of long flexible chains or links of metal, about the size of a goose-quill, sometimes of iron: those employed in H. M. Navy, however, are of copper; they are usually packed in a box, and are intended to be set up from the mast-head to the sea when occasions require, so that, as observed by Mr Singer, in his excellent work on electricity, partly from inattention, and partly from prejudice, they frequently remain in the ship's hold during long and hazardous voyages quite unemployed; a remark, the truth of which is but too frequently

verified in the damage so constantly happening at sea during lightning storms *.

13. The necessity of providing the best possible security against the effects of lightning on ship-board has been long admitted; but continuous and fixed metallic rods have been deemed inapplicable to ships, in consequence of their masts, the only parts to which they can be attached, being exposed to chances of injury, to motion in a variety of ways, to frequent elongation and contraction, and to the necessity which frequently arises for removing the higher masts altogether, and placing them on deck. It was probably from these causes that the small flexible chains or links above mentioned were employed. Such conductors, however, will probably, on examination, be found less applicable than fixed continuous lines of metal, and, in every point of view, inefficient substitutes for them. Their great want of continuity, as well as their want of mass and surface, is very unfavourable to the transmission of severe explosions, the electric matter becoming sensible at the points of junction, as is evident by the sparks which appear upon them at the time of the discharge, so that in some instances they have been actually disunited: they are likewise objectionable as being liable to every species of injury incident to a ship's rigging, and much difficulty is experienced in keeping them in their position, and unbroken, more especially during gales of wind, and at night, when the ship is under sail, and when it is perhaps required, as is already observed, to remove some portion of the higher masts. It has therefore been long considered desirable to apply, if possible, a permanent conductor, which should be always in its place, and ready for action; and various attempts have been made and suggestions advanced, at different times, to apply fixed lightning-conductors in ships, as the subject from time to time has demanded further consideration.

14. To protect a ship effectually from damage by lightning, it is essential that the conductor be as continuous and as direct as possible, from the highest points to the sea—that it be per-

* Case (*f.*), p. 158. A minute account will be found in the Liverpool Commercial Chronicle, in May 1827. The conducting chain, at the time of the first explosion, was stowed away in its box below, although set up in time to prevent the effects of the second explosion.

manently fixed in the masts, throughout their whole extent, so as to admit of the motion of one portion of the mast upon another; and, in case of the removal of any part of the mast, together with the conductor attached to it, either from accident or design, the remaining portion should still be perfect, and equivalent to transmit an electrical discharge into the sea.

15. To fulfil these conditions, pieces of sheet-copper, from one-eighth to one-sixteenth of an inch thick, and about two feet long, and varying from six inches to one inch and a half in breadth, may be inserted into the masts in two laminæ, one over the other; the butts or joints of the one being covered by the central portions of the other. The laminæ should be rivetted together at the butts, so as to form a long elastic continuous line; the whole conductor is inserted under the edges of a neat groove, ploughed longitudinally in the aft side of the different masts, and secured in its position by wrought copper nails, so as to present a fair surface. The metallic line thus constructed, will then pass downward from the copper spindle at the mast-head, along the aft sides of the royal-mast and top-gallant-mast, being connected in its course with the copper about the sheeve-holes. A copper lining in the aft side of the cap, through which the top-mast slides, now takes up the connection, and continues it over the cap, to the aft side of the top-mast, and so on as before, to the step of the mast. Here it meets a thick wide copper lining, turned round the step, under the heel of the mast, and resting on a similar layer of copper, fixed to the keelson. This last is connected with some of the keelson-bolts, and with three perpendicular bolts of copper, of two inches diameter, which are driven into the main keel upon three transverse or horizontal bolts, brought into immediate contact with the copper expanded over the bottom. The laminæ of copper are turned over the respective mast-heads, and secured about an inch or more down on the opposite side; the cap which corresponds is prepared in a somewhat similar way, the copper being continued from the lining in the aft part of the round hole, over the cap, into the fore part of the square one, where it is turned down and secured as before, so that when the cap is in its place, the contact is complete. In this way, we have, under all circumstances, a continuous metallic line, from the highest points to the sea,

which will transmit the electric matter directly through the keel *, being the line of least resistance.

16. From what has been already observed, it will be apparent, that, in whatever position we suppose the sliding-masts to be placed, whether in a state of elongation or contraction, still the line of conduction will remain perfect, for that part of the conductor which necessarily remains below the cap and top, when the sliding masts are struck, is no longer in the line of action, consequently its influence need not be considered.

18. The following table exhibits the mean proportion of a conductor thus constructed on one mast of a fifty gun frigate, as compared with the copper links usually furnished to the British navy, together with the necessary equivalent in copper or iron bolt, in order to obtain a conductor of the same mass.

The resulting quantities in the last line at the bottom of the table, represent, with the exception of the proposed conductors, the masses, surfaces, and diameters of cylindrical metallic rods, supposed to extend the whole length of the mast. Thus in column 2, we have the diameter and surface of a copper rod, containing 2423 cubic inches of metal, being an equal quantity of matter to that in the proposed conductors, and from which it is calculated. The sums, therefore, are not the result of the addition of the successive masts. The same may be observed in column 3; taking the equivalent in iron. In the third and fourth columns, we have the mass and surface of a copper rod of half an inch in diameter, generally allowed to be adequate to any shock of lightning yet experienced: and, lastly, in column 4, we have the mass and surface in the conductors now furnished to the British navy; which we find, as compared with the mass in the proposed arrangement, is only as 94.4 : 2423.

* Since the mizen-mast does not step on the keelson, it will be necessary to have a metallic communication at the step of the mast with the perpendicular stancheon immediately under it, and so on to the keelson as before, or otherwise carry the conductor out at the sides of the vessel.

TABLE.

Succession of Masts.	Proposed conductors.		Equivalent in a copper rod.		Equivalent in an iron rod; taking conducting powers only as 4 to 1.			Mass and surface in a copper rod of ½ inch diameter.		Mass and surface in present conductors.	
	Mass.	Surface.	Diameter.	Surface.	Mass.	Surface.	Diameter.	Mass.	Surface.	Mass.	Surface.
	cub. in.	sq. in.	in.	sq. in.	cub. in.	sq. in.	in.	cub. in.	sq. in.	cub. in.	sq. in.
Royal Pole. Conductor 18 ft. 3 in. long, 2 in. wide; two laminæ, each $\frac{1}{16}$th of an inch thick.	54	1752	·56	385	216	770	1·12	42	343	10·5	171
Top-gallant-mast. Conductor 17 ft. long, 2½ in. wide; two laminæ, one ⅛th of an inch thick, the other $\frac{1}{16}$th.	95	2040	·77	493	380	986	1·54	40	320	10	160
Topmast. Conductor 50 ft. long; copper 4 in. wide; two laminæ, each ⅛th of an inch thick.	600	9600	1·1	2070	2400	4140	2·2	117	942	19·2	471
Lower-mast. Conductor 93 ft. long; copper 6 in. wide; two laminæ, each ⅛th of an inch thick.	1674	26784	1·38	4837	6696	9675	2·76	219	1753	54·7	876
	2423	40176	1·2	8064	9692	16128	2·4	418	3358	94·4	1678

19. The manner in which conductors here proposed are applied to the mast, gives the form of the whole,—that of a flattened, conical surface,—wide at the base, and diminishing gradually to a point.

It has been stated by one of the most eminent of the French philosophers, that this form is the best possible for a lightning rod.

20. The objections made to fixing lightning conductors in ships, are for the most part such as have been urged against lightning rods generally; and are principally as follows:—It is said, that by fixing continuous lines of metal in the masts, we *invite* an electrical discharge from the atmosphere, and that by means of an attractive power, which, it is assumed, the metal is possessed of, the explosion is drawn exclusively upon the vessel; that, inasmuch as we can never come to know the absolute quantity of electric matter which may be discharged from a thunder-cloud, it is possible that the transmitting power of any conductors we can apply, may be inadequate to the end in view, so that they may possibly become fused; and hence it is inferred, that much damage may be the consequence:—That in fixing lightning conductors in the masts, we can only have *surface;* whereas, the properties of a conductor depend on the *mass*, and not on the *surface* of the metal: hence the metallic surface is calculated to do considerable mischief, by conducting the lightning into the body of the vessel. Such are the principal objections to this application, and which, it is hoped, are fairly stated. They are highly deserving serious consideration, but they will be found, on examination, to be inconsistent with experience, and with the known laws of electrical action. We shall, however, by a candid inquiry, give these objections all the attention which their connection with so important a question demands.

21. The notion that a lightning rod is a positive evil, will be found to have arisen out of the fact already mentioned (8), namely, that lightning invariably passes through the line or lines of least resistance between the points of action; hence it seizes on all those substances which oppose the least resistance to its passage; metallic vanes, vane spindles, iron bars, knives, and pointed metallic bodies, generally, will therefore be very commonly found in the course of the explosion; and from this circumstance, they have been considered to exert an attractive force upon the matter of lightning, so as to draw it aside from its destined course, to the destruction of the substances in connection with them.

22. It will be found, however, that the action of pointed metallic bodies is purely passive; that they only afford by the aptness of their parts an easy transmission to the electric matter; so that they can no more be said to attract the matter of lightning, than a dike can be said to attract the water which necessarily flows through it at the time of heavy rain; and, as in the one case, the water is drawn down by a force not peculiarly appertaining to the dike, so, in the other case, the electric matter is determined to a given point, in a somewhat similar way, by a force not appertaining to the metal. Moreover, it may still further be reasoned by analogy, that, as the quantity of water transmitted will depend on the capacity of the dike, and the final protection it gives in conveying the fluid on the length to which it is continued; so, on the other hand, the protection afforded by a lightning rod will also depend on *its* capacity, and the distance to which it runs. If, in both cases, the length be extended until the force in action be satisfied, the protection received will be as the capacity for transmitting the current: if both be perfect, the protection will be complete; if the dike be not present, the water must be supposed to run loose and undirected; or, if its continuity be frequently interrupted or narrowed to a small compass, the damage must then be supposed to happen in the intermediate spaces. Such is, in fact, the way in which all bodies of the conducting class already mentioned (4) operate in conveying electrical discharges; and it must never be forgotten as an important feature in this discussion, that, whenever we erect an artificial elevation on the earth's surface in the ordinary way, we do, in fact, set up a conductor of electricity, upon which the electricity of the atmosphere will fall, and no human power can prevent it. Hence, if metallic bodies be present, those will be first assailed; if not, then the electric matter will fall on the bodies next in conducting power, and so on.

23. A curious illustration of this principle will be found in an extract from the Memoirs of the Count de Forbin, which is given in the forty-eighth volume of the Philosophical Transactions. "In the night," says the author of these memoirs, "it became extremely dark, and it thundered and lightened dreadfully. As we were threatened with the ship being torn to

pieces, I ordered the sails to be taken in. We saw upon different parts of the ship above thirty St Elmo's fires; amongst the rest there was one upon the top of the vane of the main-mast more than a foot and a half in height; I ordered one of the sailors to take it down. When this man was on the top he heard this fire; its noise resembled that of fired wet gunpowder. I ordered him to lower the vane and come down, but scarcely had he taken the vane from its place, *when the fire fixed itself upon the top of the main-mast*, from which it was impossible to remove it."

24. Since, then, the conducting power of bodies differs only in degree, and that the action by which they are assailed is the result of a great natural agent quite independent of them, we may expect to find all bodies liable to be assailed by lightning, though the effects may be most apparent when the conducting power is imperfect. Thus we find cases on record, of ships struck by lightning in which no metallic spindles were present, or other iron work about the mast-head;* moreover, it is by no means an uncommon circumstance to find trees and rocks rent asunder by lightning, and to hear of men and quadrupeds, even in a plain and open country, destroyed at the time of a thunder-storm, when the electric matter strikes the earth's surface.

(*To be continued.*)

On the Proximate Causes of certain Winds and Storms. By Professor E. Mitchell, University of North Carolina †.

The four following propositions may be regarded as statements of general facts, which have been sufficiently established by numerous observations in various parts of the world.

I. That part of the great oceans which lies between the 30th parallel of latitude on both sides of the equator, is constantly swept by a wind varying but a few points from the east.

II. Between the latitudes of 30° and 60°, in both the northern and southern hemisphere, westerly winds predominate

* See Philosophical Transactions, vols. xlix. and lxix. damage done to the sheer hulk at Plymouth, and on board the Atlas, East Indiaman.

† From Silliman's American Journal of Science and Arts, vol. xix.

over those from the east quarter, in a ratio probably somewhat greater than that of 3 to 2.

III. There is in all latitudes (a few tracts of limited extent where local causes have a decided effect excepted) a predominance of winds blowing from the poles towards the equator, over those moving in the opposite direction;—but this predominance is not so well marked and decided as that of the westerly over the easterly winds, between the latitudes of 30° and 60°.

IV. During the warm weather within the temperate, and at all seasons within the limits of the torrid zone, the fall of rain is often accompanied by lightning, thunder and violent winds, constituting what is commonly called a thunder-storm. Thunder-storms generally commence between mid-day and sunset, and move from west to east.

Other general facts might be added, but these are such as require to be viewed in connexion with the laws which regulate the movements of the aërial currents over the surface of the globe, and the origin of those currents are to be investigated. The truth of the statements contained in these propositions will first be shewn, after which an inquiry will be instituted respecting the causes by which the facts asserted in them may be supposed to be produced.

I. *That part of the great oceans which lies between the 30th parallel of latitude on both sides of the equator, is constantly swept by a wind varying but a few points from the east.*

The direction, velocity, permanence and other characters of the trade-winds, are too well known to require any particular remark. They are affected by a number of local causes. Near the equator they blow from the east point, but at a distance from it their course becomes inclined to the parallels of latitude, so as to be at length from the north-east and south-east, near their northern and southern limits. Their force and direction are also influenced by the proximity of islands and continents. Along the western side of Africa their direction is reversed; to the distance seaward of about three hundred miles, they blow towards the land, and nearly at right angles to the coast.

Halley notices a tract between the 4th and 10th degrees of north latitude, and the longitudes of 17° and 23°, "wherein it were improper to say there is any trade-wind, or yet a variable one, for it seems condemned to perpetual calms, attended with terrible thunder, lightning and rains, so frequent that our navigators, from them, call this part of the sea the Rains; the little winds they have are only some sudden uncertain gusts of very short continuance and less extent, so that sometimes each hour there is a different gale, which dies away into a calm before another succeeds; and in a fleet of ships in sight of one another, each will have the wind from a different point of the compass. With these weak breezes, ships are obliged to make the best of their way to the southward, through the aforesaid 6°, wherein it is reported some have been detained whole months for want of wind *."

Instead, however, of being confined to these longitudes, it would appear that either a total cessation or a remission of the force of the trades is observed between the latitudes specified throughout nearly the whole extent of both the Atlantic and Pacific: the effect being, however, more distinctly marked and perceptible in the former than in the latter ocean. A few quotations are given; it would be easy to add largely to their number.

"The southern trade-wind being cooler in like latitudes than the northern, usually passes the equinoctial into the northern hemisphere. The northern trade-wind falls considerably short of it, as earlier attaining the maximum of heat. Between them is the region of variable winds, light airs and calms, attended with frequent squalls and rain; an uncertain wavy zone lying between the times of their influence. It is the tract in which the highest temperature prevails throughout the year; not at the equinoxes only, the sun being then vertical, but also when he is distant at the tropics. In this warm and damp region of the middle Atlantic, situated in the vicinity of the equator †," &c.

"After a most rapid run of several days, we reached the '*swamp*," as the captain calls the calm and rainy latitudes, between the north-east and south-east trade-winds, a few degrees north of the equator—clouds and tempests seem gathered before

* Philosophical Transactions for 1686.

† Colebrooke's Meteorological Observations in a Voyage across the Atlantic, in Brande's Journal.

us. The "*swamp*" was much less formidable than we expected; we have had but little rain, only a short calm, and no thunder-storm, though the "artillery of the heavens" has been heard almost constantly at a distance. We crossed the Line yesterday morning, in longitude 24 degrees west *."

"About the period of the last date, we *entered the north-east trade winds*, and have been rushing on before their freshness at the rate of more than two hundred miles a day †."

"We resumed our course to the north (from latitude 2° N.) having fine weather and *a gentle breeze*, at east and east-south-east, till we got into the latitude of 7° 45′ north, and the longitude of 205° east, where we had *one calm day*. This was succeeded by a north-east by east and east-north-east wind. *At first it blew faint, but freshened as we advanced to the north* ‡."

Between the longitudes of 160° and 172° east, and in the latitudes specified, Commodore Byron had "*only faint breezes with smooth water*"—"we most ardently wished for a fresh gale, especially as the heat was still intolerable, the glass for a long time having never been lower than 81°, but often up to 84° ‖."

II. *Between the latitudes of* 30° *and* 60°, *in both the northern and southern hemisphere, westerly winds predominate over those from the east quarter, in a ratio probably somewhat greater than that of* 3 *to* 2.

(*a.*) Daniell states that, "in Great Britain, on an average of ten years, westerly winds exceed the easterly, in the proportion of 225 to 140 §."

(*b.*) The Meteorology of Cotte, in 3 vols. 4to, is a vast repository of facts in this science, of very unequal value. It appears from the tables contained in the last volume, that, generally, in the central and western parts of Europe, and in some parts of Asia, westerly winds prevail. This is the case in most parts of France, at Amsterdam, Berne, Berlin, Stockholm, St Petersburg, Aleppo, Bassora and Bagdad—Copenhagen is the

* Stewart's Journal in the Atlantic.

† Stewart's Journal in the Pacific, W. Long. 134°, Lat. 8½°.

‡ Cook's Last Voyage.

‖ Hawkesworth's Voyages, vol. i. p. 138.

§ Meteorological Essays, p. 114.

only European capital of which an account is given, where this is not the case. " The wind is inclined to west at Paris, (Young's Philosophy, vol. ii. p. 255.) See also Annals of Philosophy for July 1822, where it is stated that, at St Petersburg, from 1772 to 1792, to which period, with the addition of 1818 and 1819, the observations are confined, " *the west wind prevailed the most, and the south wind the least.*" The numbers expressing the ratios of the winds from the different quarters are not given, except for the year 1818, when the westerly winds were to the easterly as 178 to 111.

(*c.*) Westerly winds predominate over those from the east quarter within the limits of the United States. See the different meteorological tables furnished for publication in the former numbers of this Journal, by Messrs Beck, Field, Hildreth, Hitchcock, and especially the abstract of the meteorological registers kept at the several military posts of the United States, drawn up by Dr Lovell, and inserted in the 12th volume, page 153, where the westerly are to the easterly winds, for a term of four years, in the ratio of 12.59 to 9.63.

(*d.*) That west and south-west winds prevail in that part of the Atlantic Ocean which lies beyond the northern limit of the trade winds, is so well known that quotations in proof of it can hardly be necessary, (See Bowditch's Navigation.) " Have we not reason to believe that the *almost constantly prevailing west and south-west winds* which cause the voyage from New York or Philadelphia to England, to be called down, and from England back, up, as well as that which blows at the top of the Peak, are the upper equatorial current which has here descended, to skim the surface of the ocean * ?"

(*e.*) Commodore Krüsenstern, as quoted by Wallenstein in the Boston Journal of Philosophy, vol. iii. p. 282, states that " in the Pacific Ocean, from latitude 30° to the pole, the variable winds are generally from the north-east and south-west."

(*f.*) The following statements are from Encyclopædias and other compilations. During a term of sixteen years, the westerly were to the easterly winds in Russia as 172 to 106. East winds prevail in Germany. West winds are most frequent on

* Von Buch, on the Climate of the Canary Islands, in Jameson's Journal.

the N. E. coast of Asia. In Nova Scotia, north-west, and at Hudson's Bay *west*, winds blow for three-fourths of the year.

(*g.*) Our information respecting the winds of the southern hemisphere is less ample. Cape Horn (lat. 56°), has long been infamous amongst navigators for the violent westerly gales that prevail there, rendering it sometimes almost impossible to sail round from the Atlantic into the Pacific. (See Stewart's Journal.) "The prevailing winds of this region are heavy gales from the west, the direct course to be steered in passing the Cape, and ships are often detained by them three times the period we have been (twenty-one days), and meet with weather far more dangerous and severe; so much so, that many vessels, after striving in vain for weeks here to make a passage into the Pacific, have been obliged at last to bear away for the Cape of Good Hope, and make their voyage across the Indian Ocean."

(*h.*) In an account of the Falkland Islands by William Clayton, Esq. inserted in the Philosophical Transactions for 1776, it is stated that "The prevailing winds are from the south to the west for two-thirds of the year, and in general, boisterous and stormy."

(*i.*) "In the southern Atlantic, at the extremity of South Africa, the winds are periodical, consonant during summer to the south-east trade, which constantly blows on each side of the promontory; but conforming in winter with the *western wind that prevail at all times in the Southern Ocean.* In other words, the fluctuating boundary of the western current of air touches upon the extremity of the African continent in winter, and recedes from it in summer *."

III. *There is in all latitudes (a few tracts of limited extent where local causes have a decided effect excepted) a predominance of winds blowing from the poles towards the equator over those moving in the opposite direction; but this predominance is not as well marked and decided as that of the westerly over the easterly winds between the latitudes of* 30° *and* 60°.

(*a.*) Daniell states, that in Great Britain, upon an average of ten years, "the northerly winds are to the southerly as 192 to

* Colebrooke on the climate of South Africa in Brande's Journal, vol. xiv. p. 250.

173," and that "in the central parts of Europe the northern winds are much more regular; and there, especially in summer, the Etesian breeze constantly prevails."

(*b.*) Cotte's tables do not indicate the predominance and permanence of northerly winds in that quarter of the world which is asserted by Daniell. Of the capital cities heretofore mentioned, Aleppo, Bassora, Berne, Petersburg, and Stockholm, appear to have an excess of northerly winds; Amsterdam, Berlin, and Copenhagen, of southerly; whilst at Bagdad and Paris the excess on either side is inconsiderable. These tables were, however, published in 1788, after the work to which they are attached had been in press for some years. The information they afford respecting Germany is very meagre, whilst the subject of meteorology appears to have excited an extraordinary degree of interest in that country between the years 1781 and 1792, so that Daniell may have had access to documents by which his assertions were fully warranted.

(*c.*) It is stated in the Encyclopædia Perthensis, that at St Petersburg the northerly winds were found, during a term of sixteen years, to be to the southerly as 133 to 119 (the westerly were to the easterly as 133 to 92), and that *in the Mediterranean the north wind blows for nearly three-fourths of the year.* Other citations might be made from the same quarter; but their bearing upon the question before us is doubtful, as merely the point from which the wind blows during the greatest number of days is specified without any notices by which the relative proportion of northerly and southerly winds may be determined.

(*d.*) In that part of the Atlantic Ocean lying beyond the northern limit of the trade-winds between the United States and Europe, it appears that southerly winds predominate *. Their cause is probably analogous to that of the Gulf Stream.

(*e.*) Of the meteorological registers that have been published in this Journal, some, as those of Messrs Field, Olmsted, and Wallenstein, show an excess of northerly winds; others, as those of Drs Beck, Lovell, and probably Hildreth, an excess of southerly winds; but in general the excess of the southerly over

* See the quotation from Von Buch.

the northerly where it obtains is less than that of the westerly over the easterly. Thus, in the abstract of Dr Lovell, the westerly winds are to the easterly as 12.59 to 9.63; the southerly to the northerly as 12.59 to 11.60. On the whole, there can be little room for doubt, that the winds from the north predominate over those from the south within the limits of the United States. This method of estimating the amount of wind in any direction by the number of days it blows from that point, is exceedingly defective, and may (as where the wind is commonly violent in one direction and gentle in another, and the force with which it blows is altogether neglected) lead to the most erroneous results. This happens to be the case in this country. Our south-west winds prevail chiefly in the summer season; they are mild breezes, subsiding often into a calm, which continues during a considerable part of the day. Our north-west winds, on the other hand, sweep over the continent day and night, with a constancy and velocity which renders it necessary to make a considerable allowance when we are estimating the amount of movement in the atmosphere by the time during which it occurs.

(*f.*) "The north winds (los nortes), which are north-west winds, blow in the Gulf of Mexico from the autumnal to the spring equinox. These north wind hurricanes generally remain for three or four days, and sometimes for ten or twelve *."

(*g.*) If there be a predominance of either northerly or southerly winds in the North Pacific Ocean, it is not such as to have attracted the particular attention of navigators. "On the *north-west coast* of America, from the Straits of Behring to 30° of northern latitude, the winds are variable. Captain Cook found in March, in the 44th degree of latitude, a fresh and constant north-west, which continued until the beginning of summer, with the exception of a south-east, which lasted, however, only six hours; and La Perouse, Portlock, and Dixon did not experience the south winds in the summer. According to Vancouver and the Spanish navigators, the north and north-west are the most prevailing. (Krüsenstern.) All this, however, applies almost exclusively to the summer months. During the winter,

* Humboldt's New Spain, book i. chap. 3. See also Poinsett's Mexico, in regard to the violence of these winds.

Messrs Lewis and Clarke, at the mouth of the Columbia River, had long continued gales from the south-west, and deluges of rain.

(*h.*) The violent winds that prevail at Cape Horn are not accurately from the west point, but from some other between the west and south. "I cannot, in any case, concur in recommending the running into the latitude of 61° or 62° before any endeavour is made to stand to the westward. We found neither the current nor the storms, which the running so far to the southward is supposed necessary to avoid; *and indeed, as the winds almost constantly blow from that quarter, it is scarcely possible to pursue the advice* *."

(*i.*) Cook's voyages into the high latitudes of the southern hemisphere being made when the sun was in the neighbourhood of the southern tropic, cannot be referred to as affording information of unquestionable accuracy respecting the winds that prevail in those seas.

IV. *Thunder-storms generally commence between mid-day and sunset, and move from west to east.* †

(*a.*) Such persons as have paid any attention to the changes of the weather in this country, must be well aware that our thunder-storms begin in the after part of the day, and move from west to east. They sometimes occur at night, but seldom after midnight. The direction of their motion does not appear to depend upon the predominance of the westerly over the easterly winds, being much more constant and uniform than that predominance; but to be *a result and a proof of a commotion excited in the atmosphere at the time of their formation, and of a rush of the air from the west towards the east, in consequence of some new impulse just then communicated.*

(*b.*) The author of the article "Thunder," in the Encyclopædia Perthensis, states, that along the eastern side of the island of Great Britain, it is more frequent in the month of July than at any other time of the year, which he attributes to the circumstance that a wind from the west then succeeds to the east wind

* Cook, in Hawkesworth's Voyages, vol. ii. See also Clayton's account of the Falkland Islands quoted above.

† In an easterly direction, not in the plane of the prime vertical.

that had prevailed from April till the end of June. "For the most part, however, the west wind prevails, and what little motion the clouds have is towards the east, whence the common remark in this country, that *thunder clouds move against the wind.* But this is by no means universally true, for if the west wind happen to be excited by any temporary cause before its natural period when it should take place, the east wind will often get the better of it, and *the clouds, even although thunder is produced, will move westward.*" That the most common and natural course of thunder-storms in that country is from west to east, is therefore very apparent.

(*c.*) Of the remarkable thunder-storms experienced in England, from the year of the foundation of the Royal Society down to 1800, and noticed in the Philosophical Transactions, there are about thirty-five, the time of whose commencement, or in general of their occurrence, is either distinctly stated or clearly indicated in the abridgement by Hutton, Shaw, and Pearson. Of these, the beginning of twenty-seven was between noon and midnight; generally it was about three or four o'clock in the afternoon. One lasted all day, and the remaining seven were in the morning. The *direction* of twelve is given. Two came from the south, three from the eastern, and seven from the western quarter.

If the wind blow for a great length of time, or frequently at intervals, from a particular point in any country, the fact will be likely to be noticed by the traveller who may happen to be upon the spot, and stated in his journal; whilst the direction of the gust during a storm, in which he may be involved, will be altogether neglected. For this reason it is more difficult to furnish *proof* that thunder-storms follow a particular course, than to establish the prevalence of certain winds in given latitudes. It is but reasonable that this should be borne in mind, if the evidence adduced in establishing our proposition should not be regarded as in every respect satisfactory. The bare silence of an Englishman or inhabitant of the United States, in regard to the quarter in which a thunder-cloud rises, furnishes ground for believing that it is the same as in his own country. Many sources of information and argument, which would willingly have been consulted, are not at hand.

(*d.*) Dr Young, giving the substance of a paper by Longford, in the Philosophical Transactions for 1698, on the hurricanes of the West Indies, remarks from it, that "All hurricanes begin between north and west. Their course is generally opposite to that of the trade winds. Tornados come from several points." *

(*e.*) "This is the wet season, but the rains by no means descend from morning till night, as in some other tropical countries, but commence generally every afternoon about four or five o'clock, with a thunderstorm.—Formerly these diurnal rains came on with such regularity, that it was usual, in forming parties of pleasure, to arrange whether they should take place before or after the storm.—In the excursion made from Villa Rica to Labara, it will be seen that violent thunderstorms were experienced almost daily; and I could not help noticing the way these storms commenced. The sky was perfectly clear until about two or three o'clock, when some light white clouds were seen approximating the sun with great rapidity. Sometimes they all passed, but if one lingered as if within its influence, thunder was heard, and in a few minutes no remains of a blue sky were visible. The storm commenced directly." Commencing in the direction of the sun at two or three o'clock, these storms of course begin in the west †.

(*f.*) "Thunder and lightning are ten times more frequent than in Spain, *especially if a storm comes from the north-west.* During my residence in Paraguay, several persons fell victims to lightning, and in the city of Buenos Ayres, in a storm on the 21st of January 1793, it fell in thirty-seven different places, and killed nineteen people. These storms of wind, thunder, rain, and lightning, cannot be attributed to the influence of mountains, as there are none within one hundred leagues ‡.

(*g.*) "Les vents de Nord N. de Nord-Ouest sont ceux que amènent les gros temps et les ouragans dans les mois d'Avril, Mai, Juin, Jouillet et Aout; mais ces ouragans, quelquefois furieux ne sont pas fréquens." The months specified, constitute

* Philosophy, vol. ii. p. 458. It is hardly necessary to observe that a hurricane is a violent thunderstorm.

† Caldcleugh's Observations in Brazil, in Brande's Journal, vol. xiv.

‡ Azara's Travels in South America, quoted in the Anti-Jacobin, vol. xxxiv. p. 456.

the rainy season. " La grèle ne tomb guère que dans la saison pluvieuse: le tonnere ne se fait aussi entendre que dans cette saison mais rarement ; on ne voit les éclairs de chaleur que par un temps couvert et jamais par un temps chaud et serein comme il arrive ordinairement en Europe." De la Cailles' Meteorological Observations at the Cape of Good Hope, as quoted by Cotte. Ouragan and hurricane are the same word, and stand for very nearly the same idea in the two languages.

(*h.*) " Le même Académicien (Guettard) a observé que le vent le plus dominant (at Warsaw), est le *Sud-Ouest qui y cause souvent des ouragans*, ensuite le Sud et enfin le Nord et le Nord-Ouest *."

(*i.*) Russel states, that at Aleppo, in the month of September, " Lightnings are very frequent in the night time, and *if they are seen in the western hemisphere, they portend rain, often accompanied with thunder*." There is little room for doubt, that all the thunderstorms that occur there come from the same quarter, but I have met with no passage that is quite decisive †.

(*k*) Compare Joshua x, 11—1 Sam. vii, 10, and xii, 18—1 Kings, xviii, 41 to 46—and Luke xii, 54, for the time and course of the thunderstorms in Palestine ; especially the latter text : " When ye see a cloud rise out of the west, straitway ye say there cometh a shower ; and so it is." In the other cases there was a particular interposition of the Deity, but in such a way doubtless as to produce effects according to the ordinary course of nature. Hence, after there had been " a sound of abundance of rain" or thunder, Elijah went to the top of Carmel, and sent his servant to look *westward* over the Great Sea: there arose at first " a little cloud out of the sea like a man's hand," but the heaven was soon " black with clouds and wind, and there was a great rain." It is stated particularly that these occurrences were some time after mid-day. Verse 29.

(*l*) " In the beginning of April, and sometimes earlier, particularly in the south-eastern quarter of Bengal, there are frequent storms of thunder, lightning, wind, and rain, from the north-west quarter, which happen more frequently towards the

* Cotte, vol. i. p. 365.

† See Calmet's Dictionary, vol. iii. p. 497.

close of the day than at any other time. These squalls moderate the heat, and continue until the setting in of the periodical rains." It is stated farther, that, " during the dry season, the heat of the middle districts is lessened by occasional thunderstorms, named *north-westers* *."

(*m.*) " Thunderstorms are very frequent at Batavia, especially towards the conclusion of the Monsoons, when they occur almost every evening †."

(*n.*) It is stated by Veicht in the Philosophical Transactions for 1764, that in " Bencoolen road, on the S. W. side of the island of Sumatra, as well as in the strait of Malacca, you have periodical winds, which blow for six months of the year from the same quarter of the horizon, and the other six months from the opposite quarter ; and it is observable that these thunder showers and squalls of wind usually come contrary to these stated winds, which are calmed during the thunder, but return to their constant quarter as soon as the thunder and rain are past." Also by Shorte in the Transactions for 1780, that at the mouth of the Senegal River, during the rainy or sickly season, which begins about the middle of July, and ends about the middle of October, " the wind is generally between the points of east and south, *the quarter from which the tornados come.*"

It appears also from Major Denham's account of the rainy season at Kouka, in Bornou, that in that country the thunderstorms are generally from the north-east and south-east. These are exceptions to our general doctrines, produced by local causes, such as are perpetually occurring in every part of the science of meteorology.

(To be continued.)

Further Notices in regard to the Fossil Bones found in Wellington Country, New South Wales. By Major Mitchell, Surveyor-General of New South Wales.

The account of the remarkable Bone District in New South Wales, in the last number of this Journal, delivered to us by Dr Lang of Sydney, we have inadvertently published as the composi-

* Hamilton's Account of Hindostan. † Stockdale's Java, p. 36.

tion of that gentleman, whereas it was only brought by him to Europe from the author, Major Mitchell, in New South Wales. The collection has been carefully inspected by Baron Cuvier and Mr Pentland. The latter gentleman, also eminently skilled in fossils, has sent to us the following note regarding these interesting remains. "I have to apologize for not having written to you sooner on the subject of the Fossil Bones from New Holland, which you have been kind enough to send to Paris for Baron Cuvier's inspection and my own. I had, in fact, drawn up a note on the subject, which I was on the point of sending, when your nephew Torrie (at present in Auvergne), informed me, that you had received several new specimens, and had despatched a part of them to Paris by Mr Audubon. I shall therefore defer, until I have examined this second collection, to send you any detailed views on the subject, which shall accompany the several specimens on their return with our friend Copland, who will take charge of them on his way from Auvergne. The result of our examination of the bones brought over by Dr Christie, has proved that they belong to eight species of animals referrible to the following genera: Dasyurus or Thylacins; Hypsiprymnus or Kangaroo rat, one species; Phascolomys, one species; Kangaroo, two, if not three species; Halmaturus, two species; and Elephant, one species. Of these eight species, four appear to belong to animals unknown to zoologists of the present day, viz. two species of Halmaturus; one species of Hypsiprymnus and the Elephant. The three Kangaroos are difficult to distinguish from the living species of this genus, owing probably to the imperfect nature of the specimens, whilst the eighth animal, the Dasyurus, is doubtful, from not possessing the head of the living species, to which the fossil resembles by its size (the D. ursinus.)—*Paris, 22d April* 1831."

In a subsequent note from Mr Pentland, 6th June 1831, he says,—"I have not seen among the fossils you sent to Paris anything resembling the Dugong; nor do I believe there is aught in these specimens to warrant Dr Grant's opinion (if founded on inspection of similar specimens). The collection of bones sent to you by Colonel Lindsay, from Wellington Country, contain remains of a species of Kangaroo exceeding by one-third the largest known species of that genus."

The Geological Age of Reptiles. By Gideon Mantell, Esq. F. R. S. &c. &c.

Among the numerous interesting facts which the researches of modern geologists have brought to light, there is none more extraordinary and imposing than the discovery that there was a period when *the earth was peopled by oviparous quadrupeds of a most appalling magnitude*, and that reptiles were the *Lords of the Creation*, before the existence of the human race! These creatures of the ancient world, many of which, from their extraordinary size and form, rival the fabled monsters of antiquity, existed in immense numbers, and in latitudes now too cold for the habitation of modern oviparous quadrupeds. Their remains occur in strata far more ancient than those which contain the reliquiæ of viviparous animals, and are found in marine as well as in fresh water deposites. Some of them, from their organization, have been evidently fitted to live in the sea only, while others were terrestrial, and many were inhabitants of the lakes and rivers. The animal and vegetable remains with which the fossil bones are associated, belong also to a very different order of things from that in which the modern oviparous quadrupeds are placed; and we are compelled to conclude that the condition of the earth, at the period when it was peopled by reptiles, must have been wholly different from its present state, and that it probably was then unfit for the habitation of animals of a more perfect organization. It is, moreover, interesting to remark, that some of these ancient and lost races are, as it were, the types of the existing orders and genera; and that in the pigmy *Monitor* and *Iguana* of modern times, we perceive striking resemblances to the colossal *Megalosaurus* and *Iguanodon* of the ancient world.

It is also worthy of observation, that, as in the present epoch the herbivorous quadrupeds are those of the greatest magnitude, so at the period when reptiles were the principal inhabitants of our planet, the herbivorous were those of the most gigantic proportions. The geological period when the existence of reptiles commenced must, according to the present state of our knowledge, be placed immediately after the formation of the coal measures; the remains of Monitors having been found in the bituminous slate of Thuringia; and those of a crocodile in the gypseous red sandstone of England: but it is not till we arrive at the *Lias* that the remains of reptiles occur in any considerable quantity. At that period the earth must have teemed with oviparous quadrupeds; and the *enaliosauri*, or those which inhabited the sea, appear to have been equally numerous with those of the land and rivers. The prodigious quantity of the remains of these animals which has, within a comparatively short period, been found in England alone, is truly astonishing; and if to these we add the immense numbers that have been discovered in France, Germany, &c., and reflect that for one individual found in a fossil state, thousands must have been devoured or decomposed; and that even of those that are fossilized, the number that comes under the notice of the naturalist must be trifling compared with the quantities unobserved or destroyed by the labourers, we shall have a faint idea of the myriads of "*creeping things*" which inhabited the ancient world.

In England, the lias contains more especially the remains of two extinct marine genera, the *Ichthyosaurus* (fish-like lizard), and *Plesiosaurus* (animal resembling a lizard), whose osteology is most extraordinary, combining characters observable in the cetacea, fishes, and saurians, but yet decidedly belonging to the order of Reptiles. The Ichthyosaurus, of which several species have been discovered, had a large head, enormous eyes, a short neck, and very long tail; it was furnished with four broad and flat paddles, and was evidently destined to live in the sea; it sometimes attained a length of from twenty to thirty feet. The Plesiosaurus, which in some respects resembled the Ichthyosaurus, being also furnished with four paddles, but is yet more nearly allied to the Saurians, differs, however, from it, and from all other animals, by the extreme length of the neck, and the great number of cervical vertebræ. The neck of reptiles is in general composed of from three to eight cervical vertebræ; and even birds (which have the maximum) have but from nine to twenty-three; while one species of Plesiosaurus (P. dolichodeirus) has thirty vertebræ. This extraordinary creature, unlike the Ichthyosaurus, appears to have been but little calculated to make rapid progress through the sea; and was still less fitted for progressive motion on the land; it is therefore probable that it swam on or near the surface of the water, carrying its neck like a swan, and darting on its prey, its food consisting of fishes, cuttle-fish, &c. Contemporary with the animals above mentioned, were several herbivorous reptiles, whose remains have been found in the lias at Boll, in Wurtemburg, also a species of crocodile; and at Guildorf, a salamander of enormous size. The remains of tortoises and turtles occur also, but very sparingly, although, from the foot-marks observable in the red sandstone at Corn Cockle Muir, in Dumfriesshire, this family of reptiles must have existed at a still earlier period. In this bed also, several species of the Pterodactylus, or flying reptile, first make their appearance; animals which, with the wings of a bat, and the structure of a reptile, had jaws furnished with sharp teeth, and claws with long hooked nails.

The entire series of deposites composing the oolite formation, of which the lias is the inferior, or lower member, abounds with the remains of the animals of this order, and these are associated with vast quantities of marine shells, principally belonging to the ancient multilocular genera, namely Ammonites, Nautilites, Belemnites, &c. the whole formation having manifestly been deposited by an ocean. The only apparent exceptions to this conclusion are the Stonesfield beds, composed of thin strata of calcareous sandy slate, which occur in the lower division of the oolite, and contain not only marine plants, shells, and bones of reptiles, but also the outer cases or *elytra* of winged insects, and jaws of animals allied to the opossum *(Didelphis)*. The occurrence of terrestrial mammalia in beds of this ancient epoch has not been satisfactorily explained, and it would be foreign to our present purpose to enter into any discussion upon the subject; the intermixture of terrestrial remains with those of marine origin, may of course have been effected by the agency of a river or current. In the Stonesfield slate we first meet with the remains of that gigantic reptile the Megalosaurus (Great Lizard). This monster, which, from the form of its teeth and skeleton, is evidently allied to the Monitor, must have been nearly forty feet in length, and seven or eight in height, and was probably a terrestrial animal. The crocodiles of this ancient epoch appear to have been exceedingly numerous, and belonged to species distinct from those of the present period, a great proportion being referrible to the *Gavials;* that division which has long slender snouts.

In the fresh-water formations that intervene between the oolite and the chalk, namely, the Purbeck, Hastings' sands and clays, and the Tilgate grit, the remains of several of the genera of the reptiles we have before noticed, occur; but those which are strictly marine, such as the Ichthyosaurus, are either altogether wanting, or of very rare occurrence. At the period of the formation of these deposites, turtles, both marine and fresh-water, existed in great numbers, having for contemporaries the Megalosaurus, one or more species of Plesiosaurus, several species of Gavials and Crocodiles, and probably Pterodactyles. At this epoch we have also an enormous herbivorous reptile, essentially differing from any of the oviparous quadrupeds now existing, and surpassing in magnitude even the Megalosaurus. This is the *Iguanodon* (so named from its teeth resembling those of the recent Iguana). A thigh-bone of this creature, twenty-three inches in circumference, has been discovered in the grit of Tilgate forest; the teeth are as large as the incisors of the rhinoceros, and the vertebræ, claw-bones, and other parts of the skeleton, bear the same relative proportions. This creature, like some of the recent species of Iguanas, had *warts or horns* on its snout, and an appendage of this kind has been found of the size and shape of the lesser horn of the rhinoceros! From the prevailing character of the form of the bones, it is probable that this animal was shorter in proportion to its bulk than the recent lizards, to which it is more nearly allied; and marvellous as it may appear, we cannot but infer that some individuals attained a height of nine or ten feet, and were from sixty to a hundred feet in length! A circumstance even more extraordinary than its magnitude, is that of its having performed mastication like the herbivorous mammalia, its teeth, which are of a very peculiar form, being in general worn down by the operation of grinding its food.

The vegetables associated with the remains of the Iguanodon are all of a tropical character, and consist of various kinds of ferns, and of large plants allied to the dragon-blood plant. The strata in which they are found, unlike those of the oolite which preceded, and of the chalk which followed these deposites, have clearly been formed in the bed of a river; while those of Stonesfield, which contain a somewhat similar association of fossils, have as evidently been deposited by a current which ran into the ocean of the oolite, and carried with it remains of terrestrial and fresh-water animals, the shells in the last named strata being, as before remarked; marine, and precisely similar to those of the deposites above and below them; while the shells of the Hastings' beds are decidedly fluviatile or lacustral. Besides the remains of the reptiles above mentioned, teeth and bones of other gigantic oviparous quadrupeds have been found, but the characters and relations of the latter have not yet been accurately determined.

In the extensive marine formation, the chalk, which covers the Hastings' beds, reptiles are less numerous, and the Megalosaurus, Iguanodon, and other herbivorous genera, disappear altogether; no traces of their existence occurring after the last named strata were deposited. At the epoch of the chalk formation, the Ichthyosaurus, and one or more species of crocodile, and marine turtles, existed; and another extraordinary reptile, the Mososaurus (lizard of the Meuse), or fossil animal of Maestricht, first appears. This creature, so celebrated in Oryctology since the first discovery of its head and jaws by Hoffman, attained the size of the crocodile, and held an intermediate place between the Monitors and Iguanas. It appears to have been aquatic, swimming in the manner of a crocodile, and moving its vast tail from side to side as an oar. With the chalk, the "age of reptiles" may be said to terminate—the greater part of the genera above noticed appears to have become extinct during the changes which took place on the surface of the earth at that period; the crocodiles, turtles, &c. alone survived, a new order of things commenced, and in the tertiary formations which succeeded, we perceive an approach to the modern condition of the earth.

Description of several New or Rare Plants which have lately flowered in the neighbourhood of Edinburgh, and chiefly in the Royal Botanic Garden. By Dr Graham, Professor of Botany in the University of Edinburgh.

10*th June* 1831.

Allium paradoxicum.

A. *paradoxicum;* folio (unico ?) plano, argute carinato, lanceolato-lineari; umbella bulbifera (uni ?) pauciflora; pedunculis pendulis, spatham membranaceam superantibus; scapo triquetro folium æquante; petalo oblongo, staminibus uniformibus, duplo longiori.

Allium paradoxicum, *Fischer,* MS.

Description.—*Bulb* small, ovate, covered with a thin brown exfoliating tunic, forming offsets at its base. *Scape* (6 inches high) erect, naked, triquetrous. *Leaf* (solitary ?) lanceolato-linear, flat in front, sharply keeled behind, equal in length to the scape, the base of which it embraces, and is itself encased by a thin membranous bluntish compressed *sheath. Umbel* bearing several ovate, somewhat pointed, white shining bulbs, few- (in our specimens only one-) flowered. *Spathe* thin, membranous, colourless, transparent, splitting as the bulbs enlarge into two or three acuminated segments. *Peduncles* longer than the spathe, nodding or pendulous, nearly round, swollen at the apex. *Corolla* white, having to a cursory glance the appearance of a *Leucojum;* petals elliptical, in two rows, the inner narrowest. *Stamens* half the length of the corolla; filaments of rather unequal length, otherwise uniform, white, subulate, erect, attached by their backs at the base to the petals; anthers small, yellow. *Pistil* equal in length to the stamens; stigma trifid, segments short, diverging; style straight, slightly tapering, 3-sided, colourless; germen trilobular, pale green, seated on a dark green receptacle, which between the lobes has on each side a minute yellow gland; ovules placed in two rows, between which, in each cell, is the suture. The whole plant has the strong garlic smell.

To the often-experienced liberality, and obliging friendly attention of Dr Fischer of St Petersburgh, I was indebted for this, and a variety of other interesting bulbs in September last. It is a native of the banks of the Volga, and flowered with us in the open border in the beginning of May. If its pretty, pendulous, and pure white blossoms, shall fail to attract the attention of the florist, perhaps its neat small bulbs may suggest to another set of cultivators the propriety of inquiring whether it has other qualities which may make it desirable as a pickle. It will probably produce bulbs in abundance.

Arbutus mucronata.

A. *mucronata;* caule lignoso diffuso; foliis ovatis, cuspidatis, denticulato-serrulatis, rigidis, utrinque nitidis; pedunculis axillaribus, folia subæquantibus, bracteatis, 1-floris, cernuis.

Arbutus mucronata, *Forst.*

Description.—*Shrub* much branched from the root; branches diffused, round, bark brown and cracked; younger branches reddish, sparingly pubescent, the hairs flexuose, subulate, arising from red glands, at first white, and soon becoming yellow. *Leaves* (8 lines long, 4 broad) on short petioles, scattered, turned towards the light, flat, naked and shining, dark green in front, pale behind, coriaceous, with a distinct middle rib, but obscure veins, excepting on the old leaves, which are faintly reticulated, ovate or lanceolato-ovate, denticulato-serrulate, and terminated by a long rigid bristle. *Flowers* axillary, solitary, white, nodding. *Peduncles* pale green, nearly as long as the leaves, sprinkled with reddish pubescence, and having several scattered adpressed ovate bracteæ on their lower half. *Calyx* naked, white, 5-parted; segments acute. *Corolla* white, campanulate, similar in general appearance to the flowers of *Convallaria majalis*, but smaller, somewhat transparent between the calyx segments, 5-toothed, segments reflected. *Stamens* 10; filaments cordato-ovate, white, and under a moderately powerful lens appearing rough; anthers attached by their backs to the apex of the filaments, erect, brown, attenuated at their apices, where they open by two pores; bristles very short, erect. *Pistil* included; stigma of five erect points; style nearly half the length of the whole pistil, erect, cylindrical, pale yellowish-green; germen equal to the length of the stamens, round, smooth, green.

We received a seedling plant of this species from Mr Mackay in 1828. It flowered in May last for the first time. It is stated by Forster to be a native of the Straits of Magellan. Mr Mackay's seeds were received from Mr Anderson, the indefatigable and most successful collector sent to the southern parts of the continent of America by the establishment at Clapton; but I do not know the exact station where it was found by him.

Chorizema Baxteri.

C. *Baxteri;* foliis omnibus integerrimis, lanceolatis, superne farinosis, subtus adpresse villosis; floribus terminalibus, verticillato capitatis.

Mirbelia Baxteri, *Hort.*

Description.—*Stems* very numerous, much branched, diffused, slender, twiggy, round, covered with adpressed hairs. *Leaves* (1½–2 inches long, ½–¾ of an inch broad) lanceolate or elliptico-lanceolate, somewhat farinose in front, covered with adpressed hairs behind. *Stipules* subulate. *Peduncles* (½ an inch to 1 inch long) terminal. *Flowers* capitate, or in two somewhat irregular verticels at the top of the peduncle, or sometimes drawn out into a secund raceme. *Bracteæ* small, subulate, single at the base of each pedicel, and two opposite, at the apex of each; the terminal pedicel has also generally a pair of opposite bracteæ about the middle, from which point the peduncle is often prolonged, when the inflorescence becomes verticillate, or a raceme. *Calyx,* like the peduncle and pedicels, covered with adpressed hairs, bilabiate, upper lip 2-toothed, lower 3-parted, teeth of the upper lip ovate, acute, reflected at their apices, and slightly diverging, segments of the lower ovate, acute, spreading at right angles to the tube and to each other. *Corolla* orange-yellow, becoming paler as it expands; vexillum reniform, emarginate, spreading wide, reflected, slightly concave behind, in front near the throat having a radiated deep red-orange horse-shoe shaped mark, claw clavato-linear, shorter than the calyx; alæ shorter than the vexillum, obliquely obovate, claws linear; carina ventricose, of two petals, distinct at the claws and apices, but slightly connected in the middle, each petal similar to the alæ, but rather smaller, and with rather a longer linear claw. *Stamens* 10, free, included; anthers incumbent, purple. *Pistil* equal in length to the stamens; stigma minute, terminal; style subulate, hooked, smooth; germen substipitate, oblong, densely covered with silky hairs.

We raised this plant at the Botanic Garden from New Holland seed, communicated as a species of *Mirbelia* by the Rev. David Landsborough of Stevenston. It is known in gardens under the name of *M. Baxteri,* and is a very desirable addition to our greenhouse plants, flowering very freely.

Calceolaria angustiflora.

C. *angustiflora;* caule suffrutescente, ramis diffusis, purpureo-maculatis, foliisque oppositis vel ternatis pedunculatis ovato-oblongis duplicato serratis pubescentibus subviscidis; pedunculis axillaribus, umbellatis, in paniculo terminali collectis; corollæ labio superiore nullo.

Calceolaria angustiflora. *Ruiz et Pavon,* Flor. Peruv. vol. i. p. 17, t. 28, fig. *a.*

Calceolaria verticillata. *Hooker,* Bot. Miscell. vol. ii. p. 233.

Description.—*Stem* scarcely woody, very brittle, slender, much branched and diffused; branches green, sprinkled with oblong purple spots, pubescent, hairs spreading. *Leaves* (nearly 2 inches long, 1 inch broad) petioled, opposite or ternate, ovato-oblong, doubly and unequally incise-serrated, pubescent on both sides, as well as the branches subviscid, shining and bright green above, paler below, veined and wrinkled, veins prominent below, channelled above. *Peduncles* axillary, umbellate, forming an oblong panicle at the extremity of the branches, the lower peduncles generally supporting four pedicels, two of which are occasionally branched, the upper peduncles with fewer pedicels, or simple; two *bracteæ* of the structure and form of small leaves, but more entire, at the origin of the pedicels; these, as well as the peduncles, pedicels, and calyx, pubescent and subviscid; the whole scarcely exceeding the length of the leaf in the axil of which they are placed. *Calyx* 4-parted, segments unequal, lanceolate, the upper the broadest. *Corolla* yellow, upper lip awanting, there being only a ring, scarcely prominent, passing round the germen; lower lip extremely slender, and somewhat pubescent at its origin, turgid below, and closed by a prolongation of its upper edge, turned up, and brought into contact with the stigma. *Stamens* two, having their origin from the lower half of the ring which forms the faux of the corolla; filaments erect; anthers large, yellow, and, as in the other species, bilocular, with the lobes greatly diverging, and bursting along the front. *Pistil* rather longer than the stamens; stigma minute; style somewhat hooked downwards; germen pubescent, and, as in other species, conical and furrowed on two sides.

The only plant of this species which we possess, we received from the Botanic Garden, Glasgow, where it was raised from seed communicated from Lima by Mr Cruckshanks. Its habit and appearance is very distinct from any of the species already in cultivation, and corresponds with a native specimen which I possess through the kindness of Mr Cruckshanks and with the figure of Ruiz and Pavon, sufficiently to induce me to consider it as illustrative of the form to which these authors gave the specific name which I have adopted; but continued experience of the tendency to the formation of mules in this genus, makes me more and more sceptical about the title which very appreciable varieties of form in it have to be considered specifically distinct. I noticed in a former Number of the Philosophical Journal some mules which had been produced by Mr Morrison, gardener at Granton, near Edinburgh, by artificially impregnating some of the most distinguishable forms of *Calceolaria;* since then, the same cultivator and others have produced all sorts of mixtures, and shaded species into each other through an infinity of gradations.

In the figure of Ruiz and Pavon, the lip of the corolla is much less turgid than it is either in the cultivated or in my native specimen; but the figures are not always correct in these details, and the station given by Ruiz and Pavon for *C. angustiflora,* Canta, is the same as that in which my native specimen was picked by Mr Cruckshank.

It is with great regret that I am forced to differ from my excellent and accurate friend Dr Hooker, regarding the species to which this plant belongs, being fully aware of the risk of error which attends every dissent from such authority; but the differences between this plant and *C. ver-*

ticillata seem to me more than enough to distinguish them. *C. verticillata* is described as glabrous, erect, and all the leaves are said to be in verticels of three: the whole of our plant is densely pubescent, and subglutinous, diffused, and too slender to support itself, many of the leaves are opposite. *C. verticillata* is also described by Ruiz and Pavon as a much larger plant than it is probable ours will ever become.

Dendrobium speciosum.

D. *speciosum;* caulibus erectis, apice 2–3-phyllis; foliis ovali oblongis, racemo terminali multifloro brevioribus; petalis angustato-oblongis, labello infra diversuram carina unica, lobo intermedio ecarinato dilatato.—*Brown.*

Dendrobium speciosum, *Sm.* Exot. Bot. 1. p. 17. t. 10.—*Br.* Prodr. 332. —Hort. Kew. 5. 212.—*Sprengel,* Sp. Plant. 3. 738.—*Lindley,* Orchideæ, part i. p. 87.—Bot. Mag. 3074.

Description.—*Stems* (5 inches long, 1¼ inch broad) bulbous, ovate, attenuated upwards, crowded, sulcated, green, with a somewhat silvery skin, marked by three or four circular lines, its structure fibrous, and very rigid, crowned at the apex with two or three leaves. *Leaves* (4–5 inches long, 1½ broad) stem clasping, contracted immediately above their origin, erect, rigid, fleshy, oblong, concave, channelled, slightly waved, reflected at the apex. *Raceme* (6 inches long) terminal, many-flowered, having a few large clasping *bracteæ* at the base, and a small ovato-subulate marcescent one at the origin of each pedicel. *Pedicels* (1¼ inch long) slightly angled, ascending and secund, at least when the raceme is deflected. *Flowers* perfumed slightly, nodding, looking towards the apex of the raceme. *Perianth,* three outer segments unequal, the two lower the shortest, dilated and united at the base, falcate, the upper narrower, erect, linear-tapering: the two inner of nearly equal length, but narrower, and linear: *Lip* unguiculate, without spur, claw covered by the united bases of the outer segments of the perianth, 3-lobed; the central lobe the largest, broader than it is long, emarginate, streaked transversely with purple, especially on the inside, and at the edges both within and without. An elevated ridge extends from the base of the middle lobe along the inside of the claw to its insertion, becoming smaller downwards. *Column* conical, flat, spotted with purple in front, concave in front near the apex. *Anther* terminal, resting upon a flat plate, stretched over the hollow in the front of the column. *Anther-case* articulated behind, white, blunt, slightly bordered, unilocular, with a ridge in the centre of the loculament. *Pollen-masses* two, each bipartite, waxy, hard, sessile. *Germen* small, green, 3-sided, immersed in the top of the pedicel, which divides into three portions, passing to the base of the outer segments of the perianth, adhering to the germen, the three angles of whch project between the partitions.

This species was introduced into Britain by Sir Joseph Banks in 1801. It is native of the tropical districts of New Holland, and likewise of the neighbourhood of Port Jackson. It is generally kept in the stove, and probably it is on this account that it rarely flowers. It has flowered very freely in the greenhouse of the Botanic Garden this year. So many splendid species of this genus have been made known to us of late, that the specific name given to our plant, is not the one which would be selected now, were it described for the first time; but still it is exceedingly ornamental. The perianth is figured and described by Dr Hooker as closed, from its having to a certain degree faded in its transmission from Liverpool to Glasgow.

I have observed an unusual circumstance in drying this plant, which, if not accidental, may be worth noticing, as possibly implying a peculiarity of structure in the cuticle. Many plants which are thick and fleshy, and very retentive of life, it is well known may often be rapidly dried by previously dipping them into boiling water, or even retaining them there for some hours. I placed the specimen which I have described in boiling water, in a vessel too shallow to admit it entirely. Nearly one-half of each of the leaves was left above the water, and subsequently dried rapidly under pressure: the portions which were submerged are still (after six weeks) succulent and plump, though they have been alternately placed under pressure and exposed to the air.

Fritillaria leucantha.

F. *leucantha;* caule pauciflora, floribus axillaribus terminalibusque, solitariis; foliis infimis oppositis ovatis apice attenuatis obtusiusculis multinerviis, superioribus verticillatis lineari-lanceolatis carinatis apice cirrosis.

Imperialis leucantha, *Fischer,* MS.

Description.—*Bulb* round, lobed, covered with a thick brown coat, which separates in large fragments, splitting along the furrows between the lobes. *Stem* simple. *Leaves* (3–4 inches long) bright green or slightly glaucous, somewhat crowded about the middle of the stem; the lowest pair opposite, many-nerved, without conspicuous middle rib, ovate, tapering towards the apex, which is rather blunt; the others more or less perfectly verticellated, linear-lanceolate, few- (3–5-) nerved, nearly flat in front, and with a strong middle rib behind, extended at the apex into a simple cirrhus. *Flowers* solitary, axillary or terminal, nodding, white, at the base on the outside green, and within at the base sprinkled with small purplish spots. *Petals* tipped with a green, callous, slightly pubescent apex, the three outer ovate, the three inner obovate and broader, all gibbous on the outside near the base, and there on the inside each having a round green conspicuous pit containing honey. *Stamens* included; filaments straight, white, collected together in the centre of the flower; anthers yellow, linear, erect, very loosely attached. *Pistil* longer than the stamens; stigma trifid, slightly diverging; style straight, somewhat clavate, 3-sided, twice the length of the anthers, colourless; germen green, with six prominent, brownish, somewhat waved longitudinal angles. *Ovules* numerous, in two rows within each of the three cells of the capsule, ovate, flattened, attached by their apices to the central receptacle.

This species, which I conceive should follow *F. pyrenaica* in the arrangement, is a native of Altaica, and was obligingly communicated in September last by Dr Fischer to the Botanic Garden, where it flowered in the open border in the beginning of May.

Geranium albiflorum.

G. *albiflorum;* radice perenne; caule herbaceo, erecto, dichotomo, subangulato, subvilloso, pilis reflexis; ramulis subteretibus villosis; foliis subpeltatis, 5–7-lobatis, lobis linearibus, multinervibus parce reticulatis, lateribus integerrimis, in radicalibus ad basin distantibus; pedunculis axillaribus, bifloris, folio longioribus calycibusque glanduloso pubescentibus; petalis emarginatis, introrsum infra mediam lanato-hirsutum.

Geranium albiflorum. *Hooker,* N. Amer. Flor.

Description.—*Root* perennial. *Stem* herbaceous, branched, erect, dichotomous, shining, green, sparingly covered with reflected hairs, scarcely angular, swollen at the lower part of the joints; branches towards the extremities nearly round, and thickly covered with glandular pubescence. *Leaves* opposite, subpeltate, supported on long petioles, gradually shortening to the uppermost pair, which is subsessile, lobed, lobes cuneato-linear, incised in their upper half, in their lower entire, bright green above and pubescent, below paler, sparingly pubescent, and only on the nerves, scarcely on the secondary veins; nerves very prominent behind, little reticulated; *radical leaves* 7-lobed, with the outermost bifid, and distant; *lower stem-leaves* 5-lobed, the *uppermost* 3-lobed, and more acute; on all the leaves the segments are mucronate, but the mucro is longest on the stem-leaves. *Stipulæ* erect, ovato-linear, acute, persisting, becoming red. *Peduncles* axillary, 2-flowered, scarcely longer than the leaves from which they spring, erect, slightly compressed, glanduloso-pubescent, pubescence spreading, red at the apex. *Bracteæ* subulate, connate in pairs at the bifurcation of the peduncle. *Calyx* green, segments oblongo-linear, 5-nerved, glanduloso-pubescent, mucronate, membranous in the edges, adpressed to the corolla. *Petals* twice the length of the calyx, spreading, obovate, emarginate, undulate, white or very pale lilac, with somewhat deeper veins, glabrous on the outside, woolly within for nearly the whole of the lower half, especially at the sides, a portion in the centre being nearly naked. *Disk* yellow, protuberant and fleshy between the petals. *Filaments* hairy on the outside, those opposite to the petals in their lower half bulging outwards, the alternate ones adpressed to the germen; upper half diverging, reddish, subulate; hairs long, erect, simple. *Anthers* linear, loosely attached by their backs, leaden coloured, pollen greenish, granules spherical. *Germen* green, covered with simple erect hairs, lobes keeled; beaks densely covered with glandular hairs, similar to those on the peduncle. *Stigmata* reddish, at first in contact with each other, afterwards elongated, and slightly diverging. *Fruit* covered with glandular hairs; cells 2-seeded.

We have had this plant in cultivation ever since the return of Captain Franklin's second expedition, and it exists in other collections. I believe it has been variously called, *Geranium maculatum*, and a variety of *G. angulatum*. It seems most nearly to resemble the last, but I think may be distinguished from either. *Geranium angulatum* differs from *G. albiflorum*, in its smooth filaments; its longer, narrower, darker coloured, much less hairy, and less expanded petals; its more angular, rather less hairy stem; and its more wrinkled darker coloured leaves, their lobes being much more serrated, and in the radical leaves the two at the base generally touching each other, or even overlapping.

Ornithogalum fimbriatum.

O. fimbriatum; racemis multifloris, subcylindraceis; pedunculis divaricatis, bracteo marcescente, subacuta longioribus; floribus erectis, pedunculos vix æquantibus; foliis omnibus radicalibus, linearibus, canaliculatis, scapo longioribus, marginibus nervisque dorso ciliatis.

Ornithogalum fimbriatum. *Pers.* Synop. 1. 364. ?—*Marsch.* Bieb. Flor. Taur. Cauc. 1. 276. ?—*Spreng.* Syst. Veget. 2. 30. ?—Bot. Reg. 555.—Bot. Mag. 3077.

Ornithogalum ciliare. *Fischer,* MS.

Description.—*Leaves* (9 inches long) all radical, glaucous, linear, channelled, beautifully ciliated by equal straight and slightly reflexed hairs on the margins and ribs on the back of the leaf, naked in front. *Scape* (3 inches high), erect, nearly round, having similar hairs to those on the leaves, and swelling upwards to the lowest peduncle, above this smooth, angular, and becoming smaller as the peduncles are given off. *Flowers* numerous, in a terminal raceme, which is preserved of nearly a cylindrical form by the stout, smooth and somewhat flattened peduncles becoming more and more divaricated as they elongate. *Bracteæ* membranous, withering, subacute, shorter than the peduncles. *Flowers* always erect; petals white, green in the centre on the outside, spreading somewhat in their upper half, elliptic, the three outer the broadest. *Stamens* half the length of the petals; filaments erect, uniform, white, dilated at the base; anthers incumbent, yellow, versatile. *Pistil* scarcely so long as the stamens; stigma forming three diverging lines upon the top of the short, undivided, erect, white, 3-sided style; germen yellowish-green, of six acute lobes, approximating at the apex in pairs, and diverging at the base to form pairs with the adjoining lobes. Interior of the cells dry, with the numerous ovules in double rows.

Ornithogalum fimbriatum is a native of the Crimea, and was sent to the Botanic Garden, Edinburgh, by my ever liberal friend Dr Fischer of St Petersburgh, under the name of *Ornithogalum ciliare.* It flowered in the open border of the Botanic Garden, Edinburgh, in the beginning of May.

I have retained the specific name given to this plant in the Botanical Register and Botanical Magazine, and have made the references which are made there to Marschall Bieberstein, Persoon, and Sprengel (the only works quoted which I have it in my power to consult), but I have added a mark of doubt. I really cannot believe that the plant of Willdenow and of these authors is the same with that now in the British gardens, and which I have here described. Dr Hooker has well remarked, that it is surely an error in Marschall Bieberstein, and Mr Ker to consider this plant so closely allied to *Ornithogalum umbellatum,* that they can scarcely be distinguished but by the hairiness of the leaves: they differ, as Dr Hooker says, in many essential characters. In fact, Bieberstein never could have made this remark if he had been describing our plant, which much more nearly approaches *Ornithogalum refractum.* In the *Ornithogalum fimbriatum* of Willdenow, the raceme is said to be sub-biflowered, the peduncles spreading wide, hirsute, and scarcely longer than the bracteæ. Sprengel adds, that the leaves are flat. In the plant of the Botanical Register, Magazine, and this article, the raceme, when the specimen is vigorous, is many-flowered, the peduncles more and more refracted as the flowering advances; they are perfectly smooth, excepting that a few of the lower ones have on their under side a few hairs, and they are nearly twice the length of the bracteæ; the leaves are nearly half cylinders. In the statement regarding the proportional length of the bracteæ and peduncles, there is an inadvertent slip in the Botanical Magazine, which the excellent figure will correct.

Notwithstanding my belief that this is not the *Ornithogalum fimbriatum* of Willdenow, I think it right to retain the name given to it, because it has been generally adopted, and the figures identify it; whereas Willdenow's plant may, when better known, get another name without inconvenience.

Papaver nudicaule-alpinum.

I am induced to mention this hybrid, on account of the peculiarity of its appearance, and the circumstances in which it was produced.

A strong plant of *Papaver alpinum* grew in an open border in the Botanic Garden last year. In the same spot this spring, three very strong plants rose, with leaves precisely similar, perhaps a little less finely divided. The flowers on expansion, however, were found not white, as in *P. alpinum*, but deep and bright yellow, with a greenish tinge in the heart. For several years, many plants of *P. nudicaule* have blossomed freely in the neighbouring borders. The plant of *P. alpinum* had been impregnated by these, had died, and been succeeded by its hybrid progeny. The three plants are precisely similar, the flowers as large as in *P. nudicaule*, and very similar to this species in colour, the leaves, as I have said, almost exactly those of *P. alpinum.*

A remarkable monstrosity appears this year among some of the plants of *Papaver nudicaule.* The flowers in some are semi-double, but in others few of the outer stamens only remain, the filaments in general assuming the form of fragments of a capsule, having hairs on their outer, and ovules on their inner surface; the anthers are awanting, and their place supplied by fragments of stigmata.

Sieversia rosea.

S. *rosea;* foliis radicalibus, interrupte pinnatis, pilosis, pinnis subtrifidis, base cuneatis, caule ascendente piloso, trifido.

Description.—Root perennial. *Stem* ascending or erect, trifid, hairy, nearly round, red when exposed to the sun, branches occasionally subdivided. *Radical-leaves* numerous, petiolate, shorter than the stem, interruptedly pinnate, veined, pale green, especially behind, loosely covered with long shining hairs, behind hairy only on the veins, and there more obviously than in front ascending laterally from tumid bases; pinnæ smaller downwards, subtrifid, and terminal segments tridentate. *Stem-leaves* small, petiolate, opposite in the middle of the stem and at its subdivisions, except where a single ultimate branch or peduncle arises, when the leaf is solitary, stem clasping, pinnatifid, segments nerved, lanceolate, incised or entire, smaller in successive divisions, the branches and segments more narrow. *Stipulæ* lateral, accompanying the stem-leaves only, adhering to the petiole, acuminate, entire or incised, resembling the stipulæ on the petioles of roses. *Peduncles* single-flowered, at first nodding, afterwards erect, hairy. *Calyx* coloured, hairy, 10-cleft, 5 segments broader, shorter, ovate, acute, never expanding, reticulate, 5 lanceolato-linear, longer, spreading, cuticle of the tube detached, and slightly inflated. *Petals* rhombeo-elliptic, keeled at the base, at first yellowish, afterwards white where covered by the calyx, rose-coloured where exposed, emarginate, and slightly diverging at the apex. *Stamens* very numerous, inserted into the calyx within the corolla; filaments hairy, nearly as long as the corolla, colourless; anthers yellow, incumbent. *Nectary* an erect yellowish-green cup, its edge tooth-crenated, surrounding the centre of the flower, immediately within the stamens; pistils numerous, slightly stipitate, equal in length to the stamens; germens silky; styles smooth except at the base, erect, colourless, persisting and becoming red, their hairy bases being greatly elongated, forming a feathered awn to the fruit; stigmata blunt, greenish-yellow, ovules solitary, erect.

Seeds of this species were gathered by Mr Drummond on the Rocky Mountains, and sent by him to the Botanic Garden in 1827. It has been in cultivation ever since, is very vigorous, and flowers most freely in a dry border in May.

Vaccinium humifusum.

V. *humifusum;* caule fruticoso, prostrato repente; foliis sempervirentibus, ovatis, subacutis, integerrimis utrinque glabris, ciliatis; pedunculis axillaribus, solitariis unifloris, pluri-bracteatis; antheris obtusis.

Description.—*Stem* woody, very slender, much branched, prostrate, cæspitose, rooting, round, grey; branches subpubescent. *Leaves* (half an inch broad) ovate, smooth on both sides, ciliated, coriaceous, on short petioles, of very unequal size, acquiring their full dimensions only towards the apices of the branches, towards the origin of these being generally small, subrotund, and, as it would seem, formed from the altered condition of the scales of the bud at the extremity of the former year's shoot. *Flowers* solitary, axillary, nodding, on peduncles twice the length of the petioles, along which are scattered four or five ovate, concave, entire *bracteæ*, enlarging upwards. *Calyx* campanulate, persisting, closing when the corolla falls, 5-cleft, segments ovate, acute, red, green at its base. *Corolla* white, campanulate, 5-toothed, teeth reflected, often partially tinged red on the outside. *Stamens* 10, included, rising from the base of the corolla and falling with it; filaments subglabrous, dilated at the base, connivent; anthers attached by their backs near the base, brown-yellow, oblong, obtuse at both ends, bilocular, opening by two pores at the apex, without beaks. *Pistil* rather longer than the stamens; stigma large, capitate; style short, straight, stout; germen round, 5-lobed at the apex, green; ovules very numerous, placed round a 5-lobed central receptacle.

This interesting little plant, which, though anomalous, especially in its habit, in the number of stamens, and in the absence of beaks to the anthers, I can still only look upon as a species of *Vaccinium*, was raised at the Botanic Gardens of Edinburgh and Glasgow, from seeds gathered on the Rocky Mountains of North America by Mr Drummond during Captain Franklin's expedition in 1827. They were marked, "Seeds of a small creeping shrub resembling *Mitchellia repens*, producing a very fine flavoured fruit; not seen in flower." We have also seeds of this species in the same invaluable collection, marked "Edible Cherry."

The plant grows sufficiently freely, but though in open dry borders it is in soil and exposure very analogous to the situations in which it grows naturally, as I learn from Mr Drummond himself, yet it flowers most sparingly.

Celestial Phenomena from July 1. to October 1. 1831, calculated for the Meridian of Edinburgh, Mean Time. By Mr George Innes, Astronomical Calculator, Aberdeen.

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

JULY.

D.	H.	′	″		D.	H.	′	″	
1.	0	0	13	☌ ♃ δ ♑	12.	20	56	50	☌ ☽ ρ ♌
1.	1	2	25	☌ ☽ φ ♒	12.	22	20	7	☌ ☽ ♀
1.	23	13	8	Im. II. sat. ♃	13.	19	20	44	☌ ☽ σ ♌
2.	23	31	12	☾ Last Quarter.	15.	3	57	–	☌ ☽ δ ♊
3.	0	52	–	☌ ☿ ζ ♉	15.	10	59	6	☌ ☽ 1 γ ♍
3.	21	59	53	☌ ☽ ν ♓	16.	17	55	44	☽ First Quarter.
4.	18	38	41	☌ ☽ 2 ξ Ceti.	19.	2	17	21	Im. I. sat. ♃
5.	0	50	48	Em. III. sat. ♃	19.	4	13	31	☌ ☽ γ ♎
5.	1	49	48	☌ ☽ μ Ceti.	19.	8	51	52	Em. III. sat. ♃
5.	21	4	40	☌ ☽ f ♉	19.	15	41	59	☌ ☽ ψ ♎
6.	0	33	23	☌ ♀ α ♌	19.	23	43	–	Sup. ☌ ☉ ☿
6.	16	45	10	☌ ☽ γ ♉	20.	8	3	42	☌ ☽ φ Oph.
6.	17	56	52	☌ ☽ 1 δ ♉	22.	16	22	16	☉ enters ♌
6.	18	24	32	☌ ☽ 2 δ ♉	23.	8	1	–	☍ ☉ ♀
6.	23	5	26	☌ ☽ α ♉	23.	15	21	28	☌ ☽ d ♐
7.	18	19	37	☌ ♀ ♄	24.	9	6	–	☌ ☿ γ ♋
7.	18	54	–	☌ ☿ η ♊	24.	20	57	56	○ Full Moon.
8.	15	35	–	☌ ☽ ☿	25.	1	20	35	Im. IV. sat. ♃
8.	18	13	57	☌ ☽ ν ♊	25.	6	3	26	Em. IV. sat. ♃
9.	1	48	0	Im. II. sat. ♃	25.	15	37	16	☌ ☽ ♅
9.	13	39	32	● New Moon.	26.	8	5	28	☌ ☽ ♃
11.	10	13	44	☌ ☽ ♂	26.	12	52	9	Em. III. sat. ♃
12.	0	22	58	Im. I. sat. ♃	27.	3	41	54	☌ ♀ τ ♌
12.	1	17	4	Im. III. sat. ♃	27.	20	7	45	☌ ☽ λ ♒
12.	3	40	22	☌ ♀ ρ ♌	27.	22	40	28	Im. I. sat. ♃
12.	4	51	3	Em. III. sat. ♃	28.	6	28	2	☌ ☽ φ ♒
12.	10	3	56	☌ ☽ α ♌	30.	14	53	–	♀ greatest elong.
21.	14	3	41	☌ ☽ ♄	31.	3	45	23	☌ ☽ ν ♓

AUGUST.

D.	H.	′	″	
1.	0	49	46	☌ ☽ 2 ξ Ceti.
1.	5	34	26	☾ Last Quarter.
1.	8	11	41	☌ ☽ μ Ceti.
2.	4	59	35	☌ ☽ f ♉
2.	16	52	29	Em. III. sat. ♃
2.	22	49	52	Im. II. sat. ♃
3.	0	17	51	☌ ☽ γ ♉
3.	1	31	52	☌ ☽ 1 δ ♉
3.	2	0	37	☌ ☽ 2 δ ♉
3.	3	8	22	☌ ♂ α ♌
3.	6	50	31	☌ ☽ α ♉
4.	0	35	10	Im. I. sat. ♃
4.	17	4	–	☌ ☿ α ♌
4.	22	18	–	☍ ☉ ⚳
5.	3	18	2	☌ ☽ ν ♊
5.	14	2	–	☿ near ♂
5.	16	55	20	☌ ☽ ζ ♊
5.	18	12	–	☍ ☉ ♅
7.	21	56	28	● New Moon.
7.	22	5	–	☌ ☿ ♄
8.	19	57	17	☌ ☽ α ♌
9.	2	16	40	☌ ☽ ♂
9.	5	20	13	☌ ☽ ♄
9.	6	44	3	☌ ☽ ρ ♌
9.	9	58	–	☌ ☽ ☿
9.	20	52	56	Em. III. sat. ♃
10.	1	24	43	Im. II. sat. ♃
10.	4	49	18	☌ ☽ σ ♌
10.	19	30	36	Im. IV. sat. ♃
10.	20	2	–	☍ ☉ ♃
11.	0	14	22	Em. IV. sat. ♃
11.	4	46	7	Em. I. sat. ♃
11.	7	18	12	☌ ☽ ♀
11.	19	43	52	☌ ☽ γ ♍
12.	14	39	–	☌ ♂ ♄
12.	23	14	58	Em. I. sat. ♃
15.	10	15	56	☽ First Quarter.
15.	11	47	32	☌ ☽ γ ♎
15.	23	13	21	☌ ☽ ψ ♎
16.	15	33	46	☌ ☽ φ Oph.
16.	21	19	46	Im. III. sat. ♃
17.	0	53	40	Em. III. sat. ♃
19.	23	0	18	☌ ☽ d ♐
20.	1	10	0	Em. I. sat. ♃
20.	20	7	36	Em. II. sat. ♃
22.	1	3	12	☌ ☽ ♅
22.	9	33	7	☌ ☽ ♃
23.	9	54	0	○ Full Moon.
23.	22	50	42	☉ enters ♍
24.	1	21	18	Im. III. sat. ♃
24.	2	52	14	☌ ☽ λ ♒
24.	13	1	43	☌ ☽ φ ♒
27.	9	16	10	☌ ☽ ν ♓
27.	13	40	58	Im. IV. sat. ♃
27.	22	42	35	Em. II. sat. ♃
28.	6	13	43	☌ ☽ 2 ξ Ceti.
28.	13	35	21	☌ ☽ μ Ceti.
28.	21	33	57	Em. I. sat. ♃
29.	7	8	–	☌ ☉ ♄
29.	9	28	21	☌ ☽ f ♉
30.	6	1	1	☌ ☽ γ ♉
30.	7	16	13	☌ ☽ 1 δ ♉
30.	7	45	15	☌ ☽ 2 δ ♉
30.	10	35	45	☾ Last Quarter.
30.	12	40	13	☌ ☽ α ♉
31.	4	3	–	♀ greatest elong.
31.	5	22	38	Im. III. sat. ♃

SEPTEMBER.

D.	H.	′	″	
1.	10	10	25	☌ ☽ ν ♊
3.	2	49	21	☌ ♂ σ ♌
4.	1	17	41	Em. II. sat. ♃
4.	9	50	4	☌ ♅ δ ♑
4.	23	29	17	Em. I. sat. ♃
5.	4	53	59	☌ ☽ α ♌
5.	15	29	3	☌ ♂ τ ♌
5.	15	47	56	☌ ☽ ρ ♌
5.	20	19	7	☌ ☽ ♄
6.	8	18	45	● New Moon.
6.	18	33	52	☌ ☽ ♂
7.	9	24	30	Im. III. sat. ♃
8.	4	10	–	☌ ☽ ☿
8.	4	47	53	☌ ☽ 1 γ ♍
8.	22	13	12	☌ ☽ ♀
11.	19	58	23	☌ ☽ γ ♎
12.	7	20	0	☌ ☽ ψ ♎
12.	23	36	48	☌ ☽ φ Oph.

SEPTEMBER,—*continued.*

D.	H.	′	″	
13.	19	53	39	Em. I. sat. ♃
14.	4	15	10	☽ First Quarter.
14.	13	25	55	Im. III. sat. ♃
15.	3	54	44	☌ ♂ β ♍
16.	7	23	29	☌ ☽ d ♐
18.	8	5	24	☌ ☽ ♅
18.	13	15	4	☌ ☽ ♃
20.	11	25	21	☌ ☽ λ ♒
20.	21	28	2	☌ ☽ φ ♒
20.	21	49	13	Em. I. sat. ♃
21.	19	45	47	Em. II. sat. ♃
21.	21	0	38	Em. III. sat. ♃
21.	21	35	50	○ Full Moon.
23.	16	20	48	☌ ☽ ν ♓
23.	19	25	32	☉ enters ♎
24.	12	47	49	☌ ☽ 2 ξ Ceti.
24.	14	54	–	☌ ☉ ♂
24.	19	59	9	☌ ☽ μ Ceti.
25.	15	26	46	☌ ☽ f ♉
26.	6	32	–	☌ ☿ ♂
26.	11	39	7	☌ ☽ γ ♉
26.	12	53	18	☌ ☽ 1 δ ♉
26.	13	11	56	☌ ☽ 2 δ ♉
26.	17	39	–	Inf. ☌ ☉ ☿
26.	18	13	23	☌ ☽ α ♉
27.	13	50	44	☌ ♂ η ♍
27.	23	44	52	Em. I. sat. ♃
28.	15	35	45	☌ ☽ ν ♊
28.	16	6	21	☾ Last Quarter.
28.	21	28	45	Em. III. sat. ♃
28.	22	21	16	Em. II. sat. ♃
29.	5	42	47	☌ ☽ ζ ♊
29.	18	13	45	Em. I. sat. ♃

On the 3d of August, there will be an occultation of Aldebaran by the Moon:

	D.	H. ′	
Immersion, ...	3.	6 31,	at 161°
Emersion, ...	...	6 54,	at 204

On the 9th of August, there will be an occultation of Mercury by the Moon:

	D.	H. ′	
Immersion, ...	9.	7 34,	at 110°
Emersion, ...	...	7 59,	at 156

The *angle* denotes the point of the Moon's limb where the phenomena will take place, reckoning from the *vertex* of the limb towards the right hand round the circumference, as seen with a telescope which inverts.

Times of the Planets passing the Meridian, and their Declination.

JULY.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	10 41	21 36 N.	15 5	15 38 N.	14 2	19 47 N.	3 4	15 8 S.	15 28	13 30 N.	2 32	17 22 S.
5	10 55	22 45	15 6	14 0	13 57	19 7	2 47	15 13	15 14	13 22	2 16	17 23
10	11 17	23 38	15 6	11 51	13 50	18 15	2 26	15 22	14 57	13 11	1 56	17 26
15	11 43	23 29	15 6	9 37	13 43	17 19	2 5	15 32	14 39	12 59	1 36	17 30
20	12 12	22 13	15 5	7 18	13 36	16 21	1 43	15 41	14 21	12 47	1 15	17 33
25	12 33	20 2	15 3	4 57	13 28	15 20	1 21	15 55	14 4	12 35	0 55	17 37

AUGUST.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	13 0	15 52 N.	15 0	1 39 N.	13 18	13 50 N.	0 51	16 13 S.	13 40	12 17 N.	0 26	17 41 S.
5	13 12	13 9	14 57	0 14 S.	13 12	12 57	0 33	16 22	13 26	12 7	0 5	17 44
10	13 23	9 39	14 53	2 34	13 4	11 49	0 11	16 35	13 8	11 54	23 45	17 48
15	13 30	6 9	14 47	4 49	12 56	10 39	23 48	16 47	12 51	11 40	23 25	17 51
20	13 36	2 44 N.	14 41	6 59	12 48	9 27	23 21	17 1	12 34	11 27	23 6	17 54
25	13 38	0 30 S.	14 32	9 0	12 41	8 13	22 59	17 13	12 17	11 13	22 47	17 57

SEPTEMBER.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	13 36	4 25 S.	14 18	11 34 S.	12 30	6 28 N.	22 29	17 26 S.	11 52	10 54 N.	22 15	18 1 S.
5	13 31	6 13	14 9	12 50	12 24	5 27	22 12	17 34	11 38	10 43	21 59	18 3
10	13 19	7 49	13 54	14 10	12 15	4 9	21 50	17 42	11 21	10 30	21 39	18 5
15	13 0	7 10	13 37	15 9	12 8	2 51	21 28	17 49	11 4	10 16	21 19	18 8
20	12 32	7 4	13 15	15 41	12 2	1 33	21 8	17 55	10 47	10 3	20 58	18 10
25	12 4	4 22	12 51	15 40	11 53	0 14	20 47	17 59	10 29	9 50	20 38	18 12

Proceedings of the Wernerian Natural History Society.—Continued from former Volume, p. 379.

1831, *March* 19.—Dr R. K. Greville, V. P. in the chair. —Professsor Jameson read a notice communicated by Mr James Smith of Jordanhill, regarding a subterranean forest discovered in the coal formation near to Glasgow.

The Secretary then read Mr James Duncan's introductory remarks to an extensive catalogue of coleopterous insects collected in the neighbourhood of Edinburgh, and likewise notices respecting the habitats of the rarer species, and descriptions of two species new to the British Fauna. The specimens of rare and new species were exhibited to the meeting. This communication gave much pleasure to the Society, as affording an earnest of the revival of the study of entomology in this place, where it has been much neglected for a good many years past. It was agreed that the thanks of the meeting be given from the chair to Mr Duncan, who was present; and that he be requested to allow his List of Edinburgh Coleoptera to be printed in the forthcoming volume of the Society's Memoirs.

1831, *April* 2.—Rev. Dr Brunton, V. P. in the chair.—Mr William Galbraith being present, read extracts of his paper on the mensuration of heights, by the barometer, and stated the result of a trigonometrical measurement of the height of Carnethy, one of the Pentlands.—The Secretary then read a botanical communication from Mr William Macgillivray, entitled, Remarks on the Phenogamic Vegetation of the River Dee, tracing the zones marked out by the prevalence of alpine, subalpine, and valley plants.

April 16.—David Falconar, Esq. V. P. in the chair.—Professor Jameson gave a discourse on fossil trees supposed *in situ*, illustrating his remarks by sketches or diagrams, and shewing that they have in general been floated into their present situations. The Professor also gave an account of bone caves in New Holland, and of the general nature of the bones found in these caves; one large bone evidently belonging to a quadruped of the size of an elephant, and not now existing in New Holland.

The Rev. Dr David Scot of Corstorphine then read an essay on the carob-tree and its fruit.

The Society, having completed its 24th session, adjourned.

List of Patents granted in Scotland from 14th March to 13th June 1831.

1831.

March 14. To David Napier of Warren Street, Fitzroy Square, in the county of Middlesex, engineer, and James & William Napier of Glasgow, machinists, for an invention of "certain improvements in machinery for propelling locomotive carriages."

24. To Robert Stephenson of Newcastle-upon-Tyne, in the county of Northumberland, engineer, for an invention of "an improvement in the axle and parts which form the bearings at the centres of wheels for carriages which are to travel upon edge railways."

To Henry Pratt of Bilston, in the county of Stafford, miller, for an invention of "certain kiln-tiles made and manufactured of clay, iron, and other metals and materials, for the purpose of drying wheat, malt, oats, and other grain, and for various other purposes, with the formation of the fire-place and kiln."

April 22. To Thomas Bailey and Charles Bailey, both of the town of Leicester, in the county of Leicester, frame-smiths, for an invention of "certain improvements in machinery for making lace, commonly called bobbin-net."

27. To James Milne of the city of Edinburgh, brass-founder, for an invention of "an improvement or improvements on gas-meters."

11. To David Napier of Warren Street, Fitzroy Square, in the county of Middlesex, engineer, for an invention of "certain improvements in printing machinery, with a method of economising the power applied to the same, which method of economising power is also applicable to other purposes."

29. To John Dickinson of Abbots Langley, in the county of Hertford, paper-maker, for an invention of "an improved method of manufacturing paper by means of machinery."

May 2. To John and James Potter of Smedley, near Manchester, spinners and manufacturers, for an invention of "certain improvements in machinery, or apparatus applicable to the spinning or twisting of cotton, flax, silk, wool, and other fibrous materials."

3. To William Rutherford *junior*, of Jedburgh, writer and bank agent, for an invention of "a combination or arrangement of apparatus or mechanism, to be used by itself, or applied to locks and other fastenings for more effectually protecting property."

18. To Samuel Morand of Manchester, in the county of Lancaster, in the kingdom of England, merchant, for an invention of "an improved stretching machine."

To Andrew Smith of Princes Street, Leicester Square, in the parish of St Martins-in-the-Fields, in the county of Middlesex, mechanist, for an invention of "certain improvements in machinery for propelling boats, vessels, or other floating bodies on the water, and in the manner of constructing boats and vessels for carrying such machinery, part of which said improvements are applicable to water-wheels for driving mills or machinery, and also to windmills."

May 20. To THOMAS KNOWLES of Charlton Row, in the county of Lancaster, cotton-spinner, for an invention of "certain improvements in certain machinery, by aid of which machinery spinning machines, commonly called mules, are or may be rendered what is termed self-acting, that is to say, certain improvements in certain machinery, by aid of which machinery spinning machines commonly called mules are or may be worked by power, without requiring the usual application of the strength of the spinners to give motion to the handles or wheels, and to such other parts of mules as are commonly worked by the strength of the spinners."

To SAMUEL LAMBERT of Regent Street, in the parish of St James, Westminster, in the county of Middlesex, gold-laceman, for an invention of "an improvement in throstle spindles for spinning and twisting silk, cotton, wool, flax, and other fibrous substances."

June 2. To Sir THOMAS COCHRANE, Knight, commonly called Lord Cochrane, of Regent's Park, in the county of Middlesex, for an invention of "an improved rotatory engine to be impelled by steam, and which may be also rendered applicable to other purposes."

To Sir THOMAS COCHRANE, Knight, commonly called Lord Cochrane, of Regent's Park, in the county of Middlesex, for "apparatus to facilitate excavating, sinking, and mining."

To ANDREW URE of Finsbury Circus, in the county of Middlesex, M. D., for an invention of "an apparatus for regulating the temperature in evaporization, distillation, and other proprocesses."

To GEORGE STEPHENSON of Liverpool, civil engineer, for an invention of "an improvement in the mode of constructing wheels for railway carriages."

To ALEXANDER CRAIG of Ann Street, St Bernard's, in the parish of St Cuthbert, and county of Mid-Lothian, in consequence of a communication made by a certain foreigner residing abroad, of an invention "of certain improvements in machines or machinery for cutting timber into vineers or other useful forms."

To MICHAEL DONOVAN of the city of Dublin, druggist, for an invention of "an improved method of lighting places with gas."

10. To JOHN AITCHISON of Clyde Buildings, in the city of Glasgow, and county of Lanark, merchant, for an invention of "certain improvements in the concentrating and evaporating cane juice solutions of sugar, and other fluids."

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THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

Analysis of Professor EHRENBERG'S *Researches on the Infusoria.* By MEREDITH GAIRDNER, M. D. Communicated by the Author *. (With a Plate.)

EVER since Hooke's great discovery of the microscope, and a partial acquaintance with the prodigious variety and number of self-existent, self-moving, forms which it disclosed to the eye of the scrupulous naturalist, the attention of physiologists and metaphysicians has been more or less excited at different periods, with the hope that it might one day reveal the secret of the living principle in the ultimate atoms of organized matter, or in the minute animalcules, where it long seemed as if vitality was reduced to its ultimate expression—voluntary motion. The observations of Leeuwenhoeck, Hartsoeker and Needham, on the seminal animalcules, suggested to Buffon the idea that every animal was made up of an aggregation of these almost invisible

* We have great pleasure in laying before our readers this excellent account of the admirable researches of Ehrenberg, hitherto known only in this country by the short notices in this Journal. Our accomplished young friend Dr Gairdner, during his late residence on the continent, paid a visit to Berlin, where he cultivated the acquaintance of Ehrenberg, who explained to him fully, by prelections and the exhibition of the animals, (in particular the anatomy of the *Vorticella citrina*, Müll.; *Rotifer vulgaris* of Schrank; and *Hydatina senta*), his important discoveries and views.

creatures, and that the body of man himself was, as it were, only an accumulation of such monads;—as if the aggregation of myriads of these could explain the principle of life itself,—the active moving agent in each individual monad.

Though, however, philosophers failed in the discovery of what Nature seems to have for ever enveloped in an impenetrable veil, the microscope did not fail to reward their labours by an immense accession to their views of the magnificence of nature. Like the telescope, it gave them a glimpse of a Milky Way of another order, equally incommensurate by the powers of numbers. Leeuwenhoeck calculated that, at the very lowest estimate, the milt of a single fish must contain a number of living beings thirty times greater than the whole population of the globe. Dr Ehrenberg himself has described monads which are not larger than from one-thousandth to two-thousandths of a line, and which are separated by intervals not greater than their diameter. Each cubic inch will, therefore, contain more than 800,000 millions of these animalcules, estimating them only to occupy one-fourth of its space; a single drop brought under the field of the microscope, and not exceeding one cubic line in diameter, will contain 500 millions, equal to the whole number of human beings on the surface of our globe. Let us only now reflect a moment on the numbers which must be crowded into a stagnant pool or lake, or contained in the vast expanse of the ocean, which the observations of Scoresby have shewn to be equally favourable to their development, and we will arrive at a result, which leads us to the inevitable conclusion that the mass of organized life is immeasurable. And yet all this is only visible to the armed eye of the naturalist; but, from its immensity, must play an important part in the economy of nature, and be a subject worthy of the most profound scientific inquiries.

Every now and then, there are periods which may be considered as epochs in the sciences; whether from the promulgation of some capital discovery, or from the direction they give to the train of future researches. Of such a character, if I mistake not, are Professor Ehrenberg of Berlin's recent discoveries on the structure and functions of the animals commonly classed under the denomination of *Infusoria*, to which were referred in common all animals possessed of a certain degree of minuteness, without any further inquiry. For this term has been substituted the successive appellations of *Animalculi*, *Animalia Microscopica*, *Phytozoa*. But as there is none which is not liable to some objection, perhaps it will be as well to retain the original one conferred on these animals by the Danish naturalist Müller, than whom none has a better title to the honour of conferring it.

I fancy my reader to pause at the mention of structure and functions in animals, the discovery of whose existence merely has been hitherto deemed the ultimatum of zoological research, and regarding whom the sum-total of our knowledge has been hitherto confined to a few details on their external forms and active motions. Yet, in the midst of their transparent tissues, the German naturalist has, by a peculiarly ingenious method of observation, developed a highly complicated organization, which, with those who arrange the animal kingdom in a linear series, will remove them far from the extremity of the scale. The existence of a digestive, muscular, and generative apparatus, is established beyond a doubt; and organs have been also discovered which bear great analogy with the vascular and nervous systems. The great changes which these facts must make in the systematic distribution of these animals, are obvious. Nay, from some circumstances, we are inclined to believe, that future observations may place these microscopic creations in a parallel order with their more apparent prototypes, and with not less varied and interesting gradations of structure.

Leaving, however, these speculative ideas, let us proceed at once to a brief exposition of the leading facts demonstrated by Dr Ehrenberg. But it will be necessary, to the full understanding of the value of his discoveries, to give a short historical summary of the systems and observations which existed previously on infusory animals. We shall, therefore, class our observations under the four following heads. 1. History of Phytozoology. 2. Organization of Infusory Animals. 3. Their Classification. 4. Their Geographical Distribution.

I. *History of Phytozoology.*

Previous to the time of Müller, observers seem to have had no fixed idea attached to the term an infusory animal; and the microscope was more devoted to the purposes of amusement or astonishment, than to the prosecution of a connected series of inquiries into the mysteries of organic forms. We can hardly except from this censure the laborious investigations on seminal animalcules, which occupied the attention of the learned world for so long a time after the discovery of this instrument. They were certainly instituted with the laudable view of throwing some light upon the mysterious process of generation, but were almost invariably preceded, accompanied, and ended in nothing else than a few fanciful microcosmic views, which ministered to the superstitious physiology of the age. Those who limited their inquiries more strictly to those animals which people the fresh and salt waters on the surface of the globe, did not sufficiently distinguish between those which are proper to these fluids, and the larvæ of insects and crustacea, in their early stages of development. We cannot, therefore, be surprised, when they ascribe to them a mouth, ovaria, eyes, &c.

With Otto Frederick Müller, who died in the year 1785, commences a second epoch in this department of zoology, which has scarcely advanced a single step beyond the point to which it was at once carried by its founder, notwithstanding the progressive improvements and extension of the microscope. Speculations and systems have been founded on his observations; but very few additional facts were added to those which he first disclosed. He was the first who separated them as a distinct group from all other animal existences; and, in his work entitled *Animalia Infusoria, &c.*, has described and figured, with much minuteness, no less than 378 species. He affords another example, to the many on record, of a great man advancing to the very threshold of a grand discovery, and proceeding no farther. He was not ignorant of the importance of an attention to the internal organization of these animals, and even describes the mouth, digestive and generative apparatus of many, and even their eyes. Although he went so far as even to separate, under the title of *Bullaria*, those who possessed such an internal structure, from the *Infusoria* properly so called, in which there were no traces of organization; yet he has not the courage to found on this his systematic division, but only enumerates these important characters as collateral circumstances in his detailed description of each species. We are certainly astonished that such important glimpses escaped the acuteness of the Danish naturalist; his work, however, is posthumous, and we cannot help thinking, that if he had lived to prosecute his investigations, Dr Ehrenberg would have been anticipated in his discoveries. As it is, Müller takes the differences of the external organs as the bases of his division, and, in consequence, associates in the same genus, species far removed from each other. He unites, for example, in the genus *Vorticella*, the complicated forms of the Furcularia and Rotatoria, with the much simple forms which are supported on a spiral peduncle. Similar examples are furnished by the genera *Paramœcium*, *Kolpoda*, and *Cercaria*, the last of which alone Nitsch, in the year 1816, divided into 12 distinct genera. The genus *Vibrio* comprises not only the *aceti* and *fluviatilis*, in which he describes an intestine and viviparous generation, but also the simple *bacillus*, in which he could not detect a single organ, and scarcely a trace of life. The same observations apply to the genus *Trichoda*, and many others.

Such was the state in which the science was left by Müller, furnished with a rich store of materials, and not a few valuable hints to direct the path of later inquirers.

Schrank, the Bavarian, was the first who made any important additions to our knowledge of infusory animals after the death of Müller. He described in the *Fauna Boica* 18 new species, but he still took the external form as the basis of his division, and seems to have been quite unacquainted with their structure and mode of development.

We may pass over Treviranus and Dutrochet, who treated the subject more in an ideal manner—examining their relations to other living forms—than by adding any thing new to what the science already possessed.

The warm fancy of Oken in 1805, revived in part the idea of Buffon, in regarding the infusoria as the primitive materials of all organic bodies, both animal and vegetable; and that growth is nothing but an increase to the already existing mass of animalcules, which constitute the animal body. He does not participate the ideas of Treviranus, the last champion of the *generatio spontanea*, on their mode of development.

The systematologists Lamarck and Cuvier only altered by divisions and subdivisions the arrangement of the already determined species, but did not add to the existing stock of facts. They even, in some measure, contributed to retrograde the science by the propagation of the errors into which Müller fell from his ignorance of the organization of these animals. The former even declared the ova to be gemmules, although Corti had long before described and figured the exclusion of the young from the ovum.

A more important accession was made by Professor Nitsch of Halle, the most important by far of any which exist from the time of Müller down to Dr Ehrenberg. His researches were principally directed to the genera *Cercaria* and *Bacillaria*. He rendered much more probable in the former the existence of a mouth and intestinal canal, and in the *Cercaria viridis* recognises distinctly the presence of eyes. This meritorious naturalist also divided this genus, as left by Müller, into twelve others from his own observations. In 1824, he compares the structure of the genus *Brachionus* to that of the Entomostraci, which, although it differs entirely from Savigny's observations, is much nearer the truth.

Schweigger of Königsberg, in 1820, communicated some interesting observations on these animals; and formed an industrious recapitulation of all that had been done up to his time. Even at this late date, we find him stating at p. 245 of his *Handbuch der Naturgeschichte der Skeletlozen Thiere*, that "the infusoria consist of mere gelatine, without any internal organ. Their nutrition can be carried on in no other way than by the surface. The same mode of nutrition has even been pointed out in the *Infusoria vasculosa*, without being limited to them. In some, (for example the *Cercaria*) Nitsch saw oval suction," &c. And again, on the subject of their propagation, he observes, p. 249, "All increase of the infusoria seems to result from the spontaneous separation either of their external parts, as in the Paramœciæ and Bacillariæ, or of their internal substance, as in the Vibrio and Volvox," which shews how indistinct was his conception of these two last genera.

In the year 1823, Losano described a great number of infusoria in the Transactions of the Turin Academy, vol. xxix. He has extended the genus *Proteus*, which Müller only reckoned to contain 2 species, and Schrank 4, as far as 69. And the genus *Kolpoda* he has increased to 64 species, which was left by Müller with only 16.

The latest general classification of the infusoria is that given by Bory de St Vincent in 1826, in the *Dictionnaire Classique de l'Hist. Nat.* In this elaborate production, which is characterized by the minuteness and spirit of system so prevalent among his countrymen, the author has exclusively confined himself to the artificial dismemberment and rejunction of the species already known in the time of Müller. He has added no observations of his own on their structure or development; and bases his system, like his predecessors, on their external forms. M. Bory seems not to have been aware of the observations of Nitsch, for in his definition of the class, he asserts them to possess no trace of eyes, and that their nutrition is performed by cutaneous absorption, and their propagation to be gemmiparous; all of which points had been previously shewn to be erroneous, notwithstanding the otherwise imperfect knowledge of their organization. More profound views were entertained by Professor Baer of Königsberg, in 1826, who published a treatise, entitled *Beiträge zur Kenntniss der Niedern Thiere*, in the 2d volume of the *Nova Acta Acad. Cæs. Leop. Car.* x. p. 702, 1826–7, which contains the following remarkable passages. P. 337, he observes, "Who can deny that even the lowest class of animals must agree with the others in being determined by its organization; since the first essential step towards the organization of an animal body must consist in the separation of an internal nutritive surface from an external circumscribing one? Lamarck must certainly be in error when he considers the want of a digestive cavity and of a mouth the character of his first class of animals." In prosecution of these simple and correct views, he again says: "This first class of animals, which must change the term of Infusoria given to it by many for Goldfuss's one of Protozoa, cannot be so circumscribed as Müller's Infusoria. It appears to us rather that many fundamental forms among the lower animals find their prototypes among the Infusoria." He stops, however, at these speculative ideas, for in another place he denies the existence of a nervous system, and even of an intestine, and carries out his analogy merely with the aid of the external form, which we will afterwards find to be so fugitive and changeable a character.

The last additions of moment to Phytozoology, previous to the publication of the labours of Dr Ehrenberg, are some additional observations by M. Losano, in the 30th volume of the Turin Memoirs, where he has described and figured no less than 50 species of the genus *Volvox*, 77 of *Cyclidium*, 28 of *Paramœcium*, and 26 of a new genus *Oplarium*. Unfortunately the addition of so many species will be of little use to science, since their characters are all founded on their changeable external form.

Such was the state of our knowledge with regard to the structure and functions of infusory animals, previous to the communication of Dr Ehrenberg's labours to the Berlin Academy; from which it will be seen, that we were only in possession of a few scattered hints and isolated facts regarding the existence or possible discovery of an internal organization, communicated by Müller, Nitsch and Baer. For it is a question, whether the systems of Gmelin, Lamarck, Cuvier, Goldfuss, and Bory de St Vincent, founded as they were almost wholly on the observations of others, did not tend rather to plunge the subject into greater and greater obscurity. It is more than twelve years since the Berlin professor first directed his attention to the structure of this order of organized beings. He commenced his researches by ascertaining precisely the Müllerian species which existed in the pools and stagnant waters in the Thiergarten, and other places in the vicinity of the Prussian metropolis. On his journey with Dr Hemprich into Egypt, Libya, and Arabia, he pursued his inquiries into the forms which characterize these burning plains, with a perseverance which did not fail of being rewarded with some extremely interesting views, and have laid the foundation already for a geographical distribution of these microscopic forms. On his return to Berlin from his tropical expedition, he repeated his former observations with improved instruments. And finally, on his late journey with Baron Alexander Humboldt into the vast steppes of Siberia, even to the frontiers of China, and of the plateau of Tartary, notwithstanding the extreme rapidity of his progress, he made this highly interesting branch of zöography a principal object of investigation. The entire reformation which these researches have made in the classification of infusory animals, will be shewn under our third division. But as a necessary preliminary, and as constituting the most valuable part of Dr Ehrenberg's discoveries, we must give some account of the

II. *Organization of the Infusoria.*

Before entering into the detail of the individual systems, it will be well to state briefly the method of observation employed for their development.

This consists in nothing else than furnishing the Infusoria with organic colouring matter for nutriment. Simple as this may appear, it was not till after ten years' observations that Dr Ehrenberg succeeded in selecting the fittest substances, and in applying them in the manner best adapted for the satisfactory exhibition of the phenomena. Trembley and Gleichen long ago had recourse to this method for the elucidation of the armed hydræ, but without consequences of much importance for the structure of these animals. The cause of the repeated failure of all these attempts, arose from the employment of metallic and earthy colouring substances, or such as had been submitted to boiling in the preparation. These were found either to kill the animals, or to be unfitted as articles of nutriment. Equally unsuccessful were some attempts made with the indigo and lack of commerce, which were found always to contain a greater or less proportion of white lead. It was not till he used pure indigo, that these experiments succeeded in a desirable manner. Immediately on a minute particle of a highly attenuated solution of this substance being applied to a drop of water containing some of the pedunculated vorticellæ (which are most adapted for the first observation), and placed under the object glass of the microscope, the most beautiful phenomena present themselves to the eye. Currents are excited in all directions by the rapid motion of the ciliæ, which form a crown round the anterior part of the animalcule's body, and indicated by the movements of the particles of indigo in a state of very minute division in different directions, and generally all converging towards the orifice or mouth of the animal, situated, not in the centre of the crown of ciliæ, but between the two rows of these organs which exist concentric to one another. The attention is no sooner excited by this most singular and beautiful phenomenon, when presently the body of the animal, which had been quite transparent, and bearing much resemblance in aspect to some of the marine Rhizostomæ, becomes dotted with a number of distinctly circumscribed circular spots, of a dark blue colour, exactly corresponding to that of the moving particles of indigo *. In some species, particularly those which are provided with an annular contraction or neck (such as the *Rotifer vulgaris*), separating the head from the body, the indigo particles can be traced in a continuous line in their progress from the mouth to these internal cavities.

It is requisite in these experiments to employ colouring matter which does not chemically combine with water, but is only diffused in a state of very minute division. Indigo, carmine, and sap green, are three substances which answer very well the necessary conditions, and are easily recognised by the microscope. But whatever substance is used, we must be very particular that it contains no lead, an impurity which very frequently enters into the colours of commerce.

The microscope which Dr Ehrenberg has used in all his investigations is one constructed by Chevalier of Paris; it possesses a power of 800. In very few cases, however, is it necessary to use this high power, and only to demonstrate the existence of an internal cavity in those species which do not exceed from $\frac{1}{1500}$ to $\frac{1}{2000}$ of a line in diameter, such as the *Monas termo, atomus*, and *lens*, and which almost elude the power even of so powerful an instrument. In almost all cases, a power of from 300 to 400 is sufficient; and Dr Ehrenberg has made all his observations and drawings of the structure of the *Hydatina senta* with a power of 380.

* It is as well, however, before applying any coloured solution to the drop of fluid under the field of the microscope, to take a general survey of the species which we may expect to find in the portion under examination.

In conformity with the great axiom of scientific observation, to measure every thing which is capable of measurement, Dr Ehrenberg has not neglected to express in numbers the dimensions not only of the totality, but also of the integrant parts of these beings, placed as it were at the verge of organized nature. For this purpose he uses a glass micrometer, constructed by Dollond, which gives directly the ten-thousandth part of an inch, and permits of a much smaller quantity being correctly estimated, as it contains the astonishing number of 400 equal parts distinctly cut in glass within the space of half a line. By means of a micrometer screw, which has been since constructed by Pistor of Berlin, he has been enabled to measure directly $\frac{1}{48000}$ of an inch, or $\frac{1}{4000}$ of a line, a degree of minuteness which is never necessary in actual practice.

1. *Digestive System.*—By the use of colouring matter in the way above mentioned, a digestive system has been demonstrated in *all* the genera of this class of animals, distinctly characterized by Müller. This fact Dr Ehrenberg states in the following proposition: "All true infusoria, even the smallest monads, are not a homogeneous jelly, but organized animal bodies, distinctly provided with at least a mouth and internal nutritive apparatus." In none has the cuticular absorption of nutritive matter ever been observed, which had been the opinion of all previous writers upon the subject, not from any positive observations, but merely from their inability otherwise to explain the nutrition of these animals. Generations of these transparent gelatinous bodies may remain immersed for weeks in an indigo solution, without presenting any coloured points in their tissue, except the circumscribed cavities above referred to; and when in a state of activity, the minute particles of indigo and carmine are seen to hurry rapidly over the whole surface of their transparent bodies, in order to reach the mouth, generally situate at one or other of their extremities. Indeed there is no necessity of having recourse to such a supposition, when we can clearly see the prehension of colouring particles, their reception into a mouth, and conveyance from thence into an internal stomach or stomachs.

The alimentary canal presents, as in the other classes of the animal kingdom, the utmost variety in respect to form, situation, and degree of complication. It is in the *Monas termo, pulvisculus*, and other larger monads, simply a round sac in the centre, and occupying the greater part of their bodies. In the genera *Enchelys, Paramœcium*, and *Kolpoda*, it assumes the form of a long intestinal canal, traversing the greater part of the body, and at times convoluted in a spiral manner, which is furnished with a great number of cæcal appendages, or stomachs; this singular disposition, of which no other example occurs in the animal kingdom, is particularly distinct in the *Leucophrys patula.* That these blind sacs are real stomachs, and do not at all correspond to the cæca of other animals, is evident from the fact of their being filled with colouring matter immediately on its being received at the mouth, or anterior orifice of the canal. The tubes which connect these sacs to the main canal of the intestine, vary very much, both in length and in diameter, as well among the different cæca, as in the same one at different times, being usually in a state of great contraction, and at times scarcely perceptible when the cavity to which it belongs is empty, and may be supposed not to be in a state of activity *. We can count from 100 to 200 of these sacs in the course of the intestine of the *Paramœcium Chrysalis* and *Aurelia.* When they are filled with colouring matter, the common intestinal tube is usually quite empty and transparent; this, joined to the bluish, reddish, or greenish tint which they often assume when empty, may have been the reason that these sacs were mistaken by Müller for ova, and by Schweigger for internal monads still adhering to the parent trunk. In other infusoria, as the *Rotifer vulgaris*, the alimentary canal is in the form of a slender tube, and extending nearly the whole length of the body, and terminating at its anal extremity in a dilatation or cloaca for the reception of the ova and the male seminal fluid, previous to its termination at the surface of the animal. Others of larger di-

* Attention must be paid to this circumstance, as, from the colourless transparency of the intestine when empty, and in a state of contraction, very erroneous ideas may be formed of the number and connexions of the stomachs of some of these animals, when they are separately filled with colouring matter. The alimentary canal, too, may be filled with water, and may hen very much resemble some forms of the ovaria.

mensions, as the *Eosphora najas* and *Hydatina senta*, and in general all the natural group of the *Rotatoria*, possess a single cavity of considerable size and oval form, situate in the anterior part of the body; the *Zygotrochis nudis* would seem to form an exception to the general rule of this division; for this animal, when filled with colouring matter, presents a slender, spirally convoluted intestine in the centre of the body. In this animal also, the posterior cloacal dilatation is enlarged into a considerable cavity, which can retain the colouring matter for some time previous to its being discharged by the anus.

The number of stomachs varies no less than their form. The whole tribe of the *Rotatoria*, as already observed, possess but a single cavity. In the *Monas termo*, four can be reckoned*.

The number of sacs, which are so many distinct digestive cavities, although connected together by a common tube, varies from 1 and 200 down to 36 in many *Vorticellæ*. The largest number is in the *Paramæcium chrysalis*, Müll., where it amounts to 120, and yet there is ample space for still more.

The *anus* is easily distinguished from the mouth, when the animal is filled with colouring matter, by its discharge from this orifice, in large irregular coherent masses, very different in appearance from the minute state of division in which it enters by

* Some ingenious speculations might be founded on the high degree of attenuation of organized matter in some of these monads. By M. Ehrenberg's measurements the *M. termo* does not exceed $\frac{1}{1500}$ to $\frac{1}{2000}$ of a line in diameter; and he states that the four stomachs did not occupy half the bulk of the animal. Each stomach must therefore be about $\frac{1}{6000}$ of a line in diameter; and probably is capable of containing a large number of atoms of colouring matter. Estimating, however, one to contain no more than three atoms, and each of these to be of a globular form, this will prove the existence of particles of matter in water not larger than $\frac{1}{36000}$ of a line in diameter, or $\frac{1}{432000}$ of an inch.

Some of Dr Ehrenberg's observations tend to prove that the genus *Monas* and some others are only the young state of some *Kolpodæ*, *Paramæciæ*, &c. But supposing them to be perfectly developed animals, and that their ova bear the same relation to the size of their bodies, which those of the *Kolpoda* do, that is, 40 to 1, we must conclude the existence of young monads which have a diameter of only $\frac{1}{60000}$ of a line, or $\frac{1}{720000}$ of an inch. Each of these monads must possess a stomach and organs passing in dimensions the power of numbers, and certainly giving us very magnificent ideas of the grandeur of organized nature.

the mouth. Its position varies exceedingly; in the greater number, such as the *Hydatina senta, Rotifer vulgaris,* and *Eosphora najas,* it opens towards the posterior extremity of the animal; in the first of these it is on the back. In the *Kolpoda cucullus* it opens into the concave surface of the animal, close to the mouth, from which it is only separated by a tongue-shaped eminence. In some of the spirally pedunculated vorticellæ, its disposition is very singular, opening along with the mouth into a common fissure, which is not situate in the centre of the circular ranges of ciliæ which surround the anterior extremity of the body, but towards the margin, between two of these concentric circles.

The *mouth* merits the notice of the systematologist, from the very precise characters which he can draw from thence for his subordinate divisions. This organ reaches its greatest complication in the *Hydatina senta,* where it consists of an orifice opening in the centre of a globular head, and provided with a pair of serrated mandibules, each resembling somewhat the single mandibules of some of the mollusca, such as the common *Helix pomatia,* or those of the echini. When the animal is in the act of taking its food, these mandibules are in perpetual motion, opening and shutting with great rapidity, to absorb the colouring particles brought within their reach by the currents excited by the motions of the ciliæ. This very singular organization is certainly one of the most curious phenomena visible in their whole structure, and is perhaps one of the most important, as shewing so close an approximation to animals far removed from them in the zoological series. Each mandibule in the species which I examined, possessed five distinct teeth, but the number varies from two, three, as far as six. Dr Ehrenberg has since succeeded in demonstrating their real nature, by the use of very fine foliæ of mica (the whole animal is not more than one-eighth of a line in length), and has come to the conclusion that they are separate, simple, hard bodies, enveloped with a fleshy covering, which are ingrained into one another like the fingers of the hands when joined.

The mouth of the other infusoria is a simple unarmed opening, surrounded more or less closely with a greater or less number of ciliæ. Its position generally determines their anterior extremity. In the genus *Paramæcium*, however, it is in the middle of the length of the animal. The *Kolpoda cucullus* possesses a sort of lip surrounding its margin.

The ciliæ play a very important part in the economy of this class of animals. They may be considered as the principal organs of taste, of touch, and of propulsion. When the animal is at rest, they are often quite imperceptible, but on the addition of a small proportion of colouring liquid to the drop of water, they become very apparent, being in a state of great activity, seeming to be the principal agents by which they excite those currents which afford so beautiful a spectacle under the field of the microscope*. In the *Monas pulvisculus*, and other larger monads, their number amount to 10 or 20, and we may from this conclude that they exist even in the smallest monad. They sometimes surround the mouth in a single row (*Vorticella convallaria, Rotifer vulgaris*), sometimes in a double row (*Vorticella citrina*); occasionally they extend in regular lines, or are irregularly dispersed over the whole surface of the body. The former disposition occurs in the *Leucophrys pyriformis* and *patula*, the latter in the *Actinophrys sol.* They occupy, in other cases, only one side of the body (*Kolpoda cucullus*).

An *œsophagus* can only properly be said to belong to those which, like the *Eosphora najas* and *Hydatina senta*, possess a notable contraction between the mouth and the stomach. This is especially distinct in the latter, where I have distinctly traced the passage of individual coloured globules along this narrow canal from the mouth into the intestine.

Perhaps this is the most appropriate place to notice an organ of a very obscure nature, which Dr Ehrenberg dignifies with the name of a pancreas. It is in the form of two kidney-shaped, greyish-white, glandular-looking, transparent bodies, which are placed on each side of the upper extremity of the intestine, firmly connected to, and closely embracing it. Dr Ehrenberg regards them as bearing a greater analogy to the pancreas than

* One of the most favourable moments for seeing these ciliæ to advantage, particularly in those species in which they invest the whole surface of the body, is when the drop of fluid under the microscope is nearly dry, when they may be seen elongated to their utmost, in a state of great activity; or if the animal be nearly expiring, in a state of rigid erection.

to the liver of the higher animals, from their colour, form, and connexions. They must, however, be left to further inquiries.

2. *Muscular System.*—A fibrous muscular tissue being the proper agent of all voluntary contraction in the animal kingdom; we might, *a priori*, expect its existence in the class of infusoria, which are so remarkable for the rapidity and energy of their movements of propulsion and translation. In the former they can only be compared with fishes, and in the latter with insects. Contractility of tissue can never explain those active voluntary efforts by which they avoid obstacles when swimming in myriads in a single drop, convey the nutriment towards the mouth, and perform the act of deglutition. Previous, however, to Dr Ehrenberg, nothing like the muscular fibre had ever been attempted to be shewn in these animals.

As yet, from their extreme tenuity, no distinct fibres have been detected in the second and more minute division styled by Cuvier Homogeneous Infusoria, and in the new system of Dr Ehrenberg *Polygastrica;* although from their extremely vigorous contractions, as well as from their presence in the division of the Rotatoria, we are entitled to infer their existence. In this last, distinct fibres are perceptible in the *Eosphora najas*, *Rotifer vulgaris*, *Philodina erythrophthalma* and *Hydatina senta*.

We shall select the muscular system of the latter, the *Hydatina senta*, as a specimen, from its greater distinctness and complexity. The perfectly transparent gelatinous body of this animal, when seen through the microscope with a power of 380, appears to be traversed longitudinally by several narrow bands of fibres, perfectly transparent, and of a greyish-white colour. When the animal throws itself into its violent lateral contortions, these fibrous bands are observed to shorten, become broader and thicker (from their slightly diminished transparency), on the side towards which the contractions are made; and on the convex to become so extremely elongated and attenuated as to be almost, in some cases, quite imperceptible. The real muscular nature of these organs, and that they are the real agents in effecting the motions of the animal, is thus placed beyond all doubt. These muscles never lose their apparent state of tension, which they would undoubtedly do on the contractions of the animal, if their nature was of another description; and when the two extremities of the body are equally approximated to each other, none of the bands become invisible, but all increase to nearly twice their former breadth, with a corresponding diminution of their transparency. I have entered into these details regarding the appearance of the muscular fibres, for the sake of those who may not have had an opportunity of having seen the animal, for it is sufficient to see them to be at once convinced of their true functions.

The envelope of the body of the hydatina consists of a double transparent membrane, the two layers of which are in contact with, and scarcely distinguishable from, each other, when the animal is in a state of repose. But, upon the contractions of two or more of the muscles, the internal membrane into which they are inserted becomes separated to a greater or less distance from the external. During the whole of these phenomena the stomach, ovaries, and the whole of the viscera, are perfectly visible through the transparent muscles.

These principal muscles are four pairs, which take their origin from the opposite ends of the animal, and proceed in a radiated manner to be inserted by broad striated bands near the middle of the body (between the fourth and fifth pair of twigs given off from what Dr Ehrenberg calls the great dorsal vessel). The four upper or anterior muscles rise by narrow insertions from the junction of the head with the body at the root of the rotatory organs; the four posterior or inferior, from the point of insertion of the bifid tail into the body. The extent of insertion of these muscles is much greater in the *Eosphora*, *Philodina* and *Rotifer*, than in the *Hydatina*; in them it reaches at least from the second to the sixth of the above mentioned transverse twigs *.

* The following are the names which Dr Ehrenberg gives to these muscles:

1. Musculus dorsalis anterior,
2. .... posterior.
3. Musculus lateralis dexter anterior,
4. .... posterior.
5. Musculus lateralis sinister anterior,
6. .... posterior,
7. Musculus ventralis anterior,
8. .... posterior

These great longitudinal muscles are distinct to the most unpractised eye, but Dr Ehrenberg views as of a muscular character, 1. The seventeen sections of the rotatory organ in the Hydatina, which must be the principal agents in directing the motions of the ciliæ; 2. A contraction or sphincter near the extremity of the cloaca; 3. A striated organ behind the cloaca, which he considers, from its situation, as an acceleration of the seminal fluid, a *musculus ejaculatorius.* In none of these, however, except the last, can the existence of a fibrous tissue be considered as beyond a doubt; though, from their situation, it is more than probable that this is their true nature. All of these parts seem to be attached to the inner layer of the external double membrane, and to be unconnected with the subjacent viscera. It is not improbable that the tail may possess some proper muscles, as its motions are not performed laterally in common with the trunk, but by an alternate retraction and elongation.

3. *Generative System.*—The partizans of the *generatio spontanea* vel *primitiva*, who so long stood their ground in the class of Entozoa *, after being forced to relinquish this position, by the discovery of the ova of these parasitic animals, took refuge in the darkness and obscurity of the microscopic infusoria, where they were almost secure of an undisturbed possession, while there was nothing known concerning them except as a homogeneous mass of transparent jelly, endowed with a few active motions; and where their negative arguments could only be attacked by analogical reasonings.

The candid and impartial mind of Müller himself, too rigid an observer to be seduced by the allurements of theory, considered the infusory animals as furnishing an incontrovertible argument for the existence of certain living forms, which are neither of oviparous nor gemmiparous origin, but derive their existence immediately from a certain indestructible living generative energy inherent to all matter;—for this very plain reason, that he had never witnessed the secrets of their origin. Such a conclusion, though perhaps too hasty, is allowable in such an observer. When, however, we see other men of distinguished

* We are surprised that this class should still be ranged under its ancient category by the anatomical school of Halle.

talent, such as Treviranus and Oken, take up the question, where, if it were possible, they ought to have ended, and assume at once the existence of a mysterious power inherent in organic matter of generating infusory and other molecular animalcules, which form by their aggregation all organic living forms, and into which the latter are, at the cessation of their proper vitality, again resolved; we cannot help referring them to the well known maxim of Bacon, that "Homo naturæ minister et interpres tantum facit et intelligit quantum de natura ordine re vel mente observaverit: nec amplius scit, aut potest."

The observations of Dr Ehrenberg have not only given an additional extension to the great principle of Harvey, *omne vivum ex ovo;* but have, by a connected train of ocular demonstration, proved the existence in this class of the whole three species of generation, the viviparous, the oviparous, and the gemmiparous, and even of the simultaneous exercise of two of these in the same individual, at different epochs of its existence. Waiving at present the corroboration which this might give to the view of infusory animals forming a parallel series to their more apparent prototypes, let us proceed to state shortly a few examples of each of these varieties.

In the interior of the *Rotifer vulgaris* we often see young animals of a diminutive size (that of the parent varying from $\frac{1}{4}$th to $\frac{1}{8}$th of a line), perfectly formed, and near the period of exclusion, which already possess the two red points (eyes) near their anterior extremity, and a distinct mouth and head. They assume various postures in the interior of the parent trunk, being at times coiled up in a spiral form, or extended to their whole length. These same fœtus, if we may so call them, Dr Ehrenberg has seen excluded in a living state from the parent. All the individuals of the *Hydatina* are hermaphrodite, possessing the completely formed male and female organs. The female consists of an ovarium, which, when in the unimpregnated state, is an oval perfectly transparent bilobed bladder-like body, closely embracing the lower part of the intestinal tube. When in an impregnated state, it increases very much in size, being augmented by the addition of two or more oval appendages, so that the whole mass fills the greater part of the posterior half of the body of the animal. When quite ready to burst it assumes a greenish-grey colour. These rounded bodies communicate by a canal, scarcely perceptible in the unimpregnated state, broad and distinct when nearly ripe, with the cloacal dilatation formerly noticed as existing near the anal orifice of the intestine. That the ova are not internal gems, an opinion entertained by many older observers, such as Lamarck and others, is proved not only from the above mentioned development and connections of their containing vesicles, but also by the distinct existence of the three substances which in the ova of the Entozoa M. Rudolphi considers as the chorion, allantois and amnion. In the centre of many ova there can be recognised a darker point, which is either the embryo, or cicatrix in which the latter is developed.

The adult Hydatina possesses, besides, two organs which Dr Ehrenberg considers as the male organs of generation, but the real nature of which is a little more doubtful than that of the preceding. They resemble very much in form the milt of fish, consisting of two elongated bodies, extending nearly the whole length of the animal, exterior to the ovaria, broader towards the head, diminishng towards the tail. They terminate (a strong corroboration of this view of their true nature) in a number of spirally convoluted tubes, which finally open by two separate canals immediately behind the oviduct. These spiral convolutions are enveloped by an organ of a very singular nature, the function of which is very obscure: it is oval, transparent, remarkable for its irritability and sudden changes of form; at one time swelling out into a vesicular form, at another contracting into a small glandular looking organ. Dr Ehrenberg at one time considered it to bear some analogy to an uterus; but it is more probably connected with some office in applying the seminal fluid to the ova previous to the exclusion. This organ is wanting in the *Rotifer* and *Philodina*, where the male apparatus otherwise resembles very closely that of the Hydatina.

In the *Kolpoda cucullus*, the parent animal excludes the ova in the form of extremely minute globules, bearing much similarity to some of the species of the genus *Monas*, connected by a number of filaments interwoven together in a reticular form. In an animal $\frac{1}{24}$th of a line in diameter, that of the ova was $\frac{1}{1000}$th of a line. The young Kolpoda were $\frac{1}{144}$th of a line before they were distinctly seen to excite currents, and swallow the coloured particles. In the genus *Vorticella* there seems to be a combination of the oviparous and gemmiparous generations. The single species *Convallaria*, has, from their entire ignorance of its mode of development, been subdivided into no less than six distinct genera, by different observers, according to the variety in its form at different stages of its existence. It first appears in the form of minute points, not more than $\frac{1}{1000}$th of a line in diameter, scattered upon the peduncles of a group of adult Vorticellæ. After a time these minute points enlarge in size, and send out delicate peduncular prolongations to the larger adult roots, in which state Schrank styled them *Vorticellæ monedicæ*. When still more advanced, these peduncles become coiled up in a spiral form. And when they may be considered as having reached their complete organic development, though still much inferior in size to what they afterwards attain, the usual currents may be observed in the coloured solutions in which they are immersed. The same species propagates itself by gems, on the separation of a part of its body from the parent trunk. This is performed in three different ways, each of which has been dignified with the title of a distinct form.

The first is the longitudinal division in which the animal divides itself into two nearly equal halves. A fissure first appears traversing the whole length of the body; this becomes deeper anteriorly, where two horns are now visible, each provided with a distinct set of ciliæ, and a mouth, recognisable by the two currents of colouring particles directed to the apices of the two horns. The fissure becomes deeper and deeper, till they form two distinct, perfectly formed animals, attached to the apex of a single peduncle; one of these is soon detached from the latter, when it agrees in form exactly with Lamarck's genus *Urceolaria*. When the same animal moves with the hinder part forward, it forms Schrank's genus *Ecclissa;* when the conical basis by which it was attached to the peduncle, has not quite disappeared, it forms Bory de St Vincent's genus *Rinella;* and when a little broader and more bell-shaped, with apparently only two ciliæ, it is the genus *Kerobalanus* of the same author; when fully provided with ciliæ, without any remaining vestige of the conical appendage, it is the genus *Craterina*. This Vorticella also passes through the same phases of a *transverse* division into two equal independent animals. The third method is the true gemmiform division, as in the Hydræ and Planariæ, in which a small bud is given off from the posterior surface of the animal, which is provided with ciliæ, and when separated from the parent trunk, is still of a very diminutive size.

Such are a few of the observations on the generation of these animals, from which it will be seen that they are but in their commencement, and that much remains to the patience and labour of future observers.

4. *Vascular System?*—The existence of a digestive, a muscular, and a generative system of much complexity, and very far from what we might consider as their simplest expression, may now be viewed as an ascertained fact with regard to infusory animals. The existence of the two systems which remain for our attention, viz. the vascular and nervous, is as yet somewhat problematical. The organs on which Dr Ehrenberg confers these appellations, are very apparent, but much doubt exists with regard to their real functions.

What has been denominated a vascular system is distinctly visible only in the *Hydatina senta.* Traces of a similar arrangement are now and then perceptible in the *Eosphora*, in particular positions of the animal, but they quite disappear when the integuments are in a state of strong tension. In the former, a series of transverse lines of a white colour, and inferior transparency to the rest of its body, succeed one another at regular intervals, from the head towards the tail. These transverse striæ might at first be taken for muscles, but they differ from these entirely in their aspect and connections. They are nine in number, exactly parallel to, and nearly at equal distances from, each other. At first sight they seem to be complete rings encircling the whole body; but, upon a closer inspection, they are observed to diminish in breadth, and finally vanish on approaching the inferior or abdominal surface of the animal. On the contrary, they augment in diameter towards the back, where they all terminate at right angles, in a line, of an exactly similar appearance to themselves, running in a longitudinal direction from the head to the tail. This longitudinal line or vessel is nearly twice the caliber of any of its tributary transverse twigs.

It will be observed, that the disposition of this main dorsal trunk, with its collateral branches, is almost exactly that of the vascular system of the Ascidia, so beautifully demonstrated by M. Savigny, which is a strong argument for their being of the same character. No motion of an internal fluid is discernible in their interior, nor has any pulsation, analogous to a heart, been ever observed. Both these phenomena, which would decide the question as to their true nature, Corti asserted that he had observed in the *Rotatoria* and *Brachionus*, but he was deceived by the tremulous motion of the canal, leading from the mouth to the œsophagus. The same was the case with Gruithuysen, who mistook the motion of the intestine in the *Paramæcium Aurelia* for that of a sap-like fluid. It is worthy of note, that these white striæ are attached to the internal, not to the external tunic of the integuments.

5. *Nervous System* *.—This name is given to a series of six or seven round glandular-looking greyish bodies, which envelope the upper or dorsal part of the œsophagus of the *Hydatina*. They are closely connected together, and are distinguished from all the other viscera of the body by their darker tint. The uppermost of these bodies (ganglia), or that situate in the mesial place, is much larger than the rest, and gives off, from its apex, a slender branch which proceeds upwards towards the integuments at the back of the neck a little before the second pair of vascular twigs, where it forms a slight enlargement (ganglion); it does not stop here, but returns back and unites again, not with the large ganglion from which it was originally given off, but in one of the adjacent smaller ones. A complete circle is thus formed, bearing some resemblance to the nervous

* According to all our ideas of known physiological laws, the existence of active voluntary motion presupposes the necessity of an animating nervous system. Hitherto, however, no attempt had ever been made to prove its existence. But here again in these animals, excluded by their delicacy and minuteness from the ordinary means of anatomical investigation, the transparency of their tissues, as it has enabled us to discover the existence of a muscular, has no less assisted us in the more than probable discovery of its necessary appendage, a nervous tissue.

circle, which encircles the œsophagus of the mollusca, except that in this case the whole circle is situate on the dorsal or upper side of that canal. From the point of contact of this nervous circle with the dorsal vessel, it gives off two very slender twigs forward to the anterior part of the head, where, in other forms of the Rotatoria, such as the *Rotifer vulgaris*, the two red points (eyes) are situate. In some, such as the *Eosphora najas*, a single large red point is situate on the back of the neck, in the exact position of the ganglion at the apex of the circle *. The above mentioned large mesial œsophageal ganglion (brain) sends off posteriorly another branch of much larger size, backwards along the abdominal surface of the animal, which closely adheres to the internal layer of its double envelope.

That these different filaments and ganglia, to which we have given the name of nerves, are not muscles, is evident from their form, their mode of insertion into the integuments, and because in the contractions of the animal they are not shortened, but assume a serpentine form, being apparently quite passive. They are not vessels, because no pulsation nor motion of a contained fluid has been hitherto perceived through their transparent tissues. If they are not organs of an entirely unknown nature, the whole analogy of their form and position, compared with that of the nervous system in other invertebrate animals, favours the idea of this being their true nature.

We may here consider as appendages to the nervous system, those coloured points situate in the anterior part of the head of these animals, and most usually on the dorsal surface, which have been considered as eyes. As already noticed, the first discovery of these organs was made in 1816 by Nitsch, who saw in the *Cercaria viridis* (now referred by Dr Ehrenberg to the genus *Euglena*) three black scaliform points. In the *Rotifer vulgaris*, their pigment is of a red colour, and they are three in number, two small ones at its anterior extremity, and a single larger one at the nucha in the situation of the apex of the

* The best view of the disposition and appearances of the œsophageal ganglia, is got from the dorsal side of the animal, in a line with the great dorsal vessal. The nervous collar given off from the brain, is however best seen on a lateral view.

Fig. 2.

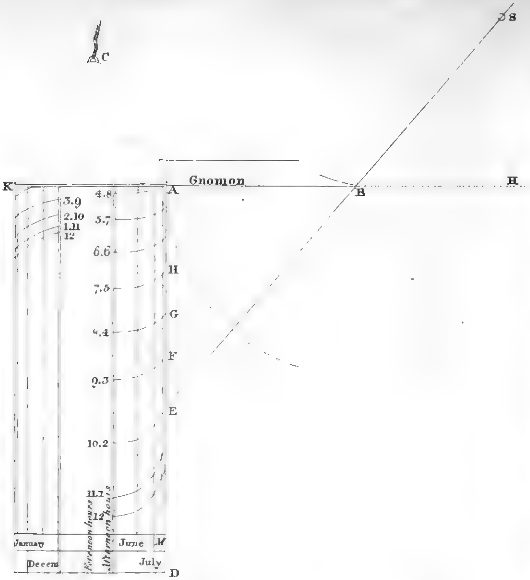


Fig. 3.

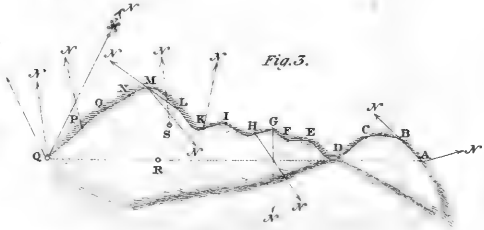
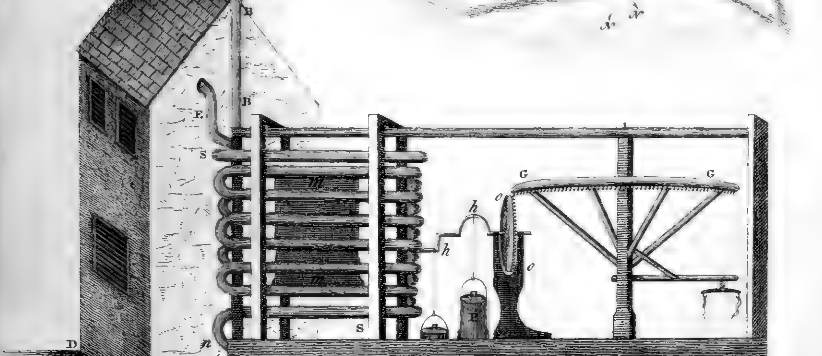


Fig. 1.



E. Mitchell sculpt.

above mentioned nervous circle in the *Hydatina ;* and it is very probable that the two filaments, which in the latter animal are sent forwards from this ganglion, or even the ganglion itself, subserve the purposes of vision. The number, disposition, and colour of these points is the same in the *Eosphora najas*, where the mesial eye is still larger and more distinct. In the *Philodina erythrophthalma* their colour is the same, but they are only two in number, (the most common disposition in this class), much smaller, and situate more posteriorly. In the *Lepadella ovalis* one only is visible of considerable size in the mesial situation of the large one of the Eosphora *.

(To be concluded in our next Number.)

Plan for Cooling Rooms and Ventilating them in Tropical Climates. By Captain Robert Wauchope, R. N. Communicated by the Author. (With a Plate.)

Nothing can be more simple than the plan adopted for warming houses in cold climates by means of heated air, to accomplish which requires no mechanical process whatsoever.

The reverse, however, is more difficult, viz. the cooling and ventilating houses in warm climates, where the air in the interior of the house is always cooler than that which is outside. In the dead calms of the tropics this can only be effected by mechanical means, first cooling the external air, and then forcing it into the room by pressure. In India, indeed, the punka is used; but this machine does not change the air in the room, being merely a large fan, and is of no service for ventilating, which is the great desideratum for soldiers' barracks and hospitals, &c.

The plan I propose for this purpose, which is shown by the accompanying model and drawing (Pl. IV. Fig 1.), is as follows:

The pipes, which should be of about six inches in diameter, are made of porous earthenware, and are connected by bent pieces to their ends, as seen in the model, so that a blast of air may pass freely from the lower pipe in connection with the bellows or funnel, to the uppermost, which conveys it into the

* The Plate illustrative of Ehrenberg's discoveries will be given in next Number of Journal, along with the conclusion of the article

apartment to be ventilated. The pipes are piled, in the manner shewn, round the fanners, which are worked by the gin; these must be wetted from time to time, and in this way a very great evaporation takes place on the outer surface of the pipes, which cools the air in its passage through them. One pair of fanners may in this way act upon three or four hundred yards of pipe, as there may be a double or treble pile connected together in the same way as the one represented in the model.

The pipes should be covered over by a shed, open at the sides, with a flat roof of straw or leaves, impervious to the sun, but not to the rain; so that during the rains, there need be no necessity for wetting the pipes by hand: and should there be any wind, the gin may be stopped, and the funnel will then convey the air into the pipes; so that when there is any wind, the air may be cooled and conveyed to the apartment without any mechanical operation.

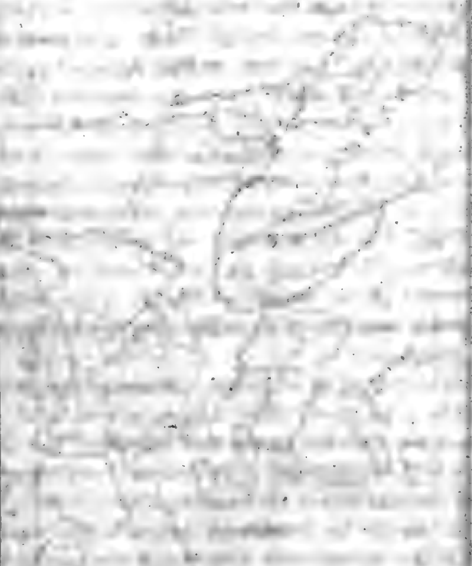
The gin, which is worked by a bullock, will be therefore only required during the dead calms, when not a breath of wind is stirring; and at such a time the cooled and refreshing air will come as medicine to the sick soldier in his hospital, and impart vigour and sound sleep to him in his barracks.

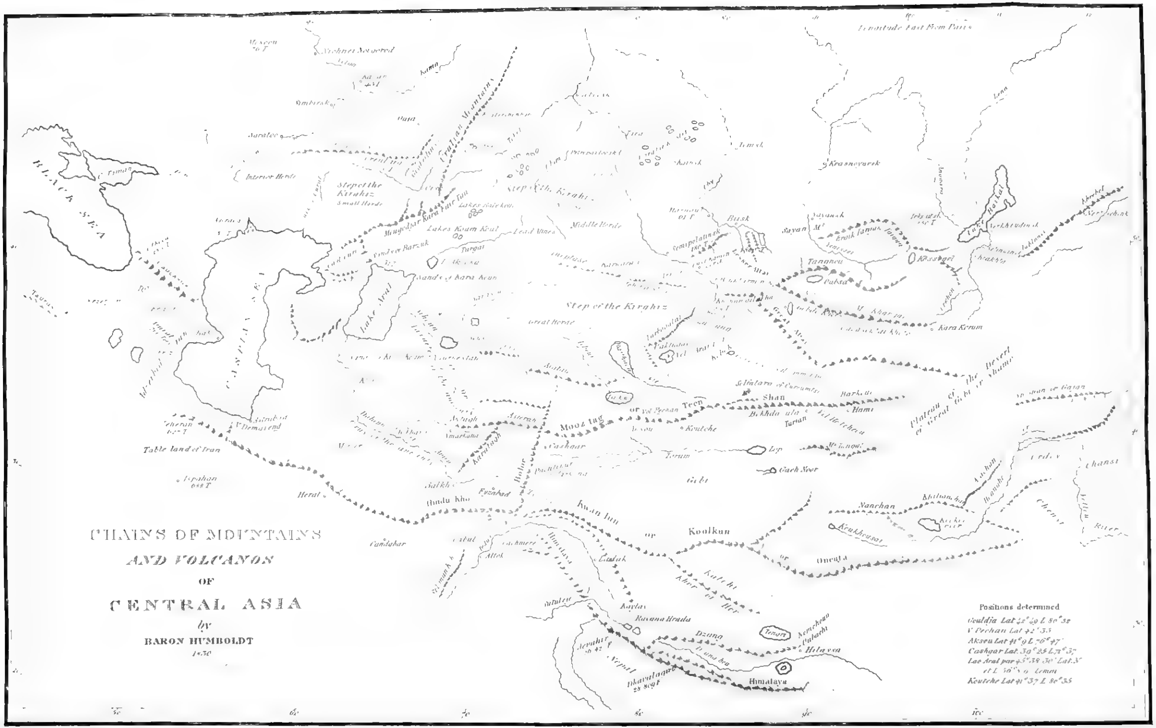
The cooled air should be introduced into the apartment through a hole in the ceiling, with a screen, a few inches in front of it, and of a larger circumference than the hole, to spread the cooled air over the room, which will of course fall by its greater specific gravity; and there ought to be openings in the upper part of the wall of the room, to permit the hot displaced air to escape.

Should the mode of wetting the pipes by hand be thought too laborious, the best plan would be to have a cistern upon the roof, filled by a pump made to work by the gin, and when they required wetting, a valve might be opened, and the water spread over them by the same means as that employed for watering the streets.

The hydrostatic bellows employed in the model was suggested to me by Mr Howel, as that which is easiest to work, and the least friction. I also feel indebted to him for making the model I have the honour of laying before you *.

* It is evident that this apparatus will work but imperfectly when the air is very moist.—EDIT.




CHAINS OF MOUNTAINS
AND VOLCANOS
OF
CENTRAL ASIA
by
BARON HUMBOLDT
1830
BLACK SEA
CASPIAN SEA
Lake Aral
Step of the Kirghiz
Moos tag
Kuan lun
Koolkun
Himalaya
Table land of Iran
Herat
Candahar
Cashgar
Lop
Gobi
Hami
Kara Kerum
Krasnoyarsk
Lake Baikal
Positions determined
Nepal
Shan
Teen

Description of Plate IV.

A B C D Represents soldiers' barracks, with the ventilating machine placed at the gable end.

E The pipe conveying the cooled air, which enters the room through a hole in the ceiling. *n n* a pipe connected with the hydrostatic pump P P, which conveys the air to the pipe E, after having been cooled by passing through all the continuous pipes of porous earthenware S S. In the pipe *n n* there is a valve opening upwards, allowing the air to pass to E, but in no other direction.

B B A pipe connected with the funnel F, which is fixed on the top of the house, in the same manner as that used over a malt-kiln, made so as always to present its open side to the wind. It is connected at the bottom with the pipe *n n*, and at its junction has a valve opening down, so as to permit the air to pass down from the funnel, but not upwards: this prevents the air passing up through the funnel in a calm, when the gin is used, and the other valve in the pipe *n n* prevents the air escaping through the pump *p p*, when the funnel only is used.

m m The fanners seen between the pipe S S, and round which they are coiled. They are worked by the crank *h h*, which also works the pumps P P, by means of the toothed-wheel *o o*, connected with the gin G G.

On the Mountain-chains and Volcanoes of Central Asia, with a Map of Chains of Mountains and Volcanoes of Central Asia. By M. de Humboldt*. (With a Map.)

Volcanoes, which demonstrate a perpetual communication between the earth which is fluid, or in a state of fusion, and the atmosphere surrounding its hardened and oxidated surface, are, by their connexion with the formation of beds of rock-salt, with *Salses* (small conical hills, which in their eruptions emit mud, naphtha, gases unfit for supporting life, and sometimes also, but only for a short period, flames, vapours, and blocks), with hot springs, earthquakes, and the upraising of mountains, an object of so great importance for every thing which appertains to the observation of nature, that they interest not only geologists, but likewise natural philosophers, in the general acceptation of this term. Leopold von Buch has already, in his great work on the

* This memoir we consider of high importance, as illustrating not only the geography, but also the geognosy, of several interesting parts of Central Asia.

Canary Isles*, explained, with much talent, luminous ideas upon the distribution of volcanoes, which are sometimes in isolated groups around a central volcano, at other times arranged longitudinally in a series. The memoir which I now present on these volcanic phenomena, situated at a great distance from the sea, is certainly much less important; it treats of the local phenomena of Central Asia, and of the interior of South America, concerning which I have had opportunities of collecting information little known hitherto. We know still so little of the kind of mysterious connexion of volcanoes in activity with the vicinity of the sea, that every thing which relates to a volcano of which we learn the existence very unexpectedly in the interior of a continent, gives a very high interest even to a local phenomenon.

The central and interior portion of Asia, which forms neither an immense cluster of mountains nor a continued table-land, is crossed from east to west by four grand systems of mountains, which have manifestly influenced the movements of the population; these are, the Altaï, which is terminated to the west by the mountains of the Kirghiz; the Tëen-shan, the Kwan-lun, and the Himalaya chain. Between the Altaï and the Tëen-shan, are placed Zungaria and the basin of the Ele; between the Tëen-shan and the Kwan-lun, Little or rather Upper Bucharia, or Cashgar, Yarkand, Khoten, the great desert of Gobi (or Cha-mo), Toorfan, Khamil (Hami), and Tangout, that is, the northern Tangout of the Chinese, which must not be confounded with Tibet or Se-fan; lastly, between the Kwan-lun and the Himalaya, Eastern and Western Tibet, where H'lassa and Ladak are situated.

1. *The system of the Altaï* encompasses the sources of the Irtish, and of the Yenisseï or Kem; to the east, it takes the name of Tangnu; that of the Sayanian mountains between lakes Kossogol and Baikal; farther on, that of the lofty Kentaï and the mountains of Dauria; lastly, to the north-east, it joins the Yablonnoy-khrebet, the Khingkhan and the Aldan mountains, which stretch along the sea of Okhotsk. The mean lati-

* This splendid and very valuable work we trust to see translated into English. If published in octavo, it would be accessible to every geological reader, and find a place in every library of Natural History in Britain.—EDIT.

tude of its course from east to west is between 50° and 51° 30′. We shall soon have satisfactory notions respecting the geography of the north-eastern part of this system, between the Baikal, Yakutsk, and Okotsk, for which the world will be indebted to Dr Erdmann, who has recently traversed those parts. The Altaï, properly so called, scarcely occupies seven degrees of longitude; but we give to the northernmost portion of the mountains encompassing the vast mass of high land of Inner Asia, and occupying the space comprised between the 48th and 51st parallels, the name of the *System of the Altaï*, because simple names are more easily impressed upon the memory, and because that of Altaï is best known to Europeans, from the great metallic wealth of these mountains, which now annually yield 70,000 marks of silver and 1900 marks of gold *. The Altaï, in Turkish, in Mongol, Altaï-in-oola, 'gold mountain,' is not a chain of mountains, forming the limit of a country, like the Himalaya, which bounds the table-land of Tibet, and which consequently lowers itself abruptly only on the side of India, which is lower than the other country. The plains adjoining lake Zaïsang, and especially the steppes near lake Balkashi, are certainly not more than 300 toises (1968 English feet) above the level of the sea.

I avoid, intentionally, in this paper, conformably to the statements I collected on the spot, employing the term Lesser Altaï, if this term is applied to the vast mass of mountains situated between the course of the Narym, lake Teletsky, the Bia, Serpent Mountain, and the Irtish above Oustkamenogorsk, consequently the territory of Russian Siberia, between the 79th and 86th meridians east of Paris, and between the parallels of 49° 30′ and 52° 30′. This Little Altaï is probably, owing to its extent and elevation, much more considerable than the Great Altaï, whose position and existence as a chain of snowy mountains are, perhaps, equally problematical. Arrowsmith, and several modern geographers, who have followed the model he has arbitrarily adopted, give the name of Great Altaï to an imaginary continuation of the Tëen-shan, which is carried to the eastward of Khamil (Hami) and Barkoul (Chin-se-foo), a Manchoo town, and runs to the north-east, towards the eastern

* A mark is equal to 4608 grains.

sources of the Yenissëi and Mount Tangnu. The direction of the line of separation of the waters, between the affluents of the Orkhon and those of the Aral-noor, lake of the steppe, and the unfortunate practice of marking by high chains of mountains where systems of streams separate, have occasioned this error. If it be desired to retain on our maps the name of Great Altaï, it should be given to the succession of lofty mountains ranged in a course directly opposite (parallel to the chain of the Khangai*), or from the north-west to the south-east, between the right bank of the Upper Irtish, and the Yeke-Aral-noor, or Lake of the Great Isle, near Gobdo-Khoto.

" There, consequently, to the south of the Narym and of the Bukhtorma, which bounds what is called the Little Russian Altaï, was the primitive abode of the Turk tribes; the place where Dizabul, their grand khan, towards the close of the sixth century, received an ambassador from the Emperor of Constantinople. This *gold-mountain* of the Turks, the *Kin-shan* of the Chinese, a name with the same signification, bore heretofore also those of *Ek-tag* and *Ektel*, both of which probably have an analogous meaning. It is said that more to the south, under the 46th parallel, and almost in the meridian of Pijan and Toorfan, a lofty peak is still called in Mongol *Altaïnniro*, ' summit of the Altaï.' If some degrees farther to the south, this Great Altaï unites itself to the Naiman-ula mountains, we there find a transverse ridge which, running from the north-west to the south-east, joins the Russian Altaï to the Tëen-shan, northward of Barkoul and Hami †. This is not the place to

* " Mount Khanggay-ula is to the north of the source of the Orkhon. Its summits are lofty and considerable. This chain is a branching of the Altaï, which comes from the north-west: it extends to the eastward to the rivers Orkhon and Tula with their affluents, and becomes the Kenteh of the Khinggan. A branch of this chain separates to the west, and runs to the north under the name of the Kuku-daban; it encompasses the Upper Selengga and all its affluents, which take their origin in it, and then runs a distance of 1000 *le* into the Russian territory. The Orkhon, the Tamir, and their affluents, have likewise their sources in this chain, which is probably the same which the Chinese distinguish by the name of Yang-jin-shan.—Klaproth.

† " The Chinese (in their *imperial geography of China*), in tracing the direction of the Great Altaï from the north-west to the south-east, make it almost re-unite itself to the Tëen-shan, which corresponds exactly with what M. de Humboldt states.—Klaproth.

develope how the system of north-western direction, so general in our hemisphere, is traced in the beds of the rocks, in the line of the Alps of Alghin, of the lofty steppe of the Chuya, of the chain of the Jyiktu, which is the culminating point of the Russian Altaï, and in the hollows of the narrow valleys, where flow the Chulyshman, the Chuya, the Katunia, and the Upper Charysh; lastly, in the whole course of the Irtish from Krasnoyarskoi to Tobolsk.

" Between the meridians of Oust-Kamenogorsk and of Semipolatinsk, the system of the Altaï mountains extends from east to west, beneath the parallels of 59° and 50°, by a chain of hills and low mountains, for 160 geographical leagues, as far as the steppe of the Kirghiz. This range, though of very small importance in respect to size and elevation, is highly interesting to geognosy. There does not exist a continuous chain of Kirghiz mountains, which, as the maps represent under the names of Alghidin-tsano or Alghidin-chamo, unites the Ural and the Altaï. Some isolated hills of 500 or 600 feet high, groups of small mountains, which, like the Semi-tau near Semipolatinsk, rise abruptly to the height of 1000 or 1200 feet above the plains, deceive the traveller who is not accustomed to measure the inequality of the soil; but it is not less remarkable that these clusters of hills and small mountains have been raised across a furrow which forms this line of division of the waters between the affluents of the Saras, or to the south in the steppe, and those of the Irtish to the north: a fissure which follows uniformly, as far as the meridian of Sverinagolovskoy, the same direction for sixteen degrees of longitude.

" In the line of division of the waters between the Altaï and the Ural, between the 49th and 50th parallels, is observable an effort of nature, a kind of attempt of subterranean energy, to force up a chain of mountains; and this fact recalls powerfully the similar appearances I remarked in the new continent.

" But the non-continued range of low mountains and hills of crystallized rocks, by which the system of the Altaï is prolonged to the west, does not reach the southern extremity of the Ural, a chain which, like that of the Andes, presents a long wall running from north to south, with metallic mines on its eastern side: it terminates abruptly under the meridian of Sverinogovloskoy, where geographers are accustomed to place the Alghinic mountains, the name of which is entirely unknown by the Kirghiz of Troitsk and of Orenburg.

"II. *System of the Tëen-Shan.*—Their mean latitude is 42°. Their culminating point is perhaps the mass of mountain remarkable by its three peaks, covered with eternal snows, and celebrated under the name of Bokhda-ula, or 'Holy Mountain,' in the Mongol-Calmuc tongue; which has caused Pallas to give to the whole chain the denomination of Bogdo. From the Bokhda-ula, the Tëen-shan runs easterly towards Barkoul, where, to the north of Hami, it sinks abruptly, and spreads itself to the level of the high desert called the Great Gobi, or Shamo, which extends south-west and north-east, from Kwachow, a town of China, to the sources of the Argun. Mount Nomkhun, to the north-west of the Sogok and the Sobo, little lakes of the steppe, denotes perhaps by its position, a slight swell, an angle in the desert; for after an interruption of at least ten degrees of longitude, there appears, a little more to the south than the Tëen-shan, in my opinion, as a continuation of this system, at the great bend of the Hwang-ho, or Yellow River, the snowy chain of the Gajar, or Yn-shan, which runs likewise from west to east, under the parallels of 41° and 42°, consequently to the north of the country of Ordos.

"Let us now return to the neighbourhood of Toorfan and the Bokhda-ula, and follow the western prolongation of the second system of mountains; we shall perceive that it extends between Gulja (Ele), the place whither the Chinese government exiles criminals, and Kucha; then between Temoortu, a large lake, the name of which signifies 'ferruginous water,' and Aksu, to the north of Cashgar, and runs towards Smarkand. The country comprised between the first and second systems of mountains, or between the Altaï and the Tëen-shan, is closed on the east, beyond the meridian of Peking, by the Khingkhan-ula, a mountainous crest which runs SSW. and NNE.; but to the west it is entirely open on the side of the Chwei, the Sarasu and the lower Sihoon. In this part there is no transverse ridge, provided, at least, we do not regard as such the series of elevations which extend north and south, to the west of lake Zaisang, across the Targabatay, as far as the north-eastern extremity of the Ala-tau *; between lakes Balkash and Alak-tugulnoor, and then beyond the course of the Ele, to the eastward of the Temoortu-nor (between lat. 44° and 49°), and which present the appearance of a wall occasionally interrupted on the side of the Kirghiz steppe.

It is quite otherwise with the portion of Central Asia, which is bounded by the second and third systems of mountains, the Himalaya and Kwan-lun. In fact, it is closed to the west in a very evident manner by a transverse ridge, which is prolonged from south to north, under the name of Bolor or Beloortagh † This chain separates Little from Great Bucharia, and from Cashgar, Badakshan and the Upper Jihoon or Amoodaria. Its southern portion, which connects with the system of Kwan-lun mountains, forms, according to the denomination used by the Chinese, a part of the Tsung-ling. To the north it joins the chain which passes to the north-west of Cashgar, and bears the name of the defile of Cashgar (*Cashgar-divan* or *davan*), according to the narrative of Nasaroff, who, in 1813, travelled as

* This is a name which has occasioned much confusion. The Kirghiz, particularly those of the grand horde, give the title of Ala-tagh (*Alatau*, 'speckled mountains') to a series of elevations extending from west to east, under the parallels of 43° 30′ to 45°, from the Upper Sihoon (Syr-daria or Jaxartes), near Tonkat, towards lakes Balkashi and Temoortu. The eastern portion of the Ala-tau rises considerably at the great sinuosity made by the Sihoon to the north-west, and connects with the Kara-tau ('Black Mountain') at Taras or Turkestan. The natives likewise give the name of Alatau to the mountains to the south of the Tarbagatay between lakes Ala-kul, Balkashi, and Temoortu. Is it from these denominations that geographers have been in the habit of calling the whole second system of mountains that of Tëen-shan, Alak or Ala-tau? The Oolug-tagh, or 'Great Mountain,' named on some maps Oulug-tag Oolu-tau, and Ooluk-tagh, must not be confounded with the Ala-tau or Ala-taghi.

† According to M. Klaproth, this transversal ridge is named in Ouigoor *Boolyt-tagh*, 'Cloudy Mountain', on account of the extraordinary rains which fall uninterruptedly in this latitude during three months. West of this transverse ridge of Beloor, is the station of Pamir, nearly under the parallel of Cashgar. Marco Polo has named after this station a table-land, of which modern geographers have made sometimes a chain of mountains, sometimes a province situated farther to the south. This district is still interesting to the naturalist, on account of the celebrated Venetian Traveller having first observed there a fact, which has so often occurred in my experience, at considerable elevations, in the New World, namely, that it is extremely difficult to light and to keep fire in there.

far as Kokand. Between Kokand, Dervazeh and Hissa, consequently between the still unknown sources of the Sihoon and Amoo-daria, the Tëen-shan rises previous to sinking again in the Khanat of Bokhara, and presents a group of lofty mountains, several summits of which, such as the Takt-i-Suleyman, the crest called Terek and others, are covered with snow even in summer. Farther to the east, on the road which runs from the western bank of lake Temoortu to Cashgar, the Tëen-shan does not appear to me to attain so great an elevation; at least no mention is made of snow in the itinerary from Semipolatinsk to Cashgar. The road passes to the eastward of lake Balkashi, and to the westward of lake Yssi-kul or Temoortu, and traverses the Narun or Narym, an affluent of the Sihoon. At 105 versts to the south of the Narun, it goes over Mount Rovatt, which is pretty high, and about fifteen versts wide; it has a large cavern, and is situated between the At-bash, a small river, and the little lake of Chater-kul. This is the culminating point previous to arriving at the Chinese post placed to the south of the Aksu, a small river of the steppe, the village of Artush, and Cashgar. This city, built on the banks of the Aratumen, contains 15,000 houses and 80,000 inhabitants, but is yet smaller than Samarkand. The Cashgar-davan * does not appear to form a continuous wall, but to offer an open passage at several points. M. Gens expressed to me his surprise that none of the numerous itineraries of Bokharians which he has collected, make mention of a lofty chain of mountains between Kokand and Cashgar. The great snowy mountains seem not to reappear till east of the meridian of Aksu, for these same itineraries mention Jeparleh †, a *glacier*

* The terms *davan* in Oriental-Turki, *dabahn* in Mongol, and *dabagan* in Manchoo, denote not a mountain, but a pass in a mountain; *Cashgar davan*, therefore, signifies only the pass across the mountains to Cashgar.—Klaproth.

† This is the Moosar-tag, or *glacier* between Ele and Kucha. The ice with which it is sheeted gives it the appearance of a mass of silver. A road, called *Mussar-dabahn*, cut through these glaciers, leads from the SW. to the N., or, to speak more accurately, from Little Bucharia to Ele. The following is a description of this mountain by a modern Chinese geographer: 'To the north is the post station of Gakhtsa-karkai, and to the south that of Tamga-tash, or Terma-Khada; they are distant from each other 120 *le*. On proceeding

covered with perpetual snow, on the Kura road, on the banks of the Ele at Aksu, nearly half-way between the warm springs of Arashan to the north of Kanjeilao, a Chinese station, and the advanced post of Tamga-tash.

The western prolongation of the Tëen-shan or Mooz-tag, as the editors of the Memoirs of Sultan Baber called it by pre-

to the south, after quitting the former, the view extends over a vast space covered with snow, which in winter is very deep. In summer, on the top of the ice, snow and marshy places are found. Men and cattle follow the winding paths at the side of the mountain. Whoever is so imprudent as to venture upon this sea of snow is irrecoverably lost. After traversing upwards of twenty *le*, you reach the glacier, where neither sand, trees, nor grass can be seen: the most terrifying objects are the gigantic rocks formed of masses of ice heaped upon one another. When the eye dwells upon the intervals which separate these masses of ice, a gloomy chasm appears, into which the light never penetrates. The sound of the water rushing beneath the ice resembles the report of thunder. Carcasses of camels and horses are scattered here and there. In order to facilitate the passage, steps have been cut in the ice, to ascend and descend, but they are so slippery that they are extremely dangerous. Too frequently travellers find their graves in these precipices. Men and cattle walk in file, trembling with alarm, in these inhospitable tracts. If night surprise the traveller, he must seek shelter under a large stone; if the night happen to be calm, *very pleasing sounds are heard, like those of several instruments combined;* it is the echo which repeats the cracking noise produced by the breaking ice. The road, which is pursued the day before, is not always that which it is convenient to follow the next day. At a distance, to the west, a mountain, which has been hitherto inaccessible, displays its steep and icy summits. The halting-place of Tamga-tash is eighty *le* from this place. A river, called Moossur Gol, rushes with frightful impetuosity from the edges of the ice, flows to the south-east, and joins the Erghew, which falls into lake Lob. Four days' journey to the south of Tamga-tash, is an arid plain, which does not produce the smallest plant. At eighty or ninety *le* further off, gigantic rocks still recur. The commandant of Ushi sends every year one of his officers with oblations to this glacier. The formula of the prayer recited on this occasion is transmitted from Peking by the Tribunal of Rites. Ice is found along the whole crest of the Tëen-shan, if it is traversed lengthwise: but, on the contrary, if it is crossed from north to south, that is in its width, ice is found only in a space of a few *le*. Every morning ten men are employed in the pass of Mussar-tag, in cutting steps for ascending and descending; in the afternoon the sun has either melted them or rendered them extremely slippery. Sometimes the ice gives way under the feet of the travellers, and they are ingulfed, without a hope of ever seeing day-light again. The Mohamedans of Little Bucharia sacrifice a ram previous to traversing these mountains. Snow falls there throughout the year: it never rains.—KLAPROTH.

eminence, deserves a particular notice. At the point where the Beloor-tag joins the right angle of the Mooz-tag, or traverses as a vein this great system, the latter continues its course without interruption from east to west, under the denomination of Asferah-tag, to the south of the Sihon, towards Khojand and Urateppeth, in Ferghana. This chain of Asferah, which is covered with perpetual snow, and is improperly called the chain of Pamer, separates the sources of the Sihon (Jaxartes) from those of the Amoo (Oxus); it turns to the south-west, nearly in the meridian of Khojand, and in this direction is called, as far as near Samarkand, Ak-tag ("White or Snowy Mountain"), or Al-botom. Farther to the west, on the smiling and fertile banks of the Kohik, commences the great dip or depression of land, comprehending Great Bucharia, the country of Maveralnahar, which is so low, and where the highly-cultivated soil and the wealth of the towns attract periodically the invasions of the people of Iran, Candahar, and Upper Mongolia; but beyond the Caspian Sea, nearly in the same latitude, and in the same direction as the Tëen-shan, appears the Caucasus, with its porphyritic and trachytic rocks. One is inclined, therefore, to regard it as a continuation of the rent, in the form of a vein, on which the Tëen-shan rises in the east, just as, to the west of the great group of the mountains of Azerbaijan and Armenia, is observable, in Taurus, a continuation of the action of the fissure of the Himalaya and the Hindu Coosh. It is thus that, in a geognostic sense, the disjointed members of the mountains of Western Asia, as Mr Ritter, in his excellent View of Asia, calls them, connect themselves with the forms of the land in the east.

III. *The System of the Kwan-lun*, or Koolkun, or Tartash-davan, enters Khoten (Elechi *), where Hindu civilization and the worship of Buddha penetrated 500 years before it reached

* The position of Khoten is very incorrectly laid down in all the maps. Its latitude, according to the astronomical observations of the Missionaries Felix d'Arocha, Espinha, and Hallerstein, is 37° 0′; the longitude 35° 52′ W. of Peking. This longitude determines the mean direction of the Kwan-lun

Tibet and Ladak, between the group of mountains of Kookoo-noor and Eastern Tibet, and the country called Kachi.

This system of mountains commence westward of the Tsung-ling ("Onion or Blue Mountains"), upon which M. Abel Rémusat has diffused so much light in his learned *History of Khoten.* This system connects itself, as already observed, with the transverse chain of Bolor; and according to the Chinese books, forms the southern portion of it. This quarter of the globe, between Little Tibet and Badakshan, abounding in rubies, lazulite, and turquoise, is very little known; and, according to recent accounts, the table-land of Khorasan, which runs towards Herat, and bounds the Hindu-Kho or Hindu-Coosh to the north, appears to be a continuation of the system of the Kwan-lun to the west, rather than a prolongation of the Himalaya, as commonly supposed. From the Tsung-ling, the Kwan-lun or Koolkun runs from west to east, towards the sources of the Hwang-ho (Yellow River), and penetrates, with its snowy peaks into the Chinese province of Shen-se. Nearly in the meridian of these sources, rises the great cluster of mountains of lake Kookoo-noor, a cluster which supports itself, on the north, against the snowy chain of the Nan-shan, or Ki-lian-shan, extending also from west to east. Between the Nan-shan and the Tëen-shan, on the side of Hami, the mountains of Tangout bound the edge of the high desert of Gohi or Shamo, which stretches from south-west to north-east. The latitude of the middle portion of the Kwan-lun is about 35° 30′.

IV. *System of the Himalaya.*—This separates the valleys of Cashmer (Serinagur) and Nepal from Butan and Tibet; to the west, it stretches by Jevahir, to 4026 toises (26,420 feet); to the east, by Dhavalaghiri, to 4390 (28,809 feet) of actual height above the level of the sea: it runs generally in a direction from NW. to SE., and consequently is not parallel with the Kwan-lun; it approaches it so nearly, in the meridian of Attock and Jellalabad, that between Cabul, Cashmer, Ladak, and Badakshan, the Himalaya seems to form only a single mass of mountains with the Hindu-Kho and the Tsung-ling. In like manner, the space between the Himalaya and the Kwan-lun is more shut up with secondary chains and isolated masses of mountains, than the table-lands between the first, second, and third systems of mountains. Consequently, Tibet and Kachi cannot properly be compared, in respect to their geognostic construction, with the elevated longitudinal valleys *, situated between the chain of the eastern and western Andes, for example, with the table-land which encloses the lake of Titicaca, a correct observer of which (Mr Pentland) found that its elevation above the sea was 1986 toises (13,033 feet). Nevertheless, it must not be represented that the height of the table-land between the Kwan-lun and the Himalaya, as well as in all the rest of Central Asia, is equal throughout. The mildness of the winters, and the cultivation of the vine †, in the gardens of H'lassa, in the parallel of 29° 40′,—facts ascertained by the accounts published by M. Klaproth and the Archimandrite Hyacinth,—proclaim the existence of deep valleys and circular hollows. Two considerable rivers, the Indus and the Zzambo (Sampoo ‡), denote a depression in the table-land of Tibet, to the north-west and south-east, the axis of which is found nearly in the meridian of the gigantic Javahir, the two sacred lakes of Manassoravara and Ravana Hrada, and Mount Cailasa, or

* In the Andes, I found that the mean height of the longitudinal valley between the Eastern and Western Cordilleras, from the cluster of mountains of Los Robles, near Popayan, to that of Pasco, as well as those in 2° 20′ N. Lat. to 10° 30′ S. Lat., was about 1500 toises (9843 feet). The table-land, or rather longitudinal valley of Tiahuanaco, along the Lake of Titicaca, the primitive seat of Peruvian civilization, is more elevated than the Peak of Teneriffe. However, according to my experience, it cannot be asserted generally that the absolute height to which the bottom of the longitudinal valleys appears to have been raised by subterranean force, augments with the absolute height of the neighbouring chains. In like manner, the elevation of isolated chains above the valleys is very various, showing that at the foot of the chain the raised plain is elevated at the same time, or has preserved its ancient level.

† The cultivation of plants, whose vegetable life is almost limited to the duration of summer, and which, despoiled of leaves, remain benumbed during winter, may be accounted for by the influence which vast table-lands exert upon the radiation of heat; but it is not the same with the less rigour of winters, when we refer to elevations of 1800 to 2000 toises (11,812 to 13,125 feet) at six degrees to the north of the equinoctial zone.

‡ The researches of M. Klaproth have proved that this river, which is entirely separated from the system of the Brahmaputra, is identical with the Irrawaddy of the Burmese empire.

Cailas, in Chinese O-new-ta, and in Tibetan Gang-dis-ri. From this nucleus springs the chain of Kara-korum-padisha, which runs to the north-west, consequently to the north of Ladak, towards the Tsung-ling; and the snowy chains of Hor (Khor) and Zzang, which runs to the east. That of Hor, at its north-western extremity, connects itself with the Kwan-lun; its course, from the eastern side, is towards the Tangri-noor (" Lake of Heaven"). The Zzang, farther to the south than the chain of Hor, bounds the long valley of the Zzangbo, and runs from west to east, towards the Nëen-tsin-tangla-gangri, a very lofty summit which, between H'lassa and lake Tangri-noor (improperly called Terkiri), terminates at Mount Nom-shun-ubashi. Between the meridians of Ghorka, Katmandu, and H'lassa, the Himalaya sends out to the north, towards the right bank, or the southern border of the valley of the Zzang-bo, several branches covered with perpetual snow. The highest is Yaria-shamboy-gangri, the name of which, in Tibetan, signifies " the snowy mountains in the country of the self-existing deity." This peak is to the westward of lake Yamruk-yumdzo, which our maps call Palteh *, and which resembles a ring, being almost filled by an island.

If, availing ourselves of the Chinese writings which M. Klaproth has collected, we follow the system of the Himalaya towards the east, beyond the English territories in Hindustan, we perceive that it bounds Assam to the north, contains the sources of the Brahmaputra, passes through the northern part of Ava, and penetrates into the Chinese province of Yun-nan, where, to the westward of Yung-chang, it exhibits sharp and snowy peaks; it turns abruptly to the north-east on the confines of Ho-kwang, of Keang-si, and of Fuh-kien, and extends with its snowy summits near to the ocean, where we find, as if it was a prolongation of this chain, an island (Formosa), the mountains of which are covered with snow during the greatest part of the summer, which shows an elevation of at least 1900 toises (12,469 feet). Thus we may follow the system of the Himalaya, as a continuous chain, from the Eastern Ocean, and track

* There can be no doubt that *Palteh* is derived from *Bhaldi*, the Tibetan name of a town a little to the north, which has been corrupted by the Chinese into *Peiti* or *Peti*.—Klaproth.

it by the Hindu-Coosh, across Candahar and Khorasan; and lastly as far as the Caspian Sea in Azerbaijan, through an extent of seventy-three degrees of longitude, half that of the Andes. The western extremity, which is volcanic, but covered likewise with snow to Demavend, loses the peculiar character of a chain in the cluster of the mountains of Armenia, connected with the Sangalu, the Bingheul, and Cashmer-dag, lofty summits in the pashalic of Erzeroum. The mean direction of the system of the Himalaya is N. 55° W.

(To be continued.)

On the Ripple Marks made by the Waves, observable in the Sandstone Strata of Sussex. By Gideon Mantell, Esq. F.R.S., F.L.S., &c.

The deep undulations with which the surface of many of the slabs of Horsham-stone are covered, must have been observed by all who have noticed the pavements in the towns and villages where that stone is employed. In some instances the slabs are so rough as to be made use of for stable-yards and crossways, where an uneven surface is required to prevent the feet of horses from slipping when passing over. Obvious as the cause of this curious appearance seems to be, yet it has been a subject of dispute among men of science, the mind being but too apt to seek for a mysterious agent, to explain effects which have been, and still are being, produced by some simple operation of nature.

In the case before us, it appears scarcely possible that any one who examines the markings produced by the undulations of water on sand and mud, on the margins of lakes, rivers, and estuaries, or on the sea-shore, can doubt that characters so precisely analogous as those observable in the Horsham-stone have been effected by a similar operation. In the description of the fossils of Tilgate Forest, a short notice is taken of the phenomenon under consideration: a recent examination of the quarries of Horsham, in company with my friend Mr Lyell, induces me to offer a few additional remarks on this subject.

When a large surface is first exposed, a most interesting appearance is presented, and the spectator is struck with the conviction that he is standing on an ancient shore. In some places the furrows are deep, affording evidence of the water having been much agitated, and the ripple strong; in other instances the undulations are gentle, and are frequently intersected by cross ripples, from a change in the direction of the waves. On some parts of the stone there are slightly elevated longitudinal ridges of sand, made up of gentle risings, disposed in a crescent-like form, resembling most closely the sand ridges which are produced by the little rills which flow back into the sea or river at low water. Some of the slabs are covered with thin angular ridges, irregularly crossing each other like the fissures in septaria, and which have obviously been caused by the deposition of sand into the crevices made in sand or mud by drying. A very considerable portion of the stone (the flat as well as the furrowed variety) is covered with small cylindrical bodies, which have been moulded in the hollows produced by some species of vermes. Similar forms of a larger size also occur; these re-resemble the trails left by mussels, and have probably been occasioned by some of the analogous bivalves whose remains are imbedded in the strata of Tilgate Forest *.

Since, in some instances, the foot-marks of animals (supposed to be reptiles) have been discovered in sandstone of England and Scotland, we examined the slabs in the quarries at Horsham with considerable attention, in the expectation that similar indications might there occur; but although our researches were not attended with success, yet as reptiles are known to have existed in vast numbers on the land and in the water at the period of the formation of these strata, and as the markings on the surface of the stone is a proof that it was deposited in shallow water, and was occasionally left dry, it is more than probable that impressions will sooner or later be discovered. The object of this brief memoir is to draw attention to the subject, in the hope that persons of taste and leisure will pursue the inquiry.

* This appearance is common in the sandstone quarries around Edinburgh.

1. *Progress of Geology.—2. Werner according to Cuvier, Lyell, and MacCulloch.—3. Hutton according to Playfair and MacCulloch.—4. Antiquity of the Earth.*

1. *Progress of Geology.*

The fortunes of this science, during the last half century, have conducted it, by a very remarkable course, at the same time, through four main divisions of its subject, and through the four principal scientific nations of Europe.

Germany: Primary Geology.—The first form under which this portion of knowledge was systematically presented, was mineralogical geology, the cultivation of which had Germany for its point of origin and activity. The disciples of Werner received from their highly gifted teacher an arrangement of rocks, which taught them to distinguish their kinds according to the mineralogical character, and to look for the same succession of such members in every part of the world. As a doctrine generally applicable, nothing can be more hasty and baseless than this. The generality of the type laid down by the school of Freyberg, was an assumption perfectly gratuitous; nor could any progress be made in determining the order of superposition of strata, till the distinction and identification of them were made to depend on all their characters; and of these, the marks derived from their organic contents are incomparably more important than those from their materials *. But to this

* The accomplished author of the above remarks will probably find, on reconsidering his judgment, that it is rather a hasty one. Werner taught that mineralogical, geological, and organic characters, were to be employed in determining formations, and that probably the same general geological arrangements would be found to prevail throughout the earth. But, he added, the truth or falsity of this view, in regard to the similarity of formations, can only be determined by the united labours of geologists continued for a long series of years. He attached much importance to the mineralogical and geological characters, and in this he was right, notwithstanding all that has been said to the contrary. What are modern geologists at this moment doing, but following out the Wernerian mode of investigation, and his view in regard to the universality of formations? Do not geologists in Britain determine the characters of formations according to the Wernerian rules, and is this not also the case on the Continent?—are not the geologists of England endeavouring to identify the formations of our island with those of Germany, France, and Italy?—are not the Americans doing the same?—and do we not find geologists tracing our old red sandstones, coal formations, lias, oolites, &c. throughout India? What is this but attempting to prove the universality of formations?—Edit.

celebrated school we must not refuse the praise of having undertaken the stratigraphical examination of Europe, in a spirit of zeal, of acuteness, and of combination, worthy of the philosophical character of the Germans, and of the vivid and comprehensive mind of the founder of the sect. And even yet we do not possess, for the classification of primary rocks, those, namely, which are not characterized by remains of organized beings, any better means or rules than have proceeded from the Wernerian investigators. Several of the divisions of the floetz or secondary formations, as discriminated by Werner, have undoubtedly also been retained by the most enlightened modern geologists. But we conceive that this arrangement was undeniably constructed at first without any clear or proper appreciation of that organic evidence which alone can authorize its extensive application. It is on this account that we attribute to the Wernerians, as their really valuable distinction, the cultivation of mineralogical or *primary geology.*

England: Secondary Geology.—We turn from them to notice *secondary geology*, a wide department of the science which belongs in a very considerable measure to England. The conviction suggested by an intimate acquaintance with an immense variety, details that the strata of this country may be distinguished by the shells and other fossils which are found in them: that by this means even minute subdivisions of beds may be traced from one end of the kingdom to the other, and recognised unerringly under almost any mode of occurrence. This discovery, so important in itself and in its consequences, is due to Mr Smith; who, as a mineral surveyor, had his attention early drawn to such views. We are informed, that Mr Smith published his "Tabular View of the British Strata" in 1790, and there proposed a classification of the secondary formations of the west of England; but the map of England, in which he embodied the results of many patient and active years' labour, did not appear till 1815; and, in the mean time, others had caught (some probably from him) the same spirit of investigation, and were verifying the same conceptions. The Geological Society of London, founded in 1807, was at the same time an evidence of the existence of these views, and a means of applying them to the analysis of every part of our soil and shore. It so happens, moreover, that our island exhibits, in a form singularly condensed, and yet distinct, most of the members of the secondary stratigraphical series of Europe; and our coasts afford natural sections which eminently facilitate the examination of these phenomena. From these causes it has arisen, as we have already said, that England has hitherto been the head-quarters of secondary geology—the country where its cultivators are most active and successful, and where most of its leading and normal exemplifications are sought.

France: Tertiary Geology.—The glory of the third great branch of the subject, *tertiary geology*, belongs to France, and forms one of the brightest points in the luminous path of discovery which her men of science have trodden in our times. We cannot sufficiently admire the happy conjunction which, at this period of geological investigation, placed together the excavations of the Parisian district, so teeming with new and strange facts, and the vast talents and profound knowledge of Cuvier, so peculiarly adapted to create the new science which these phenomena required for their solution. It was in 1808, that Cuvier and Brongniart began to publish those views of the mineral geography of the neighbourhood of Paris, which soon became a subject of leading curiosity throughout Europe. Their investigations led them to the conviction, that the rock on which Paris rests is composed of a succession of deposites, not extending across the country like the secondary strata, but limited within a certain circle or *basin*, and most remarkable for their contents. It appeared that these rocks contain some beds, characterized by remains, belonging entirely to land and fresh water animals; that above these were other beds, in which the organic remains were exclusively marine; that above these again were other beds, containing bones and shells of fresh water origin, but of kinds entirely different from those of lower fresh water formation. It appeared, too, that those fresh water formations contain bones of various quadrupeds of great size, differing in a curious manner from the animals which at present exist. Many of these remains were of course very imperfect and obscure; and, in all cases, the structure and habits of the animals to which they belonged, could be divined only by the most consummate knowledge of natural history and anatomy. These requisites

Cuvier brought to the task of such unparalleled interest which thus devolved upon him; and he has so well executed it, that in reading his works, and those to which his have given occasion, we seem to be wandering in a land of enchantment. His magical power has called from the slumber of ages the unwieldy and marvellous forms of antediluvian life; and we find around us an array of paleotheriums and anoplotheriums, of extinct crocodiles and pelicans, which appear in all the bodily reality that their present successors exhibit to us in Mr Wombwell's menagerie.

These discoveries were of the most attractive interest, even if we were to confine ourselves to the zoological views which they present, and they speedily led to similar investigations of various spots in Europe, and to the discovery of other basins and deposites more or less resembling those of Paris. But besides this charm, there was another train of inference, or at least of irresistible conjecture, to which they drew men's thoughts. There was contained in the succession of different races of animals, thus unbedded in the materials of our earth, the evidence of changes and revolutions which had taken place in a manner and order hitherto unguessed. Incursions and retreats of the sea, changes in the form and elevation of continents, dislocation and rupture of large portions of the crust of the earth; such and many more were the operations of which the history was read in the facts thus disclosed: and this violence and ruin was interwoven as it appeared with the existence of dry land supporting vegetables and quadrupeds, that were but one remove from those of our present world. The fascination of such speculations would have been all-powerful if the phenomena had not been incalculably better adapted to suggest problems and perplexities, than to help us to their solutions. As the matter was, geologists saw the futility of attempting at present to explain all these strange discoveries by hypothesis, and with an intellectual temperance and self-command, very different from the spirit of former times, went on with their labours, content to be certain and clear in limited propositions, and leaving the true general view of the connexion of those appearances to unfold itself when the proper epoch should arise.

Still it must be allowed, that the almost universal impression among geological speculators was, that the causes by which the earth had been urged from the state evidenced by one formation to that exhibited in another, were different from any agencies of which we have any experience. In the dislocation of provinces,—in the elevation of hills from the bottom of the sea,—in the comminution and dispersion of vast tracts of the hardest rocks,—in the obliteration and renewal of a whole creation, they seemed to themselves to see, without the possibility of mistake, the manifestation of powers more energetic and extensive than those which belong to the common course of every-day nature. They conceive, that what even might be the causes which had been at work in these former ages, their fury was now spent, their task performed, their occupation gone.

They spoke of a break in the continuity of Nature's operations; of the present state of things as permanent and tranquil; the past having been progressive and violent. They considered the existing condition of the earth as separated by a vast chasm from its previous convulsions. They could not imagine how theorists were to pass by any known road from a creation in which scarcely one species of animal (if one) was identical with those which now live, to the world of our contemporary shell-fish and crocodiles; or how the strata of the Isle of Wight, thousands of feet thick, were by any usual machinery to be overturned and set on edge. And these difficulties do no doubt appear, even at this day, so formidable to most geognosts, that they will not acknowledge themselves bound to account for such alarming revolutions, nor do we believe that Mr Lyell, stout-hearted as he his, would have ventured upon this perilous expedition into realms of chaos, if he had not found a half-way station in the fourth class of strata, the *penultimate* * formations of which we now proceed to speak.

Italy: *Penultimate Formations.*—These formations consist of strata more recent than the regular tertiaries to which we have referred, and yet announcing, by their fossils or their position, an antiquity greater than that belonging to the present condition of our globe.

They thus seem to offer themselves as the results of the state of things which last preceded that under which we live and geologize, and indeed they are, in a greater or less degree, interwoven with the existing condition of things. It is curious that this fourth class of phenomena carries us to *Italian rocks* and

* We would rather say *Quaternary* formations.

Italian writers. In this way our still youthful science seems to be completing the grand tour of Europe. The literary history and the natural history of this part of the subject are equally curious; and these are, one and the other, admirably treated of by Mr Lyell, who has, by singular good fortune, skill, and industry, both collected a mass of new and important facts with regard to this fourth class of strata in Italy, and also brought into notice a number of very remarkable geological books and authors, hitherto little known and heard of, at least in this part of the world.—*Whewell.*

2. *Werner according to Cuvier, Lyell, and MacCulloch.*

(1) *Werner according to Cuvier.*—The earth, in fact, is composed of mineral masses, and modern observers have satisfied themselves, that these masses are not thrown together at random. Pallas, during his laborious travels to the extremity of Asia, had remarked that their superposition could be referred to fundamental laws. Saussure and De Luc in traversing in many directions the most elevated mountain-chains of Europe, had confirmed their joint observations. *Werner,* without quitting his own country, has carried the knowledge of these laws to its utmost; and he has been able to read, in the laws, the history of the revolutions of which they are the work.

Tracing every bed throughout its whole length, without permitting himself to be led astray by the interruptions which divide it, by the mountain crests and different elevations which arise above it, he has determined in some degree the different ages, and the age of all the accessory matters which are intermingled with the principal substances.

The different fluids by which the globe has been surrounded, —the changes of their composition,—the violent movements by which each change has been accompanied;—all of these have been found, written to his eye, in the monuments which they have left.

A universal and tranquil ocean deposites, in great masses, the primitive rocks,—those rocks which are distinctly crystallized, and in which silica is the first predominating ingredient. Granite forms the base on which all others rest. To granite succeeds gneiss, which is only a granite beginning to be slaty. By degrees, mica predominates. Slates of different kinds appear; but in proportion as the purity of the precipitations is changed, the distinctness of the crystalline grain is diminished. Serpentines, porphyries, and traps succeed, in which this grain is still less distinct, although the siliceous nature of these rocks evinces the returning purity of the deposition. Intestine agitations in the fluid destroy a part of these primary deposites: new rocks are formed from their debris united by a cement. It is amidst these convulsions that living nature arises. Carbon, the first of these products, begins to shew itself. *Coal, a mineral formed from vegetables,* appears in vast quantities. Lime, which had already been associated with the primitive rocks, becomes more and more abundant. Rich collections of sea-salt, to be one day explored by man, fill immense cavities. The waters, again tranquillized, but having their contents *changed*, deposite beds less thick, and of greater variety, in which the *remains of living bodies are successively accumulated, in an order not less fixed than that of the rocks which contain them.* Finally, the last retreat of the waters diffuses over the land immense collections of alluvial matters, the first seats of vegetation, of cultivation, and of social life. The rents in the strata formed during these convulsions become filled with rocks of various kinds, as granite, trap, &c., thus forming *veins or dikes.* The metals, like the rocks, have had their epochs and their successions. The last of the primitive, and the first of the secondary rocks, have received them in abundance. They become rare in countries of later formation. Commonly they are found in particular situations, in those *veins which seem to be rents produced in the great rocky masses, and which have been filled after their formation.* But they are not all of equal age. Those which have been last formed are easily known, because their veins intersect those of the more ancient, and are not themselves intersected. Tin is the oldest of them all; silver and copper are the latest formed. Gold and iron, those two masters of the world, seem to have been deposited in the bowels of the earth, at all the different epochs of its formation; but iron appears at each epoch under different forms, and we can assign the age of its different ores.

The necessity of abridging, obliges me thus to unite under one view, results which we can easily imagine could only have been obtained by many thousand observations. But Werner made all these observations with so much care; he combined them with such scrupulous correctness, that all those which have since been made by others, have confirmed his, and if we except his opinions respecting ignigenous rocks, most of his ideas have only met with a temporary opposition.

Such, then, is the explanation of the geognosy, or of the position of minerals above one another, and when they are considered in their vertical situation. But there are other differences in their horizontal position, that is, as they are placed by the sides of each other, of which it is not less important to give an account; these form, therefore, a fourth point of view under which minerals may be considered, and which Werner designated by the name of *geographical mineralogy*.

Indeed, the latest formed rocks, or generally those which cover the others, are generally less elevated; they are pierced by the more ancient rocks, which form the lofty mountains. From this we conclude, that the fluid became lower in its level as its solid productions were multiplied *. It divided itself into basins, of which the productions were different. The surface of different countries is different, and the more so, the more attentively their structure is considered.

But every mineral may be turned to some use; and on its greater or less abundance in particular places, on the greater or less facility with which it can be procured, depend frequently the prosperity of a people,—their progress in civilization,—all the details, indeed, of their manners.

It is thus that in Lombardy we see only houses of brick, though contiguous to Liguria, which is covered by palaces of marble. Its quarries of travertine made Rome the most beautiful city of the ancient world. Those of coarse limestone (calcaire grossiere) and gypsum, have made Paris one of the most agreeable of the modern world. But Michael Angelo and Bramant, could not have built at Paris in the same style as at Rome, because they could not have found the same materials; and the same local influences extend to things of a very different nature.

Under the shelter of those limestone ridges which intersect Italy and Greece, which are of all heights,—which are ramified in all directions,—and which abound in springs;—in

* Werner did not attempt to explain the *sinking of the level of the ocean*, which some referred to the disappearance of the water, or changes in the atmospherical pressure, others to the rising of the land.—Edit.

those charming valleys, rich in the productions of living nature, Philosophy and the Arts first sprang to life. It is there that those minds have arisen of which the human race has most reason to be proud; whilst the vast deserts of Tartary and Africa have always been inhabited by fierce and wandering shepherds. And even in countries which have the same laws, and the same language, a practised traveller is able, from the manners of the people, from the appearance of their houses and their clothes, to guess at the composition of the soil of each canton; in the same manner as from this composition the philosophical mineralogist conjectures what may be their manners, their degrees of comfort and of instruction. Our granite districts produce, upon all the arts of life, very different effects from our calcareous. The natives of the Limousin, or of Lower Brittany, are not lodged, they are not fed, we might even say they do not think, like those of Champagne or of Normandy. Even the results of the conscription have been different, and different according to a fixed law in the different districts. Geographical mineralogy thus assumes a high importance, when we connect it with what Werner called *Economical Mineralogy*, or the history of the employment of minerals, for the wants of man.

The comprehensive mind of this great professor seized equally all these relations, and it was with an ever new delight, that his hearers listened to his exposition of so much of them as his public prelections embraced. But in his private conversations he traced their application a great deal farther. The history of nations and that of their languages, was connected, in his apprehension, with that of minerals, and he never considered himself as departing from his principal object, when he gave himself up occasionally to those other inquiries. He traced the various tribes in their migrations, according to the declivities and directions of countries, and he thus connected their progress and their stations with the structure of the globe. He connected the different languages with families; he traced each family to a common source, originating always in the most elevated point of a mountain-chain: from that point he considered every dialect as descending, dividing itself according to the directions of the valleys, becoming soft or hard according as it became stationary in a level or in a mountainous district, separating itself in process of time from the neighbouring dialects, and becoming always so much the more distinct, as the natural obstacles to communication became more insurmountable.

He endeavoured even to trace the laws of the military art by those of geology; and, if he had been to be believed, all generals should have begun by studying some time at Freyberg. In a word, he connected every thing with the object of his own passion, and as Tournefort, the illustrious botanist, had fancied that stones vegetated, Werner imagined that stones could speak. He imagined that he might interrogate them respecting the whole history of the world.

Strangers who happened to be at Freyberg, and who expected only to converse with a mineralogist, were astonished at his continual discussions respecting tactics, politics, and medicine. They were sometimes tempted to treat these discourses as reveries of a highly excited imagination. Indeed, we may allow that there was something of exaggeration in generalizing so far the relations of one object; but we ought also to recollect how powerfully these ideas, so varied, and so inviting, presented always gracefully, and often with eloquence, must have warmed the imagination of youth. At that age, when we naturally dislike exceptions, and when we pass so easily over difficulties, the disciples of Werner plunged into a career which, as he showed it to them, was so vast and profound. A mineralogy purely mineralogical, would probably have disgusted many of them; but they gave themselves up with eagerness to this mineralogy, which seemed to put into their hands the key of nature; and although as the result of this analysis, there might only remain to them the foundation of the science, would they not still have had reason to bless the pleasant illusions by which they had been conducted to it? Many individuals, who afterwards became great mineralogists, had only wished to hear him, that they might gain a summary idea of the science of minerals; but, having once listened to him, that science became the profession of their lives.

It is to this irresistible influence that the scientific world has been indebted for those discoveries and observations which have rendered the names of Humboldt, Buch, and a host of other geologists, renowned throughout Europe. We may say of

Werner, what had formerly been said with truth of Linnæus, that every where Nature has been interrogated in his name.

Few teachers have enjoyed this pure and unreserved gratitude to the same degree; but perhaps no one ever better deserved it by his paternal feelings. He grudged nothing for the good of his scholars: his time, his exertions, were at their disposal. If he knew any of them that were in occasional need, his purse was open to them. When his audience became so numerous that every one could not conveniently see what he exhibited, he divided his students and repeated his lecture. His door was never shut to them: his meals were commonly taken with some of them in his company, as if it had been his wish that not a moment should be lost to their improvement.

Such a master might safely devolve the care of his reputation upon his scholars; and they, accordingly, have been the means of diffusing it. Like Socrates, in this respect also, to whom he has been compared for so many other qualities, his ideas were almost solely known from the notes which had been taken during his prelections. Whether it was that he was satisfied with the irresistible influence which his oral communications gave him, or whether the vivacity of his imagination could not endure the *ennui* of writing, it was with the utmost reluctance that he determined to publish a few tracts or to give some articles for journals. He talked as much as any one desired, and his conversation was always that of a man of genius, as well as that of a man of kind feelings. During whole hours, he would develope the boldest and best connected ideas; but it was impossible to make him take up his pen. He had an antipathy for the very mechanical art of writing,—an antipathy, the excess of which rendered it very amusing. But the public and posterity will have reason to lament this peculiarity which prevented him publishing his works on mineralogy and geognosy. It is said that his great work on mineralogy had begun to be printed, and that the first sheet had been composed, but that he could not endure the fatigue of correcting the proofs.

His life was therefore entirely passed either in the elevated regions of contemplation, or in philosophical or friendly conversation,—ignorant of all foreign events, and without reading even the literary journals, without being at the trouble to inform himself whether envy was not busy sometimes with his fame. He might still have lived many years, for of all the *methods* which he had studied, that of taking care of his own health was not one of those which occupied him the least. Among his little whims, his care never to be between two different streams of air, was one of the most remarkable. But of all his wise precautions, the wisest, without doubt, was the calm of a peaceful mind, which did not even wish to be informed of any thing that would excite within it any feelings of ill-will.

(2.) *Werner according to Lyell.*—Werner was named, in 1775, Professor of Mineralogy in the "School of Mines" at Freyberg in Saxony. He directed his attention not merely to the composition and external characters of minerals, but also to what he termed "Geognosy," or the natural position of minerals in particular soils, together with the grouping of those rocks, their geographical distribution, and various relations. The phenomena observed in the structure of the globe had hitherto served for little else than to furnish interesting topics for philosophical discussion; but when Werner pointed out their application to the practical purposes of mining, they were instantly regarded by a large class of men as an essential part of their professional education, and from that time the science was cultivated in Europe more ardently and systematically.

Werner's mind was at once imaginative and richly stored with miscellaneous knowledge *. He associated every thing with his favourite science; and, in his excursive lectures, he pointed out all the economical uses of minerals, and their application to medicine; the influence of the mineral composition of rocks upon the soil, and of the soil upon the resources, wealth, and civilization of man. The vast sandy plains of Tartary and Africa, he would say, retained their inhabitants in the shape of wandering shepherds; the granitic mountains and the low calca-

* Our miners have been left to themselves almost without the assistance of scientific works in the English language, and, without any "school of mines," to blunder their own way into a certain degree of practical skill. The inconvenience of this want of system in a country where so much capital is expended, and often wasted, in mining adventures, has been well exposed by an eminent practical miner.—See Prospectus of a School of Mines in Cornwall, by J. Taylor, 1825.

reous and alluvial plains, gave rise to different manners, degrees of wealth, and intelligence. The history even of languages, and the migrations of tribes, had, according to him, been determined by the direction of particular strata. The qualities of certain stones used in building would lead him to descant on the architecture of different ages and nations; and the physical geography of a country frequently invited him to treat of military tactics. The charm of his manners, and his eloquence, kindled enthusiasm in the minds of all his pupils, many of whom only intended at first to acquire a slight knowledge of mineralogy; but, when they had once heard him, they devoted themselves to it as the business of their lives. In a few years, a small school of mines, before unheard of in Europe, was raised to the rank of a great university, and men already distinguished in science, studied the German language, and came from the most distant countries to hear the great oracle of geology.

Werner had a great antipathy to the mechanical labour of writing; and he could never be persuaded to pen more than a few brief memoirs, and those containing no development of his general views. Although the natural modesty of his disposition was excessive, approaching even to timidity, he indulged in the most bold and sweeping generalizations, and he inspired all his scholars with a most implicit faith in his doctrines. Their admiration of his genius, and the feelings of gratitude and friendship which they all felt for him, were not undeserved; but the supreme authority usurped by him over the opinions of his contemporaries, was eventually prejudicial to the progress of science; so much so, as greatly to counterbalance the advantages which it derived from his exertions. If it be true that delivery be the first, second, and third requisite in a popular orator, it is no less certain that, to travel, is of threefold importance to those who desire to originate the just and comprehensive views concerning the structure of our globe; and Werner had never travelled to distant countries. He had merely explored a small province of Germany, and conceived, and persuaded others to believe, that the whole surface of our planet, and all the mountain-chains in the world, were made after the model of his own province *. It

* Werner used to remark, The countries with which I am acquainted, (by-the-by, *a little more than Saxony*), exhibit a certain series of geognostical rela-

was a ruling object of ambition in the minds of his pupils, to confirm the generalizations of their great master, and to discover, in the most distant parts of the globe, his "universal formations," which he supposed had been each in succession simultaneously precipitated over the whole earth, from a common menstruum or chaotic fluid *. Unfortunately, the limited district examined by the Saxon professor was no type of the world, nor even of Europe: and, what was still more deplorable, when the ingenuity of his scholars had tortured phenomena of distant countries, and even of another hemisphere, in conformity with his theoretical standard, it was discovered that "the master" had misinterpreted many of the appearances in the immediate neighbourhood of Freyberg †.

(8.) *Werner according to MacCulloch.*—If Werner's system first appeared about 1787, its subsequent modifications prevents us from knowing with whom its several portions now rest. While his audiences diffused it with the blind zeal of religious sectaries, his lectures became the endless treatises of all who sought the fame of geological authorship. But to entertain an opinion is not to form one; and hence the student, influenced by the weight of numbers, should recollect that but one voice speaks through all these organs. If, therefore, the leader should be charged with the faults of his followers, it is the sect which is the object of examination, while it is an idle office to settle the contending claims to ignorance.

In an original fluid earth, the materials of all minerals were

tions, and it is probable similar (besides many still to be discovered) relations will be found in other quarters of the globe, and the globe may possibly have the same general structure throughout.—Edit.

* Werner, when lecturing, used to say, The various *stratified* rocks have been deposited from water; some from a state of chemical solution; others from a state of mechanical suspension; and a third set appear to be partly of a chemical, partly of a mechanical nature. The mechanical matter he derived from the previously existing strata: in regard to the chemical matter, he conjectured that it made its appearance in the universal ocean at *different times*, but whether it came from *below* or from *above* he knew not.—Edit.

† The accuracy of this statement may be questioned; allowing it to be correct to the extent here stated, is there any thing *deplorable* in misinterpreting, *if Werner has misinterpreted*, a few geological phenomena.

dissolved in water. From this, granite was first precipitated, at specific points, being followed by gneiss, and successively by primary schists, in an "invariable order," though it is not explained why the former is irregular, and the latter stratified. These rocks were "primitive" and anterior to the creation of animals; and they are purely chemical, as the produce of aqueous crystallization. Certain marine animals are then created; and the water having diminished in quantity new rocks are laid bare. The precipitation which had ceased, is now renewed; while the fragments of these rocks, and the spoils of animals, become intermixed with the new chemical precipitate, forming the "transition" class: and because the water continued progressively to diminish, each succeeding rock appears at lower levels, granite occupying the highest place, while all rocks occur, throughout the globe, in the same order, constituting "universal formations." More land becoming dry after the transition-rocks, the "flœtz" rocks are formed necessarily less inclined to the horizon, and more regular; though the reasons why are not given, any more than for their frequent erect positions at present. And the creation of new animals accounts for the superiority of their remains in these. After this, the waters rose again to deposite the trap-rocks; thus once more covering even the Andes, yet depositing them on such chosen places, as, in subsiding, it let them fall on Britain and elsewhere. But, as they lie among successive "flœtz" strata, the sea rose and fell over the whole globe, as often as it was necessary to produce the first, the second, and third "flœtz" trap formations," in the few chosen spots where they exist. This being done, the superfluous sea vanishes for the last time, and man is created.

I have avoided a more minute account of this theory, out of respect for this philosopher; as it is unfortunately the less intelligible the more it is explained. But of all the properties of that which explains every thing in the most perfect manner, the most perfect is, that it is peculiarly and exclusively consistent with the Mosaic history, which it also proves. The reader will judge whether those who assert, or those who believe in, this marvellous property, are most worthy of marvel. But, as Whiston says of his own, "whether it be possible or not, such is the fact."

If it has not accounted for the "tertiary" strata, a sea so convenient might always contain the necessary rocks at the necessary places; while so moveable a substance can ascend and descend as often as is needful. The minerals of mineral veins were precipitated in the fissures, from the universal solutions. Rock veins are contemporaneous with the including rocks, and formed by crystallization, as are the fragments in the conglomerates; as contortions, fractures, elevations, and so forth, are also modes of crystallization, and as are mountains and valleys; there being no subsequent process of denudation. The coal deposites were formed by an elective attraction at those points from carbon in solution; as the vegetable fragments also tend to the same places. The induration of strata near trap, is the result of intermixture during crystallization; though the former were completed many ages before the latter were produced; and, while volcanos are purely modern, and heated by coal, pumice and obsidian are deposites from water.

This is a sufficient view of the "Theory" under which all Europe became a land of philosophical geologists, for which much of Europe yet fights, and in which much of the rising generation is still educated. We need not wonder at the progress of geology: *when geology shall have forsaken all that Freyberg or Werner taught, it will have a clear field.*

3. *Hutton according to Playfair and MacCulloch.*

(1.) *Hutton according to Playfair.*—Dr Hutton possessed, in an eminent degree, the talents, the acquirements, and the temper, which entitle a man to the name of a philosopher. The direction of his studies, though in some respects irregular and uncommon, had been highly favourable to the development of his natural powers, especially of that quick penetration and originality of thought, which strongly marked his intellectual character. From his first outset in science, he had pursued the track of experiment and observation; and it was not till after being long exercised in this school, that he entered on the field of general and abstract speculation. He combined, accordingly, throughout his whole life, the powers of an accurate observer, and of a sagacious theorist, and was as cautious and patient in the former character, as he was bold and rapid in the latter.

Long and continued practice had increased his powers of observation to a high degree of perfection; so that, in discriminating mineral substances, and in seizing the affinities or differences among geological appearances, he had an acuteness hardly to be excelled. The eulogy so happily conveyed in the Italian phrase of *osservatore oculatissimo,* might most justly be applied to him; for, with an accurate eye for perceiving the characters of natural objects, he had, in equal perfection, the power of interpreting their signification, and of decyphering those ancient hieroglyphics which record the revolutions of the globe. There may have been other mineralogists, who could describe as well the structure, the figure, the smell, or the colour of a specimen, but there are few who equalled him in reading the characters which tell not only what a fossil *is*, but what it *has been*, and declare the series of changes through which it has passed. His expertness in this art, the fineness of his observations, and the ingenuity of his reasonings, were truly admirable. It would, I am persuaded, be difficult to find in any of the sciences a better illustration of the profound maxims established by Bacon, in his *Prærogativæ Instantiarum*, than were often afforded by Dr Hutton's mineralogical disquisitions, when he exhibited his specimens and discoursed on them with his friends. No one could better apply the luminous instances to elucidate the obscure, the decisive to interpret the doubtful, or the simple to unravel the complex. None was more skilful in marking gradations of Nature, as she passes from one extreme to another; more diligent in observing the continuity of her proceedings, or more sagacious in tracing her footsteps, even where they were most lightly impressed. With him, therefore, mineralogy was not a mere study of names and external characters (though he was singularly well versed in that study also), but it was a sublime and important branch of physical science, which had for its object to unfold the connexion between the past, the present, and the future condition of the globe.

The loss sustained by the death of Dr Hutton was aggravated to those who knew him, by the consideration of how much of his knowledge had perished with himself, and notwithstanding all that he had written, how much of the light collected by a long life of experience and observation was now completely extinguished. It is indeed melancholy to reflect, that with all who make proficiency in the sciences, founded on nice and delicate observation, something of the sort must unavoidably happen. The experienced eye, the power of perceiving the minute differences and fine analogies which discriminate or unite the objects of science, and the readiness of comparing new phenomena with others already treasured up in the mind; these are accomplishments which no rules can teach, and no precepts can put us in possession of. This is a portion of knowledge which every man must acquire for himself, and which nobody can leave as an inheritance to his successor. It seems, indeed, as if nature had, in this instance, admitted an exception to the rule, by which she has ordained the perpetual accumulation of knowledge among civilized men, and had destined a considerable portion of science continually to grow up and perish with the individual.

A circumstance which greatly distinguished the intellectual character of the philosopher of whom we now speak, was an uncommon activity and ardour of mind, upheld by the greatest admiration of whatever in science was new, beautiful, or sublime. The acquisitions of fortune, and the enjoyments which most directly address the senses, do not call up more lively expressions of joy in other men, than hearing of a new invention, or being made acquainted with a new truth, would at any time do in Dr Hutton. This sensibility to intellectual pleasure was not confined to a few objects, nor to the sciences which he particularly cultivated: he would rejoice over Watt's improvements on the steam-engine, or Cooke's discoveries in the South Sea, with all the warmth of a man who was to share in the honour or the profit about to accrue from them. The fire of his expression, on such occasions, and the animation of his countenance and manner, are not to be described; they were always seen with great delight by those who could enter into his sentiments, and often with great astonishment by those who could not. With this exquisite relish for whatever is beautiful and sublime in science, we may easily conceive what pleasure he derived from his own geological speculations. The novelty and grandeur of the objects offered by them to the imagination, the simple and uniform order given to the whole natural history of the earth, and, above all, the views opened of the wisdom that governs nature, are things to which hardly any man would be insensible; but to him they were a matter not of transient delight, but of solid and permanent happiness. Few systems, indeed, were better calculated than his, to entertain their author with such noble and magnificent prospects; and no author was ever more disposed to consider the enjoyment of them as the full and adequate reward of his labours.

Huttonian Theory of the Earth, according to Playfair.—I. The object of Dr Hutton was not, like that of most other theorists, to explain the first origin of things. He was too well skilled in the rules of sound philosophy for such an attempt; and he accordingly confined his speculations to those changes which terrestrial bodies have undergone since the establishment of the present order, in as far as distinct marks of such changes are now to be discovered.

With this view, the first fact which he has remarked is, that by far the greater part of the bodies which compose the exterior crust of our globe, bear the marks of being formed out of the materials of mineral or organized bodies of more ancient date. The spoils or the wreck of an older world are everywhere visible in the present, and though not found in every piece of rock, they are diffused so generally as to leave no doubt that the strata which now compose our continents are all formed out of strata more ancient than themselves.

II. The present rocks, with the exceptions of such as are not stratified, having all existed in the form of loose materials collected at the bottom of the sea, must have been consolidated and converted into stone by virtue of some very powerful and general agent. The consolidating cause which he points out is subterraneous heat; and he has removed the objection to this hypothesis by the introduction of a principle new and peculiar to himself. This principle is the *compression* which must have prevailed in that region where the consolidation of mineral substances was accomplished. Under the weight of a superincumbent ocean, heat, however intense, might be unable to volatilize any part of those substances which at the surface, and under the lighter pressure of our atmosphere, it can entirely consume. The same pressure, by forcing these substances to remain united, which at the surface are easily separated, might occasion the fusion of some bodies which in our fires are only calcined. Hence the objections which are so strong and unanswerable, when opposed to the theory of volcanic fire, as usually laid down, have no force at all against Dr Hutton's theory; and hence we are to consider this theory as hardly less distinguished from the hypothesis of the Vulcanists, in the usual sense of that appellation, than it is from that of the Neptunists, or the disciples of Werner.

III. The third general fact on which this theory is founded, is, that the stratified rocks, instead of being either horizontal, or nearly so, as they no doubt were originally, are now found possessing all degrees of elevation, and some of them even perpendicular to the horizon; to which we must add, that those strata which were once at the bottom of the sea, are now raised up, many of them, several thousand feet above its surface. From this, as well as from the inflexions, the breaking and separation of the strata, it is inferred, that they have been raised up by the action of some expansive force placed under them. This force, which has burst in pieces the solid pavement on which the ocean rests, and has raised up rocks from the bottom of the sea into mountains 15,000 feet above its surface, exceeds any which we see actually exerted, but seems to come nearer to the cause of the volcano or the earthquake, than to any other, of which the effects are directly observed. The immense disturbance, therefore, of the strata, is in this theory ascribed to heat, acting with an expansive power, and elevating those rocks which it had before consolidated.

IV. Among the marks of disturbance in which the mineral kingdom abounds, those great breaches among rocks, which are filled with materials different from the rock on either side, are the most conspicuous. These are the veins, and comprehend not only the metallic veins, but also those of whinstone, of porphyry, and of granite, all of them substances more or less crystallized, and none of them containing the remains of organized bodies. These are of posterior formation to the strata which they intersect; and in general also they carry with them the marks of the violence with which they have come into their place, and of the disturbance which they have produced on the rocks already formed. The materials of all these veins, Dr Hutton concludes to have been melted by subterraneous heat, and, while in fusion, injected among the fissures and openings of rocks already formed, but thus disturbed and moved from their original place.

This conclusion he extends to all the masses of whinstone, porphyry, and granite, which are interposed among strata, or raised up in pyramids, as they often appear to be, through the midst of them. Thus, in the fusion and injection of the unstratified rocks, we have the third and last of the great operations which subterraneous heat has performed on mineral substances.

V. From this Dr Hutton proceeds to consider the changes to which mineral bodies are subject when raised into the atmosphere. Here he finds, without any exception, that they are all going to decay; that from the shore of the sea to the top of the mountain, from the softest clay to the hardest quartz, all are wasting and undergoing a separation of their parts. The bodies thus resolved into their elements, whether chemical or mechanical, are carried down by the rivers to the sea, and are there deposited. Nothing is exempted from the general law: among the highest mountains and the hardest rocks, its effects are most clearly discerned; and it is on the objects which appear the most durable and fixed, that the characters of revolution are most deeply imprinted.

On comparing the first and the last propositions just enumerated, it is impossible not to perceive that they are two steps of the same progression, and that mineral substances are alternately dissolved and renewed. These vicissitudes may have been often repeated; and there are not wanting remains among mineral bodies that lead us back to continents, from which the present are *third* in succession. Here, then, we have a series of great natural revolutions in the condition of the earth's surface, of which, as the author of this theory has remarked, we neither see the beginning nor the end; and this circumstance accords well with what is known concerning other parts of the economy of the world. In the continuation of the different species of animals and vegetables that inhabit the earth, we discern neither a beginning nor end; and in the planetary motions where geometry has carried the eye so far, both into the future and the past, we discover no mark either of the commencement or termination of the present order. It is unreasonable, indeed, to suppose that such marks should any where exist. The Author of nature has not given laws to the universe, which, like the institutions of men, carry in themselves the elements of their own destruction; he has not permitted in his works any symptom of infancy or of old age, or any sign by which we may estimate either their future or their past duration. He may put an end, as he no doubt gave a beginning, to the present system, at some determinate period of time; but we may rest assured, that this great catastrophe will not be brought about by the laws now existing, and that it is not indicated by any thing which we perceive.

(2.) *Hutton according to MacCulloch.*—The theory of Hutton is best known through the commentary of Playfair. I must make the following sketch as brief as possible; while by commencing from the present state of the earth, it will easily be seen that it is almost a transcript of Lazzoro Moro's, with some extension, and some aid from succeeding sources; yet with some important additions united to numerous and serious errors.

The action of the elements, and the flow of water, transfer the materials of rocks to the lower lands and the sea; and the same proceeding having occurred in former times, those alluvia were the germs of the present strata, as the existing ones are those of a subsequent earth. The ancient rocky strata have therefore been produced from the waste of a former world; as their organic fossils are the evidences of former life. The central ignited matter has protruded, as it does now in volcanoes; and, under different circumstances, has produced granite and trap forming the unstratified rocks which have elevated the older strata, and producing there several accidents, as in the former system; while the fluid matter, filling their fissures, has generated rock veins. The consolidation of the strata is attributed to the same cause; but wherever there are differences in the action of this and of ordinary fire, it is attributed to pressure from superincumbent weight; under which the trap-rocks are falsely said to be never cavernous; as limestones become fusible. Lastly, having conceived no other division of rocks but into primary and secondary, this theory traces but three forms of the earth; namely that which anteceded the primary strata, that which included these alone, and the present one; though arguing for its past eternity, as it does for a future renovation, and to all eternity. In this simple view, this system possesses an aspect which its author will soon injure by his details. With exception of the theory of trap-rocks and volcanoes, he had borrowed well, and safely extended, what he had borrowed, but, with the usual ambition to erect an entire theory, though ignorant of the necessary facts and sciences, he has, in almost all else, levelled himself to the Werners; while his commentator has, unluckily for his fame, pursued the same course.

In arguing against subsidences, we trace equally the spirit of hypothesis and antagonism, with a want of both geological knowledge and sound reasoning. Of some structure of discontinuity, if not strictly cavernous, there is evidence in the lineal directions of volcanoes; as coal, and more, are proofs of subsidences. Though gneiss, and some other primary strata, are in their present condition from heat, this mode of consolidation cannot be admitted for all strata. The theory of trap is untrue, because injudiciously rigid; while the anxiety of opposition has introduced inextricable confusion into this part of the system; under which also he has, by disclaiming demonstrated truths, forfeited one of his strongest supports, while maintaining a perpetual hostility against Dolomieu and Faujas de St Fond, on the very facts by which he might have profited, but did not understand. Knowing the igneous rocks most imperfectly, he denies the existence of scoriform traps, while having recourse to a most unhappy expedient for explaining the amygdaloidal nodules. Perpetually indeed misapplying a favourite principle, even though admitting water to a large share in his operations, it is called on where neither needful to the theory, nor reconcileable to the facts. Such is the unnecessary fusion of carbonate of lime, with the igneous origin of quartz, chalcedony and silicified wood; while the theory of flints is peculiarly infelicitous and unintelligible, as is that of the septaria. But the whole theory of igneous secretion is without excuse; as it compels us to deny that this writer was the chemist he has been called. The theory of coals equals the very worst of the schemes of Werner; while it indicated that narrow spirit of hypothesis which misapplies a sound principle as often as the reverse; proving, that reasoning was, in any case, a very doubtful cause of its successful application. If I am to do justice to my readers, I am bound to protect them from the assertion that he always proceeded on the legitimate principles of induction; for thus, under reputed authority, is the young mind misled.

There is an equally unfortunate anxiety after the hypothesis, where the present forms of the surface are concerned; since ever thinking of the slow action of feeble forces, he forgets that elevations must have produced inequalities, and therefore, that valleys must have existed before rivers. To deny, also, any other alluvia than those of rivers, is not only to deny palpable facts, but to overlook some necessary consequences of the very theory; while if we can pardon the zeal of the original theorist, there is no excuse for the commentator. The system which assumes to be perfect, and whose pride will not yield, mistakes its own interests. It is beaten at the bad outposts, which it is resolved to defend; while, by retiring to the citadel, it might long have defied assault.

Such is a sufficient view of this theory, and such is all the criticism which appeared due to the student in geology, while I desire to avoid what is superfluous. It is sufficient, among other things, to prove that this boasted theory is little more than an hypothesis, where it is original; yet fortunate in having borrowed a better foundation, and thus far almost only a theory. Yet, wishing to do justice to all, I must point out that which I believe to be original, or if not always original, important. Such is the effects of pressure, but original as to the carbonate of lime only; and such is the igneous origin of granite, since without that, there can be no theory of the earth; though it may be questioned how far the hint was taken from Leibnitz and Buffon, as it is to believe that Lazzaro Moro would have come to the same conclusion, had he known this rock. Let Hutton, however, have the merit, though furnished by his predecessors with all the analogous proofs in trap and in volcanic rocks. Yet, on the former, I must repeat, that his confusion, added to his antipathy respecting their truly, if remote, volcanic nature in many places, must make us doubt those powers of philosophical generalization, for which he has been so lauded; an idol, like the predecessors to his own circle. Still, the practical effects of thus reviving the forgotten Italian theory, with those improvements, was great, though even yet limited; since it found all Europe believing that the ignorance of Werner and his followers was philosophy and geology.

4. *Antiquity of the Earth.*

In his earnestness to assert "the uniformity of nature on a great scale," Mr Lyell seems to thirst for an antiquity of this earth even greater than that which is indicated by geological phenomena themselves. When he maintains, after Hutton, that we see in geology, as in astronomy, "no mark, either of the commencement or of the termination of the present order;" when he implies, that the strata seem to tell us the story of a perpetual recurrence of cycles of change of the same kind; he appears to forget that the geological series, long and mysterious as it is, has still a beginning. Is there the shadow of a reason for asserting that the lowest stratified rocks, from the crystalline mica-schist to the greywacke slates, were the result of a series of operations, and of a condition of things like those which gave rise to their successors? Were these masses produced from the previous continents and seas stocked with their respective inhabitants? If so, what is become of the remnants of these continents, and why do we not see them still supporting these schistose beds thus formed from them? And where are the remains of the shell-fish and plants, which, according to the analogy thus asserted, lived at that distant period? In this case, the phenomena are different from those of the succeeding epochs; by what rules of philosophising, then, can we assert the causes and conditions to be similar? Here we have, however remote, a limit, an origin, a starting-place. Or, if Mr Lyell chooses to have the granite older than slates, the argument is transferable to that rock with still greater urgency. Is it not then most gratuitous to maintain, that the Author of Nature, "*has not permitted in his works any symptom of infancy or of old age?*" If man may go wrong, as Mr Lyell asserts of former theorists, through a disposition to assume that the economy of nature was formerly governed by rules quite different for those now established, is it not possible also to err by holding, that the economy of nature must have been the same at every period of the earth's existence, however strongly all appearances may proclaim a difference ?—WHEWELL.

On the Discovery of Diamonds in the Uralian Mountains.

DIAMONDS in the Brazils are found in those tracts that afford also gold and platina. Some years ago, platina was found along with gold at Nishnei-Tura, in Uralian Russia ; a circumstance which naturally led to the suspicion, that the diamond might also be a native of that quarter of the old world. The late discovery of the diamond in Russia has shewn the accuracy of this conjecture. This gem was discovered in the Urals in a ravine named Adolphskoi ; which, besides the diamond, affords also platina and gold. The district has many characters in common with the diamond districts in Brazil ; their comparison will probably enable us to answer the question, as to the original repository of the most precious of all the gems. In M. Moritz von Engelhardt's very interesting account of the repository of the Uralian diamonds, which he had the goodness to send to us, there are many important details, some of which we shall now present to our readers.

Black dolomite alternates in the ravine or valley of Adolphskoi, with silver-white talc-slate, with black limestone, containing embedded scales of talc, and with white limestone, with embedded scales of talc, grains of quartz, and small balls and cubes of brown iron-ore. The limestone bed, when the embedded quartz increases in quantity, forms the transition into itacolumite.

From which of the above mentioned rocks are the diamonds of the Valley of Adolphskoi derived ? Not from the talc-slate and limestone, because the alluvium, from their disintegration, contains none ; nor from the itacolumite (flexible quartz) and the gold veins, the quartz of which seems little fitted for originating perfect crystals, such as the garnet dodecahedron of the diamond ; therefore, probably, they occur in the black dolomite, or some other rock which has been removed by weathering or otherwise. The following observations will assist in determining the point.

1. The minerals that occur in the descending or mountain alluvium, viz. the crystals of pure transparent quartz, the brown ironstone and anatase, are sharp-edged, although these latter, owing to their softness, would have been rounded in a very short course; they have not therefore come from a distance, but must have been derived from the neighbouring rocks.

2. The loose crystals of pure transparent quartz, and the anatase, are derived from disintegrated dolomite; the first resemble the rock-crystals that occur in blocks of dolomite, and the latter are attached to rock-crystals, as may be distinctly seen in the impressions on the anatase crystals. The balls of calcedony sometimes met with may have lain in the dolomite, for hollows filled by infiltration with quartz occur in it The cubes and grains of brown ironstone are from the foliated limestone, in which indeed they are still found; the gold and platina are probably from disintegrated veins of quartz.

3. The dolomite is probably the repository of the diamond? In the same manner as silica, carbonate of lime, and carbonate of magnesia, have separated themselves in the form of rock-crystal and bitterspar, so also might, according to Gobel, the carbon in dolomite separate in the form of diamond. The perfect form of the diamond crystals is not against this opinion, as we find embedded in the dolomite, single rock-crystals, in which the prisms are acuminated at both extremities.

It is much to be desired, that the numerous blocks of that black dolomite of the valley of Adolphskoi, which is particularly rich in druses of quartz and bitterspar, were carefully examined; further, that comparative investigations were made on the diamond district, as on the valley of the rivulet of Rudanka, where already Mr Schmid found black dolomite and traces of gold. If it results from these investigations, that diamond actually occurs in dolomite, the following question will have to be decided.

If the dolomite already described always contains diamond, may it occur in its different formations with or without gold and platina? Or, if every gold and platina bearing formation is disposed to afford diamond, when it contains a carbonaceous rock, must the rock be dolomite or not? The arrangements Engelhardt observed in the year 1821, in the government of Olonez, where black dolomite, containing drusy cavities lined with bitterspar and rock-crystal, resembling that of the valley of Adolphskoi, may enable us to try the first question. They occur on the north-west side of the Lake of Onega, along with greenstone, which is the predominating rock.

In the Urals, Engelhardt, with exception of Kresdowosdwishenski, saw no black dolomite, probably it may be found on careful examination in the brook of Suchoi Wissi, on the west side of the mountains, where are situated the platina mines of Nishnei-Tagil. The quartzy chlorite-slate which occurs there, much resembles the itacolumite in the vicinity of the place where the diamonds are found, and both probably lie in the same line of direction. If search was made there for diamonds, although no dolomite or other carbonaceous rock was visible, it would shew whether their appearance was always connected with that rock formation or not.

According to Gobel, the *black dolomite from Valley of Adolphskoi* contains 7.50 black powder, partly carbon, insoluble in muriatic acid; 40.79 carbonic acid; 0.50 alumina; 6.28 oxide of iron; 30.65 lime; 13.05 magnesia; 1.20 water; = 99.97.

Whether this rock, says Gobel, be viewed as of Neptunian or Plutonian origin, the circumstance of its containing carbon as one of its constituent parts, and the finding of diamonds amongst its debris, is very remarkable. It may be asked if this does not afford a hint as to the mode of occurrence, and the origin of the diamond? The carbon is disseminated in an extremely minutely divided state, so that we cannot determine the geometrical form of its individual particles, and which therefore can only be derived from decomposed carbonic acid, but cannot by any means be considered as remains of burnt organic bodies. During the formation of black dolomite, very probably a great quantity of carbonic acid was present, and it is not improbable that a part of it on coming in contact with the bases of the earths and alkalies, and with iron, would be deoxidized, whereby carbon in substance would be separated, and would, along with undecomposed carbonic acid, unite with these oxides. The decomposition of carbonic acid by kalium and sodium has been long known; and the experiments of Dupretz, have shewn the conversion of carbonic acid into carbonic oxide, by means of iron, zinc, and tin; why then should we consider as impossible, a decomposition of it by means of more easily oxidizable metals, as the bases of lime, alumina, and silica, and their oxides, which occur in the dolomite here described? Is it not probable during the formation of this rock by the decomposition of carbonic acid, and the high temperature induced by the oxidation of the metals already mentioned, a part of the separated carbon may have been converted into carbonic vapour, which vapour may have been afterwards condensed and crystallized in form of diamonds, in vesicular cavities in the glowing mass?

No diamonds have hitherto been met with in the solid rocks, but only in the alluvium formed by their decomposition, and this because it was conceived that the rocks did not contain them. The rock fragments and minerals of the diamond sand of Brazil differ but little from those of Poludenka and Adolphskoi valleys in the Urals. Diamonds are found in India as well as in Brazil, always single, and never in nests or veins. Gold and platina accompany them in the Brazils and in the Urals. In India, gold only occurs; is it probable that the platina has been overlooked? In general they are found in the alluvium, and never in the true mother stone or matrix *. That the black dolomite of the Urals, with its accompanying rocks, may form, by weathering, a similar alluvium, is satisfactorily shewn by geognostical and chemical investigation. It is therefore very probable, that this dolomite, with its transition into talc-slate, is the hitherto unknown matrix of the diamond; that the diamonds found in the alluvium formed by its disintegration, had their place in the solid rock, and that the government of Russia, if they considered it for their advantage, and would permit searches to be made in this rock for diamonds, might find that the inquiry would not be in vain.

* It has been said that the diamond has been found in India, in the sandstones of the coal formation and new red sandstone. These accounts require confirmation.

On the Characters and Affinities of certain Genera, chiefly belonging to the Flora Peruviana. By Mr David Don, Librarian of the Linnean Society; Member of the Imperial Academy Naturæ Curiosorum; of the Royal Botanical Society of Ratisbon; and of the Wernerian Society of Edinburgh, &c. (Continued from p. 228. of former Volume).

MOLINA INCANA and FERRUGINEA.

These are the *Baccharis thyoides* of Lamarck, and *B. ferruginea* of Persoon, which form a very distinct genus, having no particular affinity with *Baccharis* or *Molina*, except what might be expected between plants of the same natural class. Perhaps the *Conyza bryoides* and *cupressiformis* of Lamarck may also be referable to it; but I have not had an opportunity of examining them, to determine this point. The *Tafalla* of Ruiz and Pavon proving the same with the *Hedyosmum* of Swartz and Willdenow, and no other genus having yet supplied the place of the former in the annals of botany, I have availed myself of the opportunity which this circumstance has afforded, of commemorating the labours of Don Juan Tafalla, a distinguished pupil of Ruiz, and his zealous assistant and successor in the investigation of the Peruvian Flora. The genus had been named, and its essential characters determined, by me several years ago, when engaged drawing up an account of the South American *Compositæ*, contained in the Lambertian Herbarium.

The points which essentially distinguish *Tafalla* from *Baccharis*, are the inclosed stamina, and the anthers being furnished with two bristles at their base,—characters which it has in common with the rest of its tribe, but especially with *Antennaria*, from which it is principally distinguished by the peculiarity of its habit.

Most botanists, and it is believed also M. Cassini himself, have referred *Baccharis* to *Astereæ*, but they assuredly belong to the *Eupatoreæ*, and to that portion of them that comes under *Vernoneæ*, where their habit corresponds better, and in which the stamina are also most frequently exserted, particularly in *Vanillosma*, a genus which may be regarded as establishing a connecting link between the *Eupatoreæ* and *Labiatifloræ*. The *Liatrideæ*, in which the accurate Richard thought he had remarked a peculiarity in the stigmata sufficient to separate them as a distinct group, must likewise be reduced to the *Eupatoreæ*; for there is not any thing, either in the form or structure of their stigmata, differing from the normal group of that family. While on this subject, I may mention a remarkable fact, apparently of universal application throughout *Compositæ*, and one which does not appear to have been before noticed,—namely, that the stigmata of female flowers are uniformly smooth, being destitute both of papillæ or bristles, which are only to be observed in those of hermaphrodite flowers, as is well exemplified in *Baccharis* and *Antennaria*, and certain other genera, where the capitula are exclusively composed of female flowers, and in *Aster*, &c. where the ligulate florets of the circumference only are female; and it may be set down as an established fact, that the presence of papillæ on stigmata do not necessarily prove their fertility; for in *Aster*, the florets of the disk rarely perfect seeds, although the stigmata are thickly beset with bristly papillæ, while the female florets of the circumference, with smooth stigmata, are uniformly fertile. These smooth stigmata absorb the fecundating particles by means of the numerous pores on their upper surface, which, in the early stage of maturity, is always moistened with a glutinous fluid. *Haxtonia* *, however, is an exception to the above rule, as in this the florets, both of the circumference and disk, are equally fertile.

* HAXTONIA.—*Involucrum* polyphyllum, imbricatum. *Receptaculum* subfavosum. *Flosculi radii* fœminei, ligulati, stigmatibus linearibus, obtusis, sulco exaratis, margine incrassatis! lævibus; *disci* hermaphroditi, tubulosi, 5-dentati. *Filamenta* articulo superiore brevissimo crassiore. *Antheræ* basi muticæ. *Stigmata* hermaphroditis crassa, obtusa, subclavata, copiosè papillosa, nec hispida. *Achenia* sulcato-angulata. *Pappi radiis* persistentibus, apice penicillatis.

Frutices (Novæ-Hollandiæ) *sempervirentes, pube plerumque stellatâ vestiti.* Folia *alterna, subtùs tomentosa.* Flores *terminales, paniculati.* Pappus *sæpè rufescens.*

Hùc Aster argophyllus, *Lab.*, viscosus, *Lab.*, phlogopappus, *Lab.*, stellulatus, *Lab.*, tomentosus, *Willd. et Hort. Kew.*

OBS. Joannes Haxton hortulanus peritus Legationi Macartneianæ ad Chinam olim adjunctus.

Haxtonia nomen Asteri argophyllo *Billardieri* primùm imposuit b. Georgius Caley.

I shall now proceed to give the characters and description of *Tafalla*, and of the species already ascertained to belong to it.

TAFALLA.

BACCHARIDIS sp. *Lam. Pers.*

MOLINÆ sp. *Ruiz et Pavon.*

Syst. Linn. SYNGENESIA POLYGAMIA SUPERFLUA.

Ord. Nat. COMPOSITÆ, *Adans. Brown.*

Fam. INULEÆ, *Cass.*—*Trib.* GNAPHALIEÆ.

CHAR. ESSENT.—*Involucrum* scariosum, imbricatum. *Receptaculum* nudum. *Flosculi* dioici; *masculi* infundibuliformes, 5-dentati; *fœminei* filiformes, limbo 5-fidi. *Antheræ* basi bisetosæ. *Pappi masculi radiis* apice penicillatis; *fœminei* capillaceis.

DESCR.—*Capitula* dioica! *Involucrum* polyphyllum, imbricatum: *squamis* scariosis, cartilagineo-membranaceis, coloratis. *Receptaculum* nudum, scrobiculatum. *Flosculi* indefiniti; *masculi* infundibuliformes, fauce dilatati, limbo 5-fido, laciniis elliptico-oblongis, obtusis, nervis primariis margine incrassatis; *fœminei* filiformes, imâ basi ventricosâ callosâ, limbo 5-fidi, latere interiore profundiùs fissi: *laciniis* lineari-angustissimis, subæqualibus, erectis. *Stamina* inclusa: *filamenta* capillaria, glabra; *articulo superiore* brevi, teretiusculo: *antheræ* in tubum coalitæ, basi bisetosæ, setis ramulosis, vix plumosis, appendiculâ ovatâ terminatæ. *Stigma* masculis inclusum, clavatum, bilobum, truncatum, minutè papillosum; fœmineis exsertum, bipartitum: *segmentis* semicylindricis, obtusis, recurvatis, glabris. *Achenia* oblonga, subpentagona, glabra, basi umbilico calloso prominenti foraminulo verticali perforato instructa: *disco epigyno* planiusculo, vix dilatato. *Pappi radiis* duplici ordine copiosissimis; *masculi* apice clavato-penicillatis; *fœminei* tenuissimis, capillaceis, scabris, imâ basi connexis, involucro longioribus.

Plantæ (Peruvianæ) *suffruticosæ*, Thujæ *v.* Lycopodii *facie.* Folia *alterna, sessilia, disticha, parva, adpressè equitantia, carinata.* Capitula *solitaria, sessilia, foliis ferè immersa, axillaria et terminalia.* Involucrum masculinum *subrotundum,* squamis *cartilagineis, laminâ rotundatâ terminatis;* fœmineum *oblongum,* squamis *lanceolatis, acuminatis, membranaceis, subpellucidis.* Pappus *cinereo-lutescens, supersistens;* fœmineus *pallidior.*

1. T. *thyoides*, foliis lanceolatis, antherarum appendiculâ acuminatâ.

Baccharis thyoides, *Lam. Encycl.* 2. p. 90.—*Illustr.* t. 697.—*Persoon Syn.* 2. p. 425. *Hook. Bot. Misc.* 2. p. 224. t. 93.

Molina incana, *Ruiz et Pavon Syst. Veg. Fl. Peruv. et Chil.* 1. p. 211.

Hab. In Peruviæ alpibus ad Pillao vicum, versus Silcay tractum. *Ruiz et Pavon.* ♄. *Vulgò* Palmito Floret a Novembri ad Aprilem. (V. s. sp. in Herb. Lamb.)

Planta suffruticosa, spithamæa, aut sesqui v. tripedalis, erecta, ramosa, niveo-lanuginosa. *Ramuli* sparsi disticho modo dispositi, lineares, obtusi, complanati. *Folia* alterna, sessilia, semiamplexicaulia, disticha, crebrè adpressèque equitantia, lanceolata, obtusa, compressa, carinata, integerrima, marginibus conniventibus, membranaceis coriacea, suprà concava, densè niveo-lanata, subtùs demùm glabra, nitida, viridia, 3–5 lineas longa, versus basin caulis sparsa. *Involucri masculi squamis* 12, subtriplici ordine dispositis, oblongis, scariosis, cartilagineis, nitidis, flavicantibus, apice laminâ rotundatâ, dilatatâ, fuscescenti, concavâ, leviter erosâ auctis; *fœmi-*

nei 15, 4-plici ordine imbricatis, lanceolatis, acuminatis, erosis, magisque membranaceis. *Appendicula antherarum* ovata, apice contracta, acuminata.

2. T. *ferruginea*, foliis ovatis, antherarum appendiculâ obtusâ.

Baccharis ferruginea, *Persoon Syn.* 2. p. 425.

Molina ferruginea, *Ruiz et Pavon* l. c. 1. p. 211.

Hab. In Peruviæ alpibus, in Tarmæ, Cantæ, et Huorocheri provinciis. *Ruiz et Pavon.* ♄. *Vulgò* Matara et Palmito. Floret a Decembri ad Maium. (V. s. sp. in Herb. Lamb.)

Planta suffruticosa, tripedalis, erecta, magis robusta, fulvo-lanuginosa. *Ramuli* disticho modo dispositi, complanati. Folia alterna, creberrima, amplexicaulia, disticha, adpressè imbricata, ovata, apice attenuata et obtusula, basi cucullata, duplò latiora quàm in præcedente, atque magis crassa et coriacea, subtùs convexa, carinata, demùm glabra, nitida, suprà concava, lanugine sordidè fulvâ copiosè induta, marginibus conniventibus, obtusis, nec membranaceis, 4–5 lineas longa, ad basin 3 lineas lata. *Flores* solitarii, terminales et axillares, omninò sessiles, folia propria circumcingentia vix superantes. *Involucri masculi squamis* numerosioribus elliptico-oblongis, cartilagineis, subæqualibus, triplici ordine digestis, margine supernè membranaceis, scariosis, apice laminâ rotundatâ rigidiusculâ, subintegrâ auctis, lutescentibus, nitidis; *fœminei* lanceolatis, acuminatis, scarioso-membranaceis, pellucidis, margine leviter erosis. *Flosculi fœminei* basi angustiore, vix ventricosâ: *laciniis* paullò brevioribus quàm in præcedente. *Antherarum appendicula* elliptica, obtusa. *Stigmata* breviora. *Cætera* ut in genere.

Obs. Involucri masculi squamæ interiores sæpè flosculis intermixtæ, et subinde paleas mentientes.

DESFONTAINIA, *Ruiz et Pavon.*

Syst. Linn. PENTANDRIA MONOGYNIA.

Ord. Nat. GENTIANEÆ ! *Nobis.*

Calyx 5–4-partitus, persistens: *segmentis* subæqualibus, oblongis, obtusissimis, cartilagineis, nervosis, æstivatione imbricatis. *Corolla* tubulosa, cartilaginea, 5-nervosa, nervis per laciniarum axin excurrentibus, limbo 5–4-loba: *lobis* rotundatis, retusis, venosissimis, margine ciliatis, æstivatione imbricatis. *Stamina* 5, rariùs 4, epipetala, lobis corollæ alterna, inclusa: *filamenta* glabra, tubo corollæ ferè omninò connata, apicibus liberis, crassis, hinc convexis, inde planiusculis: *antheræ* erectæ, innatæ, biloculares: *loculis* linearibus, parallelis, intervallo perangusto sejunctis, connectivo (filamenti continuationi) magno carnoso insertis, eodemque brevioribus, longitudinaliter dehiscentibus: *valvulis* angustissimis, æqualibus, margine paululùm involutis. *Ovarium* liberum, globosum, uniloculare: *ovulis* creberrimis, inordinatis, horizontalibus, placentis septiformibus adnatis. *Stylus* filiformis, glaber. *Stigma* capitatum. *Bacca* globosa, unilocularis, polysperma. *Placentæ* 5 v. 4, parietales, septiformes (subinde bacca quasi multilocularis), margine interiore liberis, incrassatis, trigonis, lateribus reflexis seminiferis. *Columella* nulla. *Semina* numerosa, inordinatè disposita, erecta, obovata, ventricosa, angulata, basi umbilico, apice chalazâ dilatatâ atrofuscâ, latere interiore raphe prominulâ callosâ instructa; *testa exterior* coriacea, fulvescens, pellucido-punctata; *interior* membranacea, pallidior, nucleo adhærens: *albumen* copiosum, carnosum, album. *Embryo* minutissimus, subrotundus, dicotyledoneus, lacteus, in regione umbilicali, erectus: *cotyledones* brevissimæ: *radicula* crassa, obtusissima.

Frutices (Amer. Austr.) *sempervirentes, sapore amarissimo.* Folia *opposita, den-*

tato-spinosa! Petioli *ramis articulati.* Flores *terminales, solitarii, pedunculati.* Pedunculi *libracteolati.* Corolla *coccinea, limbo lutea.* Bacca *alba.*

1. D. *spinosa*, segmentis calycinis ligulatis foliisque glabris.

Desfontainia spinosa, *Ruiz et Pavon Syst. Veg. Fl. Peruv. et Chil.* 1. p. 59.—*Fl. Peruv. et Chil.* 2. p. 47. t. 186. (mala).—*Gen.* t. 5.

D. splendens, *Humb. et Bonpl. Pl. Æquin. Amer.* 1. p. 157. t. 45.—*Kunth in Nov. Gen. et Sp. Pl.* 7. p. 274.—*Syn.* 4. p. 267.

Linkia Peruviana, *Persoon Syn.* 1. p. 219.

Hab. In Peruviæ nemoribus ad Churupallana præsidium Tarmæ, et inter Muna et Pozuzo *(Ruiz et Pavon)*; in Andibus Quinduensibus et in Parama de Almaguer. *Humboldt et Bonpland.* ♄. Floret Octobri et Novembri. (V. s. sp. in Herb. Lamb.)

Frutex biorgyalis, erectus, ramosissimus, rigidus, sempervirens, cortice lævi subfungoso lutescente annulatim deciduo. *Rami* brachiati, ferè articulati. *Folia* opposita, petiolata, elliptico-oblonga, coriacea, glabra, viridia, suprà lucida, exsiccatione venosa, basi cuneatâ integerrimâ, margine dentato-spinosa: *dentibus* magnis, 7–14. *Petioli* internodiis plerumque duplò v. triplò breviores. *Calyx* glaber, pedunculo vix brevior. *Corolla* calyce 4-plò longior. *Bacca* alba, magnitudine *Cerasi.*

2. D. *parvifolia*, foliorum costâ subtùs pilosâ, segmentis calycinis ovalibus ciliatis.

Desfontainia spinosa, *Herb. Ruiz,* non *Fl. Peruv.*

Hab. in Peruviâ ad Munæ Montes. *Ruiz.* ♄ (V. s. sp. in Herb. Lamb.)

Frutex ramosissimus, compactus, frondosus, sempervirens, cortice flavicanti, nitido, deciduo. *Ramuli* quadranguli, subarticulati, angulis prominentibus, demùm cortice decidenti obliteratis, subinde teretes. *Folia* opposita, petiolata, cuneata, 5 v. 7-dentata, rariùs tricuspidata, dentibus mucronato-spinosis, margine callosis; coriacea, semiuncialia, basi in petiolum alternata, suprà glabra, nitidissima, subtùs pallidiora, costâ pilosâ. *Petioli* marginati, 3–4 lineas longi, intra bases, præsertim novellorum, vaginâ (rudimento foliorum?) tenuissimè scarioso-membranaceâ, albâ, evanescenti instructi. *Pedunculi* (ramuli modificati) brevissimi, uniflori, vix unguiculares, bracteis 2 lanceolatis, carinatis, mucronato-spinosis, basi connatis, margine costâque pilosis muniti. *Calyx* 5-partitus, nunc 4 v. 6-partitus: *segmentis* ovali-oblongis, obtusissimis, concavis, multi-nerviis, coriaceis, margine membranaceis, et, præsertim apicem versus, ciliatis. *Corolla* tubulosa, pollicaris, coccinea, limbo 4-5 loba: *lobis* rotundatis, ciliatis, nervosis. *Antheræ* subtrigonæ, abruptè mucronulatæ, dorso acutè carinatæ; *valvulâ interiore* angustiori. *Ovarium* globosum: *placentis* 4. *Stylus* glaber, infernè crassior, 4-sulcatus. *Stigma* exsertum, obtusum, leviter 4-tuberculatum, pruinosum.

Some groups of plants exist in whose external features there is nothing that can lead to a knowledge of their affinities, and among these may be ranked the remarkable genus now under consideration. From observing the similarity in the disposition of the veins in the calyx and corolla, and the consistence of these organs, as well as the nervation and dentation of the leaves, I was led to conclude that it might be allied to *Theophrasta*; but a closer examination did not confirm that conjecture, although, from remarking the nature of the albumen, and the structure and position of the embryo, I was afterwards induced to compare it with the *Gentianeæ*, to which family, I am now fully persuaded, it must be referred, notwithstanding its toothed leaves and the greater number of its placentæ.

It is rather curious that my learned friend M. Kunth should have also been led to believe it allied to *Theophrasta*, but of this fact I was not aware at the time when my observations were made; and the circumstance is only mentioned now, to show that there exist some striking analogies between these two genera to have led us to the same conclusion.

Not the least trace of pubescence is discernible in the specimens of *Desfontainia spinosa* in the Herbarium of Ruiz and Pavon; but in the separate collection of Ruiz, there are specimens of the second species, marked by himself *D. spinosa*, wherein the calyx is beautifully fringed. It appears to me probable, therefore, that both plants are confounded in the description given in the *Flora Peruviana*, and that the pubescence is an after addition, either in the drawing or engraving. The figure is altogether very incorrect; the peduncles are represented as axillary, and without bracteæ; and the anthers, as if they were unilocular, although rightly shown as alternating with the laciniæ of the corolla, and not opposite, as represented in the *Prodromus* of the same authors.

BALBISIA, *Cav.*

LEDOCARPON, *Desf.*

Syst. Linn. DECANDRIA PENTAGYNIA.
Ord. Nat. FICOIDEÆ. *Nobis.*

The genus *Balbisia* was established by Cavanilles, in the seventh volume of the *Anales de Ciencias Naturales*, published at Madrid in 1804, where a very full description and figure, including the details of the structure of the flower and fruit, will be found. Fourteen years afterwards, namely, in 1818, the genus was republished by M. Desfontaines, under the name of *Ledocarpon;* but as science belongs to no particular region or country, there seems no reason why the name of Cavanilles is to be superseded by the much more recent one of the distinguished French Professor, especially as the *Balbisia* of Willdenow has been shown by Mr Brown to be identically the same with the *Tridax* of Linnæus. Cavanilles considered the genus akin to the *Rutaceæ;* by Ruiz and Pavon it was regarded as allied to *Œnothera;* and by M. Desfontaines to the *Oxalideæ*, in which opinion he has been followed by Decandolle. It is clear, however, that in many points of structure it differs essentially from either of these families. I had long ago been struck by the resemblance of *Balbisia* to certain ficoideous plants, particularly to *Mesembryanthemum villosum* of Linnæus; and an accurate comparison of its structure leaves no doubt on my mind of its really belonging to the same natural family, connecting the latter with the small group of *Reaumurieæ.* The decandrous flowers may seem, at first sight, an objection to this association; but it must be observed, that the stamina, in some of the normal *Ficoideæ*, although numerous, are nevertheless really definite; their number being fifteen, forming a triplicate of the lobes of the calyx.

The genus having been so well illustrated by the authors above mentioned, and still more recently by Dr Hooker and Mr Lindley, it seems quite unnecessary for me to give a description of it, and I shall merely content myself with adding the characters and synonyms of the species.

1. B. *verticillata,* foliis lineari-angustissimis margine revolutis, bracteis subulatis.

Balbisia verticillata, *Cav. Anal. de Cien. Nat.* 7. p. 62. t. 46.
Ledocarpon chiloense, *Desf. in Mem. Mus.* 4. p. 251. t. 13. (optima). *Decand. Prod.* 1. p. 702.
Œnothera scoparia, *Herb. Ruiz et Pavon.*

Hab. in Peruviâ inter Obragilla et Canta (*Ludov. Née, Ruiz et Pavon*); atque in Chili, *Dombey, Ruiz et Pavon.* ♄ (V. s. sp. in Herb. Lamb.)

Planta suffruticosa, ramosissima, sericeo-incana, *Œnotheræ* v. *Helianthemi* facie. *Folia* rectiùs, ut mihi videtur, simplicia, plerumque oppositè fasciculata, 3 v. 4, nunc tantùm 2, basi coadunata, lineari-angustissima, margine revoluta, subacerosa, apice mucronulo, obtuso, nudo, internodiis sæpiùs longiora. *Flores* terminales, solitarii, pedunculati. *Bracteæ* plurimæ, subulatæ.

2. B. *peduncularis,* foliis lineari-oblongis obtusis planis subtùs venis conspicuis, bracteis linearibus.

Ledocarpum pedunculare, *Lindl. in Bot. Reg.* t. 1392.
Cruckshanksia cistiflora, *Hook. Bot. Misc.* 2. p. 211. t. 90.

Hab. in Chili ad Coquimbo, *Caldcleugh, Cruckshanks, Macrae.* ♄ (V. s. sp. in Herb. Lamb.)

Folia triplò latiora, plana, internodiis semper breviora. *Pedunculi* parùm longiores. *Bracteæ* pauciores, lineares, planæ. *Calyx* longior.

Dombey is said to have gathered his plant in Chile, and there are specimens in the herbarium of Ruiz and Pavon, marked from that country; otherwise I should have been disposed to believe that some mistake had been committed with respect to that habitat. The fascicles of leaves, in both species, are opposite, or, more properly speaking, approximate, than alternate, in the native specimens.

In a former number of this Journal (January 1830), I have proposed to place *Viviania* (*Macræa*, Lindl.) next to *Mollugo*, and *Pharnaceum* among the *Caryophylleæ;* and having again directed my attention to the subject, I see no reason to alter my opinion. With respect to its monophyllous calyx, and the embryo being surrounded by albumen, if rightly represented by Dr Hooker, both these characters occur likewise in genera, of whose association with the *Caryophylleæ* there can be no question; for the seeds of *Dianthus* differ much more from its coordinates, than *Viviania,* the embryo being perfectly straight, and placed in the centre of the albumen; in which characters it accords with *Lineæ,* and it ought perhaps to be regarded as the connecting link between the two families. With respect to the supposed affinity of *Viviania,* either to the *Geraniaceæ* or *Oxalideæ,* I must candidly confess that I have not been able to detect any.

Cavanilles is sometimes wrong in the habitats he gives, and I am therefore inclined to think that the Mexican station he gives for *Viviania marifolia* is incorrect, and that the specimen was collected in Chile, as it does not appear to be specifically different from *rosea;* the calyx of which is but indifferently represented in Dr Hooker's otherwise excellent figure.

LUZURIAGA, *Ruiz et Pavon,* non *Br.*

Syst. Linn. HEXANDRIA MONOGYNIA.
Ord. Nat. SMILACEÆ, *Br.*

Perianthium duplici ordine 6-phyllum, patens; *foliolis exterioribus* ovato-lanceolatis, obtusulis; *interioribus* ovatis, duplò latioribus. *Stamina* 6, hypogyna, distincta: *filamenta* brevissima, dilatata, complanata, submembranacea: *antheræ* erectæ, longæ, lineares, obtusæ, biloculares, basi sagittatæ: *loculis* parallelis, longitudinaliter dehiscentibus, basi productis: *connectivo* supernè attenuato. *Stylus* acutè triqueter. *Stigma* trigonum, obtusum, minutè papillosum. *Bacca* globosa, trilocularis: *loculis* dispermis. *Semina* compressa, lutescentia, basi interiore umbilico instructa, hinc carinata, inde plana, latere exteriore convexiuscula, sulcata: *testa* simplex, membranacea, nucleo arctè adhærens: *albumen* durum, cellulosum! *Embryo* parvus, axilis. *Radicula* ab umbilico remota.

Planta (Chilensis) *suffruticosa, per arborum truncos, more* Hederæ *scandens et radicans.* Caulis *teres, infernè squamis (foliorum rudimentis) emarcidis glumaceis instructus.* Rami *tetragoni, flexuosi, convoluti, angulis elevatis.* Folia *alternatim disticha, brevissimè petiolata, lanceolata, integerrima, apice mucronulo calloso, cartilaginea, glabra,* 6-12-*nervia, petiolorum contortione subresupinata! pollicaria v. bipollicaria:* nervis *strictis, parallelis, utrinque prominulis, ramulis transversis, connexis.* Flores *in ramulorum apice squamis (foliis abortivis) scarioso-membranaceis, vaginantibus, fuscis munitorum, axillares, subgeminati, pedunculati.* Pedunculi *uniflori, filiformes, medio articulati, unciales.* Perianthium *albido-lutescens, uti cum staminibus styloque punctis lineolisque rubris notatum.* Bacca *rubra, magnitudine* Cerasi sylvestris.

1. L. radicans, *Ruiz et Pavon Fl. Peruv. et Chil.* 3. p. 66. t. 298.

Hab. in Chili sylvis et nemoribus ad Colium et Palomares, *Ruiz et Pavon.* ♄ Floret Septembri et Octobri. (V. s. sp. in Herb. Lamb.)

Obs. Luzuriaga, *Br.* genere omninò diversa a planta Chilensi. In L. cymosâ, *Br.* foliola perianthii subæqualia, filamenta simplicia subcapillaria, loculi antherarum vix basi producti, stylus filiformis plurimùm gracilior, pedunculus sub flore articulatus, testa seminis atra crustacea.

In Callixene, *Juss.* cui proximè affinis, perianthium 6-phyllum, patens, deciduum, foliolis exterioribus parùm angustioribus, stamina basi foliorum inserta, alternis parùm brevioribus, filamenta dilatata complanata, apice attenuata acuminata, antheræ lineares incumbentes, ovarium globosum triloculare membranaceum, ovulis in axi loculorum simplici ordine numerosis, bacca globosa rubra pisi magnitudine subdisperma, semina ovoidea, hinc gibbosa, fulvescentia erecta apice chalazâ tuberculiformi instructa, testa simplex tenuissimè membranacea leviter rugulosa, albumen magnum corneum solidum, embryo in regione umbilicali cylindraceus, albuminis dimidio vix longitudine æqualis, curvulus basi obtusus.

LAPAGERIA, *Ruiz et Pavon.*

Syst. Linn. HEXANDRIA MONOGYNIA.

Ord. Nat. SMILACEÆ, *Br.*

Perianthium 6-phyllum, tubulato-campanulatum, petaloideum deciduum; *foliolis* 3 *exterioribus* lanceolatis, acuminatis; *interioribus* longioribus, cuneato-oblongis, mucronulatis, nervosis, nervis reticulato-ramosis. *Stamina* 6, inæqualia, foliolorum perianthii basi inserta; *exteriora* 3, breviora: *filamenta* subulata, glabra: *antheræ* longæ, basi subsagittatâ insertæ, erectæ, biloculares, apice obtusæ: *loculis* parallelis, longitudinaliter dehiscentibus, basi paullò productis. *Stylus* elongatus, triqueter, glaber. *Stigma* clavatum, obsoletè trilobum. *Bacca* oblonga, obtusè trigona, trisulca, trilocularis, polysperma. *Semina* angulata.

Planta (Chilensis) *suffruticosa, scandens.* Caulis *teres, flexuosus, minutè tuberculatus, infernè squamis (foliis abortivis) scariosis plurimis instructus.* Ramuli *vix enati squamis ovatis acuminatis fuscis imbricati.* Folia *alterna, petiolata, cordato-oblonga, acuminata, intgerrima, 5-nervia, coriacea, glabra, margine lævia, cartilaginea, exsiccatione reticulato-venosa! sesqui v. tripollicaria.* Petioli *brevissimii, suprà plani, basi dilatati.* Flores *in ramulorum* *apicibus terminales, solitarii, subinde sæpiùs quasi axillares.* Pedunculi *uniflori, obscurè angulati, apice dilatato-discoideo cum flore articulati, bracteis ovatis, acuminatis, sæpè scariosis, nunc aliis foliis magis consimilibus, fuscis, subinvoluto-vaginantibus muniti.* Perianthium *bipollicare, roseum, intùs albo-maculatum.* Bacca *oblonga, pallida, pendula.*

1. L. rosea, *Ruiz et Pavon Fl. Peruv. et Chil.* 3. p. 65. t. 297.

Hab. in Conceptionis Chilensium Rere et Itatæ provinciarum sylvis per arbores et frutices scandens. *Ruiz et Pavon, Caldcleugh, P. P. King.* ♄ ◡ Floret a Februario ad Maium. *Vernaculè* Copihue. (V. s. sp. in Herb. Lamb.)

Obs. Fructûs pulpa dulcis est et incolis gratissima. Radix adstringens atque loco Sarsaparillæ usus est. In Philesiâ proximâ perianthii decidui foliola 3 exteriora elliptico-oblonga mucronulata membranacea calycina, interiora 3 5-plò majora cuneata mucronulata petaloidea, stamina 6 subæqualia, antheræ lineares incumbentes, stylus ferè staminum longitudine, stigma dilatatum leviter trilobum, lobis reflexis, ovarium trigonum triloculare, ovulis numerosis. Differt a Lapageriâ præcipuè foliolis perianthii exterioribus 3 brevibus calycinis.

The limits which separate the groups of the Liliaceous class are extremely ill-defined, the modifications of structure being so various in all of them, that nothing certain beyond mere generic distinctions can be obtained. The four genera now under consideration appertain to the group *Smilaceæ*, many of which come so near to the *Asphodeleæ*, that I have formerly proposed to unite all those whose fruit is a berry under the name of *Asparageæ* *, as it is clear no certain characters can be derived from the consistence of the testa, which is found to differ much in genera otherwise intimately allied. In *Asphodelus*, *Allium*, *Ornithogalum*, *Ruscus*, *Smilax*, and *Convallaria*, the testa is simple and membranaceous, and the albumen fleshy; while in *Asparagus*, *Dracæna*, *Cyanella*, *Anthericum*, and *Tulbaghia*, the seeds are furnished with a crustaceous covering and cartilaginous albumen. Much has been said respecting the disposition of the nerves, in the leaves of monocotyledonous plants, as affording a good characteristic mark of the class; but the whole of *Aroideæ*, and several genera belonging to other families, afford striking exceptions, and in that respect do not differ essentially from the *Dicotyledoneæ*.

(*To be continued.*)

* Prod. Fl. Nep. p. 46.

Account of a Wooden Suspension-Dial used in the Alps and Pyrenees. By Owen Stanley, Esq. R. N. With a Figure. Communicated by the Author.

This litttle wooden instrument is used in the neighbourhood of Barege in the Pyrenees, and there it is called the Barege clock. Calculated for that latitude, it was a mere object of curiosity in our latitude; but conceiving that it might, if the shadow points in the curves could be calculated for any latitude, become an article of general use and ready sale, my friend the Rev. Mr Stanley, who sent me specimens of these dials, and suggested what has just been stated, transmitted for the Journal the following notice of the principle and mode of construction of the instrument, drawn up by Mr Stanley, one of the officers of Captain King's exploratory expedition, which is here subjoined.

Cylinder CKB, Fig. 2. Plate III., is suspended from the point C by a thread, when the line AB (which is at right angles to AD) will become horizontal, and coincide with the visible horizon ABH.

The gnomon or index is fixed into the moveable head of the instrument, so as to revolve round the cylinder at right angles to its axis.

The dial is used as follows: Turn the gnomon round until it is immediately over the line denoting the day of the month; let the cylinder hang freely from the point C, and turn it round until the shadow of the gnomon falls on the line immediately under it, then the end of the shadow will mark the hour by its position with respect to the hour lines 2 E, 3 F, 4 G, &c.

Construction.—On the cylinder draw 18 parallel lines, at equal distances; the extreme line at one end representing the 21st of December, at the other end the 21st of June, and the intermediate lines every tenth day. On the line representing the 21st of June, from the line AK, with a radius equal to the length AB of the gnomon, lay off the tangents of the sun's altitude corresponding to the hours 4, 5, 6, &c. the declination 23, 30, and the latitude of the place, (which altitudes may be taken by inspection from Lynn's Horary Tables). On the next line to the right, which will represent the 11th of June or the 1st of July, (because the sun will have the same declination on those days), repeat the former operation, using the sun's declination corresponding to the 1st July in the computation of the altitudes; do the same at all the other lines, and through all the points thus determined draw the hour lines 2 E, 3 F, 4 G, &c. and the dial will be completed.

Proof.—The line AB is made to coincide with the line AH, or the visible horizon in the construction; let S represent the sun, then the angle SBH is equal to the sun's altitude. But the angle SBH is equal to the angle ABE, to which AE is tangent, at the radius AB. But it is evident from the figure that AE must be the length of the gnomon's shadow when the sun is at S, and as the point E is the tangent of the sun's altitude at 2 o'clock, the contact of the point of the shadow at that line must be the hour required.

Extract of a letter from Dr Turnbull Christie to Professor Jameson regarding the Bone Caves of Palermo, &c.

My Dear Sir, *Palermo, 31st May* 1831.

Notwithstanding all the classical interest of Italy, I saw nothing in it that gave me more real pleasure and satisfaction than Vesuvius, which I saw to great advantage. To a geologist, his first view from the summit of that beautiful mountain is one of the greatest pleasures he can expect to enjoy in this life, and I saw it to perfection. It was exactly in such a low state of activity as to enable us to walk down into the great crater, and round the summit of the internal one, which was thrown up in December last year, and which is at present only emitting smoke, and occasionally a few ashes. It has now an elevation, I should think, of about 300 feet above the bottom of the large crater; and the highest point of the mountain, which is on the north edge of the latter, I calculated, by a single barometrical observation, in connection with one made at the same time at Naples, to be 3677 feet above the level of the sea.

Hitherto I have looked upon my journey merely as one of pleasure. It is from this place that the real business of my tour will commence, and that I will begin to make observations for myself. I have already seen much to interest me in Palermo and its environs. The town, which is handsome, containing two magnificent streets which run at right angles to each other, and many fine public buildings, is situated in the centre of a beautiful bay, which opens to the north-east, and is flanked on both sides by steep rugged mountains coming close down to the shore; behind it extends a rich plain, bearing olives, figs, vines, a profusion of oleanders in full flower, the aloë, the cactus, and other plants of a hot climate, and fields of corn, great part of which is already cut; and this is encircled, at the distance of from one to two miles from the shore, by a fine amphitheatre of steep rugged limestone hills. The whole plain is composed of horizontal beds of the newest tertiary, or, if you please, quaternary system, containing in many places numerous shells of existing Mediterranean species. The hills, some of which have a very considerable elevation (I should suppose at least 1500 feet), consist of magnesiferous limestone, and, like the dolomites of northern Italy and Germany, present scarcely any trace of stratification, but are split, generally at very high angles, by numerous rents, and possessing in many places the cellular and fissured structure of true dolomite. They contain several caverns at no great distance from Palermo, in some of which bones of the large extinct *diluvian* quadrupeds have been found. These were for a long time believed by the good people of Palermo to have belonged to the ancient race of giants who inhabited this island in early ages; but upon the discovery of their being really the bones of elephants and hippopotami, they contended that they must be the remains of these animals killed in the Roman games, and it was only lately that Cuvier's report upon a collection which had been sent to him, forced them to adopt the orthodox creed of their antediluvian origin. A memoir on one of the caves has just been published by Signor Scina, Professor of Natural Philosophy in the University of Palermo, which contains an accurate, although not a very clear, description of it, and requires many additional details to make it of value to the geological reader. I have already examined the caves, and have found them to possess the greatest interest. They must be referred to the bone breccias which occur so commonly along the shores of the Mediterranean, rather than to the *true caves*, such as those of England or Germany. The most important is the Grotto di Santo Ciro, about two miles to the south-east of Palermo, for the bone breccia is there found in connection with the recent quaternary formations containing Mediterranean shells, which it distinctly overlies. The quaternary beds extend up to, and even a considerable way into, the interior of the cavern, and the breccia not only covered them within, but is still seen extending a considerable way beyond the mouth of the grotto, and forming, along with blocks of limestone, a sort of talus, which slopes from the side of the hill to the plain below. There are various other curious facts connected with this very interesting deposite, which will bear closely upon some of the prevailing theoretical views regarding these recent formations, but which I must unavoidably reserve for my notes on the geology of Sicily, which I propose to send to the Geological Society of London from Malta, after I have completed my journey through this island.

June 2.—I have just returned from visiting another deposite of bone breccia about four or five miles from here. Like the former, it is partly within, partly on the outside, of a small cave in one of the limestone hills; but there are no quaternary beds near it, no marine shells, no holes drilled in the limestone by lithodomi such as are seen in the other, in fine, no indications of the sea having been there, so that it probably had its origin under different circumstances from those which accompanied the formation of the breccia at Santo Ciro, and the comparison of the two, therefore, becomes interesting.

I intend to start from Palermo to-morrow, and to go by way of Termini, Cefalu, from thence through the centre of the island, by Castra Giovanni and the plain of Catania, to the eastern coast; after which I will ascend Mount Etna, and then go to Cape Passaro, whence I shall cross over to Malta. During this excursion I hope to have an opportunity of observing the relations which the formations of Sicily bear to the lines of elevation, and if possible to place these in connection with the great lines of Elie de Beaumont.

On the Magnetic Properties of the Rock on the Summit of Arthur's Seat. By Mr WILLIAM GALBRAITH, M. A. Communicated by the Author. Plate III. Fig. 3.

IT has been long known that rocks impregnated with iron-ore exert an influence on the magnetic needle, not only from the iron which they contain, but also from portions of the natural magnet imbedded in the mass. Basaltic rocks, in particular, are frequently possessed of this property. One of the oldest instances in this country recorded, so far as I know, is the rock on which Dumbarton Castle is built. This circumstance is noticed in Buchanan's History of Scotland *. Professor Anderson of the University of Glasgow, made repeated experiments on the magnetism of this rock, and on the direction of its poles. On the south side, near the top of the western peak, a large exposed rock has been pointed out, on which many experiments have been made, and from its situation is probably that alluded to by Buchanan. It has been asserted by Mr Drysdale, the master-gunner of the Castle, that it extends its influence to the opposite shore of the Clyde †.

* In superiore arcis parte ingens est saxum *Magnesii quidem lapidis*, sed ita cæteræ rupi coagmentatum et adhærens ut commissura omnino non appareat. Liber xx. sectio 28.

† The first distinct observations concerning the magnetic polarity of rocks, were made by Baron Humboldt in 1796. He noticed it in a serpentine rock on the Haidberg, near Celle, in the country of Baireuth. It was afterwards observed in many other rocks, such as hornblende-slate, porphyry, trachyte, basalt, &c. It is apparently confined to mountains containing magnetic ironstones, although the quantity of this admixture in itself does not limit the intensity of the property; as, indeed, it shows itself with different purely magnetic ironstones, in the greatest variety of degrees of strength, and there are some of these which show no magneto-polar action. Neither is there any regularity in the position of the axes either in one and the same mass of rock in general, or a fixed correspondence in the position of these axes with the direction of the strata of the rocks. Bergmeister Schulze of Duren, in an excursion in the Eifel, a region of greywacke and basalt, observed from the top of the Nürburg Mountain (a basaltic cone 2000 Prussian feet above the level of the Rhine), on an elevation in an eastern direction, something resembling the ruins of a building. Instead of ruins, however, he found it to be two small rocks, about three feet distant from each other in their diagonals, about six feet high, with bases not far from three feet square; one of them was six long and three feet broad; the other was a little shorter

Doubtless similar rocks will exert the same influence; and as there is some analogy between this rock and Arthur's Seat, it should have occurred to geologists that the same consequences might have been expected, as have lately fallen under my own observation, though previously, so far as is known to me, few accurate observations of the kind have been recorded.

On the evening of the 10th of August 1831, I took a walk

but broader. Both rocks were stratified, with a dip of twelve degrees, and parallel to the basaltic range on which they reposed. On presenting a magnetic needle to them, it was subject to sudden and violent changes. The circumference of one of them attracted the north pole through half its extent, but repelled it for the remainder. The manner in which the needle was affected by the other rock, may be understood by drawing a line lengthwise through the centre of the upper plane of the rock, and another crosswise through the same plane, so that the point of contact shall occupy the centre of the plane; the north pole of the needle was attracted at the extremities of the longer line, while the opposite pole was attracted at the extremities of the shorter one.

M. Reuss of Bilin, observed the same property in a mountain of dark greyish-black basalt, free from magnetic ironstone, in the Mittelgebirge. The mountain, 1800 feet high, is covered with wood to its summit, and precipitous on all sides. Its polarity is so great, that the needle at its eastern foot was moved 40°, and at the summit itself 90° W. At the western foot of the rock, the contrary was the fact; but the polarity is shown not only in the whole mass of the rock, but likewise in the larger detached pieces, and even in the smallest fragments; the north point of the needle being at one end distinctly attracted, and at the opposite end as distinctly repelled.

Many years ago, I noticed this property in the trap-rocks of the Island of Canna, and in other trap districts in Scotland. A late writer remarks, that this magnetic influence is occasionally limited to a space of three or four feet; but it is sometimes also extended to distances much more considerable, so as to produce a decided effect on the variation of the needle. There is no doubt that it has, where unobserved, been a frequent cause of error in maritime surveying, as well as in surveys on shore, where the compass is used for the observations, or when the position of the theodolite is regulated by the needle. Independently of the local disturbances produced in the Western Islands by the vicinity of masses of trap, there is a general irregularity of the magnetic variation prevalent throughout the western coast, produced, doubtless, by the combined influence of the larger tracts, whether of trap or of other rocks. It is sufficiently sensible at sea to diminish materially the use of the compass in navigating these islands; fortunately that instrument is not often wanted, as it rarely happens that some land cannot be seen. At a period when the general variation was stated at 26° west, it was found to be 19° in Loch Ryan, 36° on the east shore of Skye, and 21° near the Craig of Ailsa. The trials on land were made with a needle elevated as high as possible above the surface. —EDITOR.

to the top of Arthur's Seat, and, in order to look out for the summits of some of the mountains in the Highlands, I determined their bearing previously, so that, by means of Schmalcalder's surveying compass, I could find their directions, referred to some near fixed object, and would be enabled to examine the horizon in the proper line of bearing, whenever the weather was clear and highly favourable for distant views, required in such cases. On placing the compass, however, on what was thought a convenient place of the rock, I was struck with the remarkable deviation of the sight vane of the compass from the direction in which I knew Benlomond should be found. On removing the compass to a different position, the card was completely reversed, the north pointing to the south, and the south to the north. The compass was then carried to different points of the rock, where it still showed remarkable anomalies, the north point of the card deviating sometimes to the west, sometimes to the east, and at other times it stood nearly in the meridian. It was then resolved to make a more complete set of observations on some future day.

On the 12th, the following table, derived from a mean of two sets of observations by different compasses and different observers, was completed. The one with Schmalcalder's compass, employed by myself, the other with a new surveying compass by Mr Adie, and used by my friend Mr James Trotter, who assisted me in making the necessary observations. The angles are the bearings of the dome of the New Observatory, and are marked to correspond with the same letters in the accompanying plan of the small rock on the summit of the hill, on which the observations were made.

To obtain the true direction of the meridian, Mr John Adie found, from observations with the new astronomical circle, on a stone pillar terminating in the dome of the Observatory, that the highest point of the rock bore S. 48° 11′ E.

Also the line A Q, 31 feet in length, from which ordinates were drawn to the different points where the observations were made, formed an angle of 98°, with the magnetic meridian at the point Q, that is, the point A bore N. 98° E. from Q.

Hence the position of the north point of the compass at each point of observation may be found, and a few of the more prominent are laid down on the plan. That marked with a fleur-de-lis denotes the true north, and *Obsy.* the direction of the Observatory.

Table of Bearings of the Observatory.

A ...	N. 108°	5′ E.	G ...	N. 201°	15′ E.	N ...	N. 326°	0′ E.
B ...	332	0	H ...	174	30	O ...	12	35
C ...	2	30	I ...	355	0	P ...	6	7
D ...	319	30	K ...	33	55	Q ...	345	20
E ...	132	45	L ...	327	0	R ...	3	35
F ...	118	10	M ...	162	20	S ...	14	22

From an examination of the table, it will appear that the greatest deviations take place at the points A, E, F, G, H, and M. In this case, a reference may be made to the plan for the purpose of giving a more distinct conception.

The more remarkable anomalies, it appears, take place at the points G and H, where the needle is almost completely reversed. This shows that the portion of the rock under the compass there possesses the property of a natural magnet, having its poles nearly in the direction of the meridian,—the north pole being towards the north, and the south pole towards the south, since, by a well known law in magnetism, the opposite poles attract each other, while the same poles repel one another.

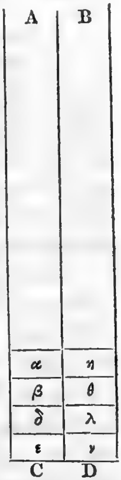
I have been more anxious to announce this fact, for the purpose of calling the attention of geologists and others to it, than to trace all its consequences, which must be left to future observation and research.

*** On the 27th these experiments were repeated, and the results confirmed, by M. E. G., a friend of the author.

On the Proximate Causes of certain Winds and Storms. By Professor E. Mitchell, University of North Carolina. (Continued from page 179.)

Of the Prevalent Movement of the Air in Winds and Storms.

It may be of use, before proceeding to account for the general facts stated in the commencement of this paper, to turn our attention to the general theory of winds, and the causes by which these movements in the atmosphere are generated. This theory is indeed abundantly simple and familiar to philosophers, but too much neglected by them when treating of meteorological phenomena. Let AC, BD be two adjacent columns of air, of which AC rests upon a sandy plain, and BD upon a forest or some other substance at D, less susceptible of being heated by the sun's rays. Let $\epsilon\ \nu$, $\delta\ \lambda$, $\beta\ \theta$ be corresponding strata of the two columns, of equal thickness and elevation. The pressure on the opposite sides of the plain separating the two columns at ϵ and ν, will in the first instance be equal; but the portion ϵ of the column AC being heated by its contact with the hot sand at C, will be expanded so as to fill both ϵ and a part, greater or less, of δ. The strata of air lying immediately above, will be lifted up out of their natural positions δ into β, and β into α. The elevation will not be extended to the whole column, but limited to its lower strata, it being in all cases the effect of the expansion of a given portion of air, to produce a condensation and displacement of the air in its neighbourhood, to which the immediate effect is confined: δ will therefore be condensed, and at the same time lifted into the position β, where, exerting in the direction of θ the same pressure as when in its original situation, this pressure will not be fully counteracted by the elasticity of θ, but a part of δ will flow into θ. Up to this time, there could be no motion in the lower strata ϵ and ν, the original pressure upon each remaining unchanged; but as soon as a part of δ flows into θ, the pressure upon ϵ being diminished, and the pressure upon ν increased, ϵ, the lighter, will give way, and ν move in to supply its place. At the same time δ, now in the position θ, will descend into λ. By a continuance of the motion it will sink to ν, pass into ϵ, and being heated there, will ascend into its original position δ. The air thus set in motion, retaining the momentum it has gained, and receiving a new impulse from time to time, a horizontal whirlwind, moving with greater or less rapidity, will be formed. A person living at the foot of the columns at C and D, and having no notice of what is going on over the earth's surface, in the direc-



tion *ν ε*. A similar motion of air, but in an opposite direction, will be produced by the condensation of the air at *ε*.

In every case of wind, the primary movement is upwards or downwards in a vertical plain. Of this the horizontal current felt at the earth's surface, is only a secondary result. It is not possible that it should be generated by those causes which affect the condition of our atmosphere, except according to the methods here represented; and we are warranted in laying down the following proposition: *The phenomena of winds and storms are the result of a vortex or gyratory movement, generally of no great extent, established in that region of the atmosphere where they prevail.*

To such persons as have been much conversant with writings on the subject of meteorology, no apology will be necessary for the formal enunciation of this proposition, and the subjoined illustrations. They must be well aware that winds are generally spoken of as long aerial rivers, flowing from one part of the earth's surface to another, with scanty and imperfect, if there are any, notices of the fact, that *they owe their existence to another movement of the air at right angles to their own course.* These obscure and erroneous views of the nature of that motion of the air which constitutes winds, seem to pervade most of the meteorological speculations of an individual holding a high rank amongst the philosophers of the age—Mr Leslie of Edinburgh. See his investigation of the cause of the oscillations of the mercury in the barometer, and his illustrations of the Huttonian theory of rain,—*that it is produced by the mingling of air of different temperatures, charged with moisture,* referred to by Playfair (Outlines, vol. i. p. 316.) with approbation, as containing a correct exhibition of the rationale of falling weather. "To explain the actual phenomena, we must have recourse to the mutual operation of a chill and of a warm current driving swiftly in opposite directions, and continually mixing and changing their conterminous surfaces*." (Leslie on Heat and

* This passage appears a second time, without any alteration of the language, in the article Meteorology, drawn up by the same author, for the Supplement to the Encyclopædia Britannica, ten years after the publication of the account of experiments respecting heat and moisture; so that he seems to regard this theory either as not admitting of, or not requiring, any correction. In the

Moisture, p. 139.) If the two currents come from opposite directions, the motion of both will be destroyed, or one will drive the other back before it, along its former track. In either case, there will be a mixture of the different portions of air only at the plane where they meet; and this will be altogether inadequate to the production of a copious rain. If their altitude be different, so that the one may glide past the other, but in immediate contact with it, there will be a more considerable mingling of the two, but still not such as is commensurate with the effect observed.

This hypothesis is besides encumbered with other difficulties. Where shall we find the cause or causes that shall set two currents in motion, in opposite directions, and make them flow on amicably together, and in contact with each other, for hundreds of miles? If they are of nearly equal coldness, no considerable effect will follow from their mixture. If they differ greatly in their temperature, their specific gravity will be so widely different that they will separate, the lighter flowing above, and the heavier below. If we suppose that combination of circumstances

fifteenth volume of this Journal, at p. 12, is an "Hypothesis on Volcanoes and Earthquakes, by Joseph du Commun, of the Military Academy of West Point." It has the stamp of originality, and no one who reads it over will doubt that it is the result of the unaided operations of his own mind; but if the author of that paper will examine this article of Leslie's, in the Encyclopædia, he will find that he has been anticipated in all the points of his hypothesis. Indeed if the writer who has furnished an analysis, with critical remarks of Professor Leslie's speculations for Brande's Journal, is to be believed, it did not originate with him, but with an individual whom we should hardly expect to find engaging in this kind of speculation,—Dr Southey, the Poet-Laureate.

"We think this the wildest conceit that has ever figured in a sober work on philosophy. It throws Bishop Wilkin's schemes into the shade, and seems to rival some of Mr Southey's oriental fictions, from one of which, the Doundaniel Cavern, it is manifestly borrowed. We shall not consume our readers' time with a serious refutation of this shower of atmospheric *air-drops*, pushing themselves down the watery abyss, from five and a half miles beneath the surface to the very bottom. Nor shall we alarm their fears for the respiration of posterity, when this unceasing operation shall have smuggled the whole atmosphere into its submarine vaults. We shall merely congratulate old Ocean on the possession of this soft, elastic, and self-adjusting pillow. To complete this *new Neptunian theory*, Mr Leslie should have shewn how, when this pillow becomes over-stuffed, the surplus air could be squeezed out, as occasion required, through one of Plato's spiracles, to inflate the bellows of the Cyclops."—*Journal for October* 1822, p. 177–8.

which, according to these views, would produce a condensation of the moisture of the atmosphere to happen occasionally, it could not, like the fall of rain or snow, be an every-day occurrence. But if the air has commonly, in storms, a vertiginous motion, the difficulty vanishes at once. The warm strata at the surface will be carried upwards, and the cold strata brought down from above, and as perfect a mixture of air, of very different temperatures produced, as any theory can demand.

Franklin draws his illustration of the movement of the air, during our north-east storms, from that of the water in a canal, when the gate by which it had previously been confined is raised; and, with his views, those of Dr Hare appear nearly to coincide. Dr Hare appears to regard the warm moist air that rises from the surface of the Gulf of Mexico, as the repository from which the rain and snow are derived, the precipitation being caused partly by a diminution of capacity, undergone by it in consequence of its rarefaction as it ascends, and partly by its admixture with the under current of cold air that comes in from the north-east, whilst it blows in from the south-west. The accuracy of these views may be questioned on a number of different grounds.

1. The precipitation arising from a change of capacity produced by rarefaction, must be confined to the immediate neighbourhood of the gulf, where the ascent and rarefaction take place. The rain and snow descending upon the middle and northern States, must therefore be ascribed simply to the lower surface or stratum of the upper current of warm air flowing towards the north-east, and the upper stratum of the current of cold air coming from that quarter. 2. The objection just stated to the doctrines of Mr Leslie, as advanced in his illustrations of the Huttonian theory of rain, applies with great force here. The source of refrigeration is altogether inadequate to the production of the effect ascribed to it. Dr Hare remarks, that by every fall of snow, twice as much caloric is liberated as would be yielded by an equal weight of red hot powdered glass. But not only is the amount of rain or snow falling during a north-east storm very great, but the weather itself often becomes intensely cold. Let it now be supposed, that the north current of air continues to move at the rate of thirty miles an hour, and the upper south-west current at the same in the opposite di-

rection for twenty-four hours. The average velocity of the wind during these storms never exceeds this estimate of forty-four feet per second,—probably it never reaches it*. The result will be simply that of bringing the air overhanging the eastern part of Maine, and that overhanging the south-western part of Georgia, into contact with each other over the state of Maryland. The effect would be gradually produced, but the total amount would be the same throughout the whole length of the Atlantic coast, with that arising from an instantaneous application of the under stratum of the air resting upon the Maine, to the upper stratum of air resting upon Georgia. But this would be altogether inadequate to the determination of a fall of snow several inches in depth, and of weather at the same time intensely cold. It is also to be remarked, that there is often almost a calm when the rain or snow commences. It is only gradually that the wind makes itself felt and rises to a gale †.

3. There are good reasons for doubting whether there be any considerable transfer of the air from the north-east towards the south-west, during the prevalence of a north-east storm. Suppose a source of heat and rarefaction to exist over the Gulf of Mexico; that the air overhanging it ascends; that the air of Georgia on the Carolina side comes in to serve its place, and the whole line of the Atlantic coast is affected by the drain established in the south-west quarter. We might look for the following results. The wind would be most violent in Georgia, and would continue to prevail there, until the cause of heat and rarefaction was removed from over the Gulf. In the States more remote, the wind would be feeble in proportion as the distance was greater, and in Maine would be hardly felt at all. The storm would cease when the cause by which it was produced had ceased to act, and at nearly the same time throughout the whole tract of country swept by it. The simplest doctrine of equilibrium as applied to elastic fluids, force these conclusions upon us. But the storm is found in fact to be as violent at the north as at the south. It proceeds and is over in Georgia, and the sun is perhaps shining there at the time when it is exerting its utmost fury in Maine.

* See the different tables of the velocity of the wind.

† Vide Mitchell's account of the NE. storm of February 1803, in the Philosophical Magazine, vol. xiii. p. 273.

I can account for all the phenomena, only by supposing that a vortex or horizontal whirlwind, or rather a succession of them, is established in Georgia, and passes gradually over the United States. The existence of such a vortex creating a wind from the north-east at the surface of the earth, is obviously not incompatible with an actual transfer of the whole body of the atmosphere, incumbent upon the United States from the south-west. It is probable, however, that the transfer is from the north-east. The warm air of the ocean saturated with moisture is in this way brought over the land; it is lifted by the vertiginous motion that has been created, and propagated along the coast into the upper regions of the atmosphere, and the intensely cold air of these regions brought down to the surface. It is believed that in this way, and in no other, we can account for the phenomena of our north-east storms.

A (C) D B

During a nine days' passage from New York to the Capes of Virginia, in the summer of 1829, I had ample opportunity of observing the movements of the air during the prevalence of those light baffling breezes by which the ocean is occasionally swept in calm weather. The water is seen roughened by the wind in the direction from which it is afterwards found to blow, as at C, every other part of the ocean probably, except the tract immediately about C, being perfectly smooth. It is calm at A beyond the place of the breeze, at B the place of the vessel, and in the intermediate space at D. The roughness gradually approaches the vessel, reaches it, fills the sails for a moment, and passes by. How are these appearances to be accounted for? It is not a vacuum at B that urges the breeze forward, for that would set the air overhanging the whole intermediate space, that at D for instance, in motion, before there would be any movement at C. The effect is not produced by a portion of condensed air seeking to expand itself, as that would swell and escape equally in all directions. But upon the supposition of a vortex rolling over the surface of the ocean, the explanation is simple and easy.

The following statement, quoted by Daniell from the "Account of the Arctic Regions," of a fact apparently of common occurrence in those latitudes, places in a clear and strong light the unsatisfactory character of the views of the nature of the movement of the air during a wind that are commonly taken. "Ships within the circle of the horizon may be seen enduring every variety of wind and weather at the same moment; some under close-reefed topsails laboring under the force of a storm, some becalmed and tossing about by the violence of the waves, and others plying under gentle breezes, from quarters as diverse as the cardinal points." The same thing is witnessed near the equator in part of the Atlantic called the Rains. See the passage heretofore quoted from Halley. Two vortices, revolving either in the same or in different directions, may exist in the neighbourhood of each other, and of a portion of air that is perfectly calm and motionless, but except upon the supposition of such vortices, these do not appear to admit of any explanation.

The phenomena of the common land and sea breezes are well known, and easily accounted for. The land is more heated by the sun's rays during the day than the water; the air resting upon it is rarefied and ascends, whilst that overhanging the sea comes in to supply its place: during the night the land is more cooled than the water by radiation, and the movement is in the opposite direction. But the fact is not commonly adverted to, that these horizontal breezes must owe their existence to vortices of very moderate dimensions, which establish themselves around the shores where these breezes prevail, and revolve in opposite directions in different parts of the twenty-four hours. "These winds," (the land breezes) "blow off to sea a greater or less distance, according as the coast lies more or less exposed to the sea winds, for in some places we find them brisk three or four leagues off shore, in other places not so many miles, and in some places they scarce peep without the rocks."—"These land winds are very cold, and though the sea breezes are always much stronger, yet these are colder by far *."

Now, it is well known, that even within the limits of the trade winds, and in the seas where they blow with great violence, an alteration of land and sea breezes is experienced in islands of very moderate extent,—in the Sandwich Islands for example, where does the land wind come from? The atmosphere overhanging the island would soon be exhausted. It must evidently

* Dampier's Voyages.

be poured down from above, and its great coldness is at once accounted for. But it reaches an inconsiderable distance only seaward;—where does it go to? It must ascend, and having traced it through three-fourths of its entire route, the remaining, which we cannot reach to observe, it may safely be inferred; when the sea breezes prevail the motion is reversed, and probably also extends through a greater space. An ellipsis, whose longer diameter is parallel to the horizon, or some other figure of the kind, may be described.

(To be concluded in next Number.)

On Artesian Wells, and the employment of the Warm Water brought from a depth for economical purposes.

WHENCE do artesian wells derive their water, and how do they acquire their power of ascension; which sometimes occasions in the middle of plains, at a distance from hills and mountains, the surprising phenomenon of spouting springs? are questions which have been often proposed, and very variously answered. The most natural explanation is undoubtedly that which supposes the water of these wells, like that of natural wells, to be derived from the atmosphere, and their power of ascension the hydrostatic pressure of a more elevated reservoir, with which the perforated canal or bore stands in connection. Sometimes, however, the local relations are such that it is difficult to refer the water to such a source, and then it is that the framers of wild hypotheses stand forth with their absurdities. A late observation, which affords a striking proof of the accuracy of the above explanation, is therefore the more worthy of being noticed.

At Tours, on the Loire, an artesian well, with a bore of 3¼ inches, which brought the water from a depth of 335 feet to the surface, was damaged, and they were obliged (on the 30th of January of this present year) to remove the tube till within 12 feet of the surface. The water suddenly rushed out, increased fully to a third more than its former quantity, and continued to flow for several hours. It was now no longer clear as before; on the contrary, it brought along with it a great quantity of fine sand, and, surprising enough, also numerous remains of plants and bivalve shells; branches of the thorn, several inches long, and blackened, owing to their residence in the water; further, fresh stems and roots of marsh-plants, seeds of many different plants, and also fresh water shells, as *Planorbis marginatus*, also *Helix rotundata*, and *Helix striata*. All these resembled those which are found after floods, on the sides of smaller rivers and brooks. This fact is so remarkable, that the truth of it might be called in question, had it not been accurately determined. There result from it the following conclusions:

1. The water of the artesian well of the city of *Tours* must occupy not more than four months in flowing through its subterranean canals, because the ripe seeds of harvest have reached the mouth of the well without being decomposed.

2. As the water carries along with it shells and pieces of wood, it cannot reach its place by filtration through the layers of sand, but must have flowed through more or less irregular canals.

3. The source of this water is to be looked for in some moist valleys of Auvergne and the Vivarais.

The remains of the plants and animals are deposited in the mineral cabinet of the city. As soon as the seeds, five or six in number, are referred to their plants, naturalists will, in places situated higher than the basin of the Loire, be able to make out the points where these subterranean waters are poured out.

It is to be wished that French observers would state how they prove that the waters of this well come from Auvergne, about 130 miles distant. If this shall be proved, the considerable rise of artesian water in other places, where no hills occur near, or where they are bored in the most elevated points in the neighbourhood, will loose every thing puzzling.

This rising is sufficiently remarkable to induce us to communicate some examples from Hericart.

Name of the Well.	Depth of the Well from the surface of the place.	Height of the rise above the level of the Seine, at the Point de la Tournelle.
	Paris Feet.	Paris Feet.
St Owen,............................	150.8	6.2
Same,................................	203.2	11.1
Epinay,..............................	166.2	24.6
Same,................................	207.8	33.8
Maison Blanche near Paris, ...	121.6	64.6
Mount Rouge at Paris,..........	215.5	80.0

The two last wells, exactly those which rise highest above the level of the Seine, are bored on heights, and hence their water remains considerably under the surface of the earth; also in both the deepest of the bore-holes is still above the level of the Seine, in the first seven metres, in the last about one metre.

In the work of Hericart, a fact is mentioned, which confirms the view of artesian wells already given. Gulfs, in which rivers and rivulets lose themselves, are very frequent in the Jura and other similar limestone mountains, and there, where the uppermost bed consists of a clayey soil, which opposes the sinking down of the rain, sometimes prove very beneficial in agricultural operations, by carrying away the superfluous water. In some places, M. Hericart remarks, man has imitated this example set by nature with great effect. The draining of the plain of Palans, near to Marseille, is an example of this. This plain, which is at present covered with beautiful vineyards, was formerly a great marshy basin, without outlet. It was drained by means of great sink-holes, which were sunk down to the underlying porous or cavernous stone, and were connected together by means of a number of ditches or drains. The water which was carried away by these shafts reached, by means of subterranean canals, the harbours of Mion near to Cassis, where it appeared again as spouting springs. Here, therefore, man, without intending it, had artesian wells, not for the purpose of obtaining water, but in order to get clear of it.

The following report, published by M. Bruckmann Köngl, Würtemberg. Baurath, in the *Verhandlungen zur Beförderung des Gewerbfleisses in Preussen*, 1830, Lieferung, No. 4., affords a striking proof how varied the uses are of artesian wells. M. Bruckmann caused to be bored, under his inspection, from

August 1827 to December 1829, at Heilbronn, five bore holes for fresh water, in order to obtain the necessary quantity of pure water for the purposes of two paper-mills and a flax spinning mill. Two of the bore holes were sunk to a depth of 60 feet, one to 90 feet, another to 100 feet, and one to 112 feet, under the lowest level of the Neckar. In all of them the water rose nearly 8 feet above the level of the Neckar, and on an average each delivered 40 to 50 cubic feet. The purpose of the borings was perfectly accomplished, even to overflow; but the discovery was made, that the water of all the bore holes had constantly a temperature of 54.5 Fahr. This fact led M. Bruckmann to a very important application of this water, viz. heating the mills with it. The paper-mill contained 72,000 cubic feet, a working hall over it 10,800 cubic feet. Both spaces, which contained together 82,800 cubic feet, were the whole winter, 1829–1830, through, warmed by means of this water alone to a temperature of 45°.5 F. and 47°.7 F., and when without, the temperature was — 24.2 F. The thermometer in the mills did not sink lower than 41° F. even when the doors were kept open. Every miller knows well how much labour, time, and expense, it occasions in hard winters to heat daily, and even in a scanty manner, the water wheels, and with what risk of life it is attended. It was reserved for Mr Bruckmann, by means of artesian water, to free his water-mills from this burthensome evil. He conducted the running water from the Hollander, which still possessed a temperature of 52°.2 F., through tubes into the Wassergasse, and had thus the satisfaction to find that his water-wheels, the whole winter through, even when the external temperature was as low as — 24°.2 F., never froze*.—*Poggendorf's Annalen*, H. ii. 1831.

* The period will come when we will be forced to look out for a substitute for coal. If, when that time arrives, no new means of procuring heat economically shall be discovered, we may be able to draw from the great subterranean depository of caloric, and partly by means of the subterranean waters, heat for our various wants.

1. *Chemical Analysis of Metallic Works of Art found in old graves and ancient fields of battle.*—2. *On Change of Arragonite into Calcareous Spar.*—3. *Chemical Examination of the* Parmelia esculenta, *a substance said to have been rained from the sky in Persia.*—4. *Chemical Analysis of Oil of Roses.*

1. *Chemical Analysis of Metallic Works of Art found in old graves and ancient fields of battle, by Professor Gobel.*

It is well known that 400 or 500 years ago, the ancients, who were ignorant of the mode of hammering cast-iron, employed, as a substitute for steel, in the manufacture of their swords, lances, spear-heads, &c. an alloy of copper and tin. It is also known, that the Romans and Grecians alloyed copper with tin or zinc, or with one of these metals, and lead, &c. and used them for all kinds of culinary vessels, bronze statues, medals, sarcophagi, vases, and ornaments of various descriptions. It results from my examination, that the ancients did not employ very determinate quantities in the formation of their alloys; but that they knew well how, in a general way, by the addition of more or less tin or zinc to copper, the alloy becomes more or less difficultly fusible, more or less brittle, or softer, or more malleable and brighter or darker in colour. Part of an old sarcophagus, brought by Professor Ledebour from the Altai, on the borders of China, is cast, and composed of tin and copper, and is as good as the cast arrow-heads of an Egyptian grave. They are distinguished, however, from each other, by the proportions of their constituent parts. The arrow-heads contain less tin than the sarcophagus, but still as much as, by a certain degree of fusibility, to acquire, after cooling, great hardness and solidity; for the ancients generally employed one part of tin to from four to six parts of copper. The ornamental articles still met with in old fields of battle, are generally alloys of zinc and copper, with or without tin; and the ancients appear to have known accurately, that, by the addition of certain weights of tin, the alloy acquired particular colours; for although the object analyzed contained little tin, yet it is not to be considered an accidental constituent part.

1. *Fragment of a Chain, found along with different weapons at Ronneburg, probably an ancient field of battle.*—It contained 82.5 copper, and 17.5 zinc; = 100.0.
2. *Fragment of an Armlet, found in a grave near Naumburg, in Thuringia.*—It afforded 1.538 tin, 15.384 zinc, and 83.077 copper; = 99.999.
3. *Fragment of a Bronze Urn, from a grave in Liefland.*—It contained 4.78 tin, 7.50 zinc, 88.66 copper, and 1.05 silver; = 100.0.
4. *A well preserved Arrow-Head, from an Egyptian grave.*—It contained 22.02 tin, and 77.60 copper; = 99.62.
5. *Roman Silver Coin of the Sixth Consulate of Trajan, found in a grave at Massel, in Silesia.*—It contained 90. silver, 9. copper, and 1. gold; = 100.
6. *A Greek Coin, found in Silesia (Av: cap. galeat barbat.*—Rev.: *tropæum, &c.).*—It contained 1.25 gold, 84.10 silver, 14.00 copper; = 99.35.
7. *Fragment of an ancient cast Sarcophagus.*—It contained 19.66 tin, and 80.27 copper; = 99.93.
8. *Fragment of an ancient cast Sarcophagus.*—It contained 26.74 tin, and 73.00 copper; = 99.74.

Schweigger, Seidel's Journ. 1831.

2. *On the Change of Arragonite into Calcareous Spar.*

Berzelius has given a very simple method for distinguishing calcareous spar from arragonite. The arragonite, when brought nearly to a red heat, swells, exfoliates, and lastly, forms a powdery slightly coherent mass. If we put a fragment of calcareous spar and a fragment of arragonite in the same glass tube, and heat both, so that they attain the same degree of heat, we observe no change in the calcareous spar, while the arragonite has fallen into powder. 10 grains of arragonite were heated in the common apparatus used for determining the smallest quantity of gas, it gave out, during its falling into pieces, no gas whatever. The change induced on arragonite by heating is not, therefore, owing to any chemical change which has taken place in it. This appearance is consequently of the same description as that of the change of the crystals of melted sulphur at the common temperature; the particles of the carbonate of lime arrange themselves in a different manner from what is the case in arragonite, and undoubtedly as in calcareous spar. It will be interesting to prove this by direct experiments. The conditions under which carbonate of lime crystallizes, sometimes as calcareous spar, sometimes as arragonite, have not been fully developed. Calcareous spar is formed, not only when the carbonate of lime crystallizes from an aqueous fluid, as is the case with calc-sinter, but also when it is melted, as is observed in the masses of limestone which have been enveloped in, and melted by, the lava of Vesuvius. So also the carbonate of lime, in the form of arragonite, is deposited from the hot springs of Carlsbad, and occurs also as arragonite in rock formations, which have undoubtedly been in a state of fusion. It is probable that the small dose of carbonate of strontites is the cause of the carbonate of lime crystallizing in a second, the prismatic form, as similar examples occur in oxide of copper, &c. Only one example, says Poggendorf, is known to him of the change of an arragonite crystal into calcareous spar. It is frequently the case, he says, that fragments of the walls of Vesuvius fall into the fluid lava, by which the minerals of which they are composed are more or less changed. This was the case, amongst many other minerals, with a crystal of arragonite. The rock in which it is contained has not been fused, but the arragonite was so strongly heated, that the outer part of it is changed into calcareous spar, while the internal part remained as arragonite, so that the whole arragonite crystal retained its original form. The heat had acted so long on it, that the parts changed into calcareous spar assumed the form of that substance, so that the crust of the arragonite crystal consists of a great many crystals of calcareous spar, in which the rhomboidal planes are distinctly visible, and which, before the blowpipe, exhibits the same characters as calcareous spar.—*Poggendorf's Annalen*, 1831.

3. *Chemical Examination of the* Parmelia esculenta, *a substance said to have been rained from the sky in Persia, by Fr. Gobel in Dorpat.*

Dr Parrot gave me this lichen for analysis, with a note stating, "he had brought a substance with him from his journey to Ararat, which, in the beginning of the year 1828, rained in several districts in Persia to a depth of five or six inches, and was eaten by the natives; it appeared to him to be of organic origin."

The result of my chemical investigation convinced me that I had analyzed either a lichen, or otherwise a diseased imperfect plant, which was probably carried by an electrical wind from its station, and deposited again in distant places, and as Parrot said, it had rained. In order to gain more information respecting it, I shewed it to Professor Ledebour. He recognised it to be the *Parmelia esculenta*, which he had frequently met with in his journey in the Kirghis Steppes, and in general in central Asia, on a dead, loamy soil, or in the fissures of naked rocks, and that it often suddenly shot out of the earth after rains. He is of opinion that the Persian specimens had not been rained from above, but rather that the plant, after a violent rain, had risen suddenly from the earth.

Whether it has suddenly appeared in Persia in the one way or the other, it remains remarkable on account of the great quantity of *oxalate of lime* it contains, and also on account of the absence of all the saline and earthy matters usually met with in plants, and may (as, according to Ledebour, it occurs abundantly in the above mentioned countries) afford a cheap means for obtaining *oxalic acid*, and *oxalates*. It afforded in the 100 parts the following ingredients :—

Oxalate of lime,	65.91
Jelly,	23.00
Inulin,	2.50
Epidermis of lichen,	3.25
Bitter substance, soluble in water and spirit of wine,	1.00
Inodorous and tasteless soft resin, soluble in spirit of wine,	1.75
Soft resin, soluble in ether,	1.75
	99.16

Schweigger, Seidel's Journal, 1831.

4. *Chemical Analysis of true Oil of Roses, by Professor Dr Gobel of Dorpat.*

Through the goodness of one of my pupils from Taganrok, on the sea of Asoph, I received a vial of true oil of roses, which I dedicated to the following analysis.

It was nearly colourless, but in so concentrated a state, that it gave out an insupportably strong offensive rosacious smell, which caused headache ; but when dissolved in spirit of wine, it afforded a most delightful odour. A single drop was sufficient to fill a room for several days with a most agreeable odour of roses. It congealed into a white, foliated, transparent mass when exposed to a temperature of 32° Fahrenheit, but became fluid again on raising the temperature to 72° Fahrenheit. Spirit of wine of 0.815 sp. gr. dissolved at 65.1 Fahrenheit $\frac{1}{180}$ part of it. A drop required for its perfect solution 8000 grains of distilled water. Owing to the small quantity of the oil in my possession, amounting to not more than 15 grains, it was impossible for me to separate the different substances of which it is composed, in order to analyze them. I was obliged to rest satisfied with obtaining the proportions of the ultimate constituent parts, which is as follows. Carbon 69.66, hydrogen 16.06, oxygen 14.29; = 100.

The oil of roses met with in trade in Germany, is very often an adulterated compound. I have about half an ounce of it, but it differs in several respects from the pure oil. It congeals much sooner than the genuine, and requires for its melting again a higher temperature. It is only partially soluble in spirit of wine, and is nearly insoluble in water.—*Schweigger, Seidel's Jahrbuch*, H. 4, 1830.

On the Utility of fixing Lightning-Conductors in Ships. By W. S. Harris, Esq., Member of the Plymouth Institution. Continued from page 167.

25. Experience shews that lightning-rods have no such attractive power as that attributed to them; and that ships are equally open to atmospheric electricity, whether furnished with lightning-rods or not. In proof of this position, we shall cite the following cases:

(*j*) His Majesty's ship Milford was struck by lightning, in Hamoaze, in January 1814, and the temporary mast fixed in her greatly damaged. This ship *had not* a lightning-conductor at the time; but there were many other ships *close by*, and a *powder magazine*, all armed with this means of defence, terminating in points: *but these were not assailed* by an explosion, so that no damage whatever occurred to them.

(*k*) His Majesty's ship Norge, at anchor in Port Royal harbour, Jamaica, June 1815, was severely damaged by lightning, so that she was completely disabled in her masts and rigging. Several ships surrounded the Norge, but *none were* struck *except* a *merchant ship, which, like the Norge, had not a lightning-conductor. All the other ships* had lightning-conductors up at the time. Amongst them was H. M. ship Warrior, of 74 guns; which ship was lying *close* to the Norge. The electric matter was observed, as appears by a very interesting account given by Admiral Rodd, "absolutely to stream down the conductor into the sea."

(*l*) To the instance above given of H. M. S. Etna, struck by lightning in the Corfu Channel (*h*) p. 159, may be added the circumstance of H. M. ships Madagascar and Mosquito being also near, and struck several times; the former having had her fore-mast and mizen-top-mast much damaged.

(*m*) The Heckingham Poor-House, damaged by lightning, an account of which may be seen in the Transactions of the Royal Society, was struck at a point the *furthest* removed from the conductors with which that building was furnished.

(*n*) In the 14th volume of the Transactions of the Royal Society, there is a similar case of a long building, struck at one *end*, a conductor having been applied to the other: that is to say, the lightning *also* fell on a point, the *furthest* removed from the conductor.

(*o*) The case of the New York Packet ship (*e*) (*f*), p. 158, is also an instance of lightning having equally fallen on the ship, whether furnished with a lightning-conductor or not.

26. It may be further remarked, that lightning-rods have now been in use for upwards of eighty years, and applied to every magazine in Europe, without ill consequences, in virtue of any attracting power assumed to belong to them; and likewise to buildings and ships in abundance; and from the whole course of experience, it will be found, that atmospheric discharges have almost invariably *occurred where lightning-rods have not been present;* that in cases in which lightning-rods *have been present,* and efficiently applied, the damage has been avoided altogether.

27. Some further appeal to experience, from which we should

never depart in inquiries of this kind, will illustrate very satisfactorily the operation of lightning-rods as a successful means of defence in thunder storms—the cases (*e*) (*f*), p. 158, already alluded to, is a striking illustration: indeed, if a great natural experiment could have been instituted for the purpose of determining the utility of a lightning-rod, such should have been the conditions under which it should have been placed. In a memoir presented to the Royal Academy of Sciences at Paris, in the year 1790, by the celebrated French philosopher Le Roy, we find two French frigates successfully protected by lightning-conductors, which completely disarmed the fury of the vivid flashes that assailed them, and transmitted the electric matter securely to the sea. In Mr Kinnersly's account of the stroke of lightning which assailed Mr West's house in Philadelphia *, we find that the lightning-conductor effectually performed its office. Charles' church and steeple, at Plymouth, struck by lightning a few years since, were protected in a similar way; the electric matter passed down in a dense stream over the conductor, into the ground, tearing up the ground in its course. It is worthy of remark, that, of six church-towers in Devonshire, struck by lightning within a few years, the only one which escaped damage was the church at Plymouth, which last was also the *only* one defended by a lightning-conductor. The cases of the Warrior and Norge, already mentioned, are also striking instances. In the fifty-second volume of the Transactions of the Royal Society, there is an instance mentioned, of a ship, called the Generous Friends, twice preserved by a lightning-conductor. Captain Winn observed, that his chain-conductor was broken for a short distance above the ship's side, leaving an interval of about three-fourths of an inch; over this space the electric matter was observed to pass in the form of sparks, during two hours and a half, at the time of a thunderstorm †.

28. It is therefore by no means unreasonable to consider the conducting power of a lightning-rod as arising, not out of any attractive property inherent in it, but from an action purely

* Priestley's History of Electricity.

† Transactions of the Royal Society.

passive; that is to say, the removal of resistance: indeed, in the case of a vacuum, or rather a very finely exhausted medium, which is found to answer the same purpose as a conducting body, since the electric discharge is freely transmitted through it, we must necessarily admit the truth of the above principle; the conducting power here evinced must arise solely from the removal of a resisting medium; for what is equivalent, in a comparative point of view, to the absence of all substance, cannot be supposed to be endowed with any peculiar or positive quality. Now, the circumstances attending the conducting power being precisely the same, whether we suppose the latter to be peculiar to a void, or to a positive substance, it is a legitimate deduction, and not contradicted by any known fact, that, in either case, the conducting power is dependent on the same cause, and is therefore a negative quality. In further confirmation of this notion, we find that an artificial discharge will rather jump over an interval of air than pervade a very extensive circuit of metallic wire; that is to say, when the resistance of the metal becomes *greater* than *that* offered by the interval of air, the electric matter will no longer pass in the best conductor, for it is no longer the *line* of least resistance.

29. With respect to the actual quantity of electric matter which may possibly be discharged in a thunder-storm, and the effect likely to be produced on lightning-rods; that must altogether be determined by experience. It is by no means contended that lightning-conductors operate as a *charm* or *nostrum*, but that they are a useful means of defence against such cases of damage as come within the experience of mankind, not against convulsions of nature, when it would not be of great consequence whether we had lightning-rods or not. It is therefore against such cases of damage as may be reasonably expected to occur, that we purpose to employ lightning-rods. Now, we have the experience of nearly a century to guide us in this; and from which we have every reasonable demonstration that our proposed conductor is more than fully efficient. We do not find in any case of damage by lightning at sea that a quantity of metal has been melted equal to that contained in a copper bolt of half an inch diameter and six inches long, or otherwise an equivalent quantity of any other metal more easily

fused by electricity *; on the contrary, we find that very heavy electrical discharges have been transmitted, without fusion, by small masses of metal. Amongst many instances, may be mentioned the following:—In the explosion which struck Mr West's house †, the lightning fell upon a spike ten inches long and a quarter of an inch in diameter—only *three inches* of the fine point were fused. The spike of the conductor on the Packet ship, New York, and on which a tremendous explosion fell, consisted of an iron-rod, four feet long and half an inch in diameter—it was only melted near its extremity for a *few inches*; the chain-conductor consisted of iron-wire, of one quarter of an inch in diameter, yet only a few of the links were melted. In the case given of the Etna, the whole explosion seems to have been transmitted

* It has been recorded, that the great conductors of St Paul's Church, in London, had marks of having been made red hot by lightning; but it seems, on consideration, that inasmuch as these conductors were not minutely examined previously to the lightning which is supposed to have fallen on them, we can never be certain that the marks were not there originally, and resulted from the forging of them: moreover, it is difficult to imagine that a stroke of lightning should have fallen on this building capable of rendering a stout bar of iron, six inches wide, red hot, and yet not have annihilated the thin gilding about the ball and cross, and without the crash of the thunder having been heard over the whole city—no mention of which is made. When St Bride's steeple was struck such was peculiarly remarkable. If, however, we admit the evidence, it is highly conclusive as to the value of lightning-conductors, since the former church of St Paul's, not defended by a lightning-conductor, was twice struck by lightning, and much damaged; and it would also tend to shew, that a flash of lightning, capable of rendering bars of iron, six inches wide and one inch and a half thick, red hot, could not fuse the small mass of thin copper covering the ball. The original ball and cross on which this lightning is said to have fallen may be inspected at the Coliseum, London.

There is another case of the effects of lightning on an iron-rod, in Port Royal, Jamaica, mentioned by Captain Dibdin, of a merchant vessel, and given in the Transactions of the Royal Society, the evidence of which is by no means complete. Two men are said to have been killed by a flash of lightning near a church wall:—on looking inside the wall, a bar of iron, of an inch thick and a foot long, was found to have been wasted away in many places, so as to be reduced in size to a fine wire; but it does not appear that the bar was examined before the lightning happened, so that we cannot infer that the lightning was the cause; more especially as the appearance described is very common on bars of iron in church-yards, in this country, which have evidently been the result of oxidation and time.

† Priestley's History of Electricity.

without fusing the conductor. In the instance of the church struck by lightning at Kingsbridge, a short time since, it was observed, that the flash which rent the steeple passed over a bell-wire, of about two-tenths of an inch diameter, without fusing it. In the case of the Plymouth church, the conductor was not fused, it was only disjointed. In the Transactions of the Royal Society for 1770, there is an instance of a bell-wire having conveyed a charge with safety, which knocked down a chimney, and did other damage; and in the same valuable work for 1772, there is an instance of a bell-wire having resisted fusion in all the doubled or twisted portions. A house was struck at Tenterden, and the whole flash fell upon a bar of iron, three-fourths of an inch square, but produced no effect on it *. Mr Calendrini was eye-witness to a flash of lightning which struck a bell-wire, and was safely transmitted by it †; moreover, we never find that the vane spindles of ships become fused by lightning. It is very remarkable, when the conditions are favourable, how very small a quantity of metal is equivalent to transmit heavy electrical accumulations. In the great experiment of the French philosopher M. de Romas, an account of which will be found in Priestley's History of Electricity, the electric matter of a thunder cloud was effectually discharged over a small wire, wove in the string of a kite, and which became sensible by insulating the string. In this case the electric fire "assumed the shape of a spindle eight inches long and five inches in diameter;" another time, "streams of fire, which appeared to be an inch thick and ten feet long," were observed to dart into the ground with a crashing noise, similar to thunder when very near.

30. Andrew Crosse, Esq. of Broomfields, near Taunton, a gentleman of high scientific attainment, has employed a very extensive atmospheric apparatus, from which similar effects have been witnessed. During the passage of a thunder-cloud, a full dense stream of sparks passes to the receiving ball, which at every flash of lightning is changed to an explosive stream, accompanied by a peculiar noise; and it has been well observed by Mr Singer, "that during this display of electric power, so

* Transactions of the Royal Society. † Ibid.

awful to an ordinary observer, the electrician sits quietly in front of the apparatus, conducts the lightning in any required direction, and employs it to fuse wires, decompose fluids, or fire inflammable substances; and when the effects become too powerful to attend to such experiments, he then connects the insulated wire with the ground, and transmits the accumulated electricity in silence and safety *."

31. It may be laid down as an axiom, that a lightning-conductor can always transmit a quantity of electricity equal to its fusion. This is evident, because the fusion has been the consequence of the quantity actually transmitted: now, on a review of all the cases of damage by lightning, it cannot be said that we have any evidence whatever to believe, that a conductor, equal to a copper-bolt of 1.3 of an inch diameter, and 210 feet long, which may be taken as the mean value of the conductor on one mast of a fifty-gun frigate, is at all likely to be fused. If we add to this the conjoint action of the conductors on each mast, and the favourable conditions under which they are placed, —that is, their termination in points above, and in a free uninsulated base below,—we have every reasonable evidence that such conductors are fully equivalent to the ends in view, and that instead of the disastrous effects which are usually experienced from a stroke of lightning, the electric matter would be transmitted in the greater number of instances in a state of low tension to the sea, so that no explosion would occur at all. If, on the contrary, we could reasonably suppose such conductors to be destroyed, then it may still be inquired, (since even in this case they *must* be supposed to have transmitted the lightning), what would have been the fate of the vessel if such conductors had not been present?

32. It is a mistake to suppose, that, in fixing conductors in the mast, we can only have surface, as will be seen by reference

* The authority of Professor Leslie has been quoted by some writers against lightning-conductors, but this eminent philosopher has too high a conception of great natural causes, to reason in the confined way attributed to him. It is true, that from some very ingenious researches on the nature of electricity, he is led to believe that lightning-rods are not of great avail; but he considers them to be quite harmless, and observes "that they *provoke* the shaft of heaven is the suggestion of *superstition* rather than of *science*."

to the table already given, (page 179): admitting that quantity of metal is the great requisite for a conducting rod, it must be equally efficient in any form. For the conducting power of the mass must consist of the conducting power of all its parts; now it would be absurd to suppose that a mass of metal, expanded into any extent of surface, would not conduct in all its parts; indeed, our experience is positively conclusive as to this point, since it is quite impossible to destroy one portion of a perfectly *homogeneous* metallic surface by artificial electricity, without destroying the whole; nor is there any instance of the kind on record in cases of damage by lightning. The case of his Majesty's ship Badger, struck by lightning at Chatham in August 1822, is in point here; the electric matter, which shattered the mast, &c. finally precipitated itself upon the copper lining of the galley, and was immediately lost. We do not take into the account any immediate edge or single point, upon which the whole force of the explosion is at first concentrated, or the occasional fusion of some points in metallic surfaces not perfectly homogeneous; since we know, for example, that a given electric explosion may be equivalent to fuse some metals and not others.

33. A further confirmation of this principle will be found in the following experiments:—

Let an accumulation of artificial electricity be passed upon a single wire, just powerful enough to fuse it; after which, let a similar charge be passed upon two such wires as the former; in this case neither of them will be fused. If a charge be now accumulated equivalent to fuse both the wires, then, by adding a third, the three will remain.

34. Let any number of wires be taken, and let a charge be transmitted through them sufficiently powerful to fuse the whole; if but one more be added in a similar arrangement, they will all remain perfect: the charge, therefore, is equally diffused upon them all. Suppose the wires infinitely near to each other, and divide them infinitely so as to make up a surface, and the result must be the same,—for this is but another term for a surface. Now, a wire may be divided into any lesser number of smaller wires, and still transmit a charge, without being heated more than the original wire from whence they are

derived, which may be shewn thus :—If a metallic wire be fixed through the bulb of an air thermometer, and an electrical discharge be transmitted through the wire, the rise of the fluid will measure the heat evolved. Let the same wire be now passed through a draw-plate until it be drawn into four times the length. Let this wire be divided into four parts, and fixed in the thermometer as before; on passing a similar charge, the four wires will evolve the same heat as the original mass. A similar result will be obtained if the original wire be flattened by passing it between rollers, so as to expand it into a surface. If the quantity of metal be present, therefore, it is of no consequence as to the form under which we place it;—it cannot be supposed that by rolling a metallic surface into a dense cylindrical form, we thereby make its conducting power *greater* than it was before; consequently we do not diminish it, when, on the contrary, we expand it into a surface.

35. It would seem, however, that if any advantage is to be obtained by form, it is on the side of the superficial conductor. Sir H. Davy found that the conducting power of a metal was improved by exposing it to a cooling medium : now, in expanding a mass of metal into a large surface, we expose it to a greater extent of air, by which the heating effect of a discharge is much diminished ; so that a quantity of metal formed into a hollow tube might possibly, from this cause, escape in some particular instances, when the same quantity, in the form of a small rod, might be melted. It is highly probable that, in electrical conduction, the electric matter operates first upon the surface, and so on in parallel strata until it pervades the mass. If a ball of wood be covered with one layer of silver or gold leaf, and a charge be passed on it sufficient to destroy the metal, then, on gilding the ball carefully with a double layer, we find that on passing the same charge it will remain perfect, which shows that the inner layer has transmitted some of the shock. If we suppose the whole sphere to be made up of distinct layers in this way, it is clear that the last will protect all the others, as in the case of the surface of wires above mentioned ; the electric matter has evidently a tendency to pass first upon the outer stratum, and then upon the next, and so on ; the next in succession, taking up the superabundant quantity with which the

others become charged, until it becomes equalized through the whole *. Now this process, which amounts in other terms to a general diffusion of the electric matter through and about the whole mass of the metal, cannot go on in any case so readily as in that of an extended surface; and it is doubtless on some such principle as this, that we find mass is not requisite to electrical accumulation. We can accumulate as much electric matter on a hollow sphere as on a solid sphere, so that at all times it can more readily diffuse itself over a surface than penetrate the mass.

36. The circumstance of the conductor passing through the ship is not an objection of any moment, taking, as in the former cases, experience for our guide. It has been well observed in the Transactions of the Royal Society, that, in cases of lightning on shipboard, no mischief has occurred after the explosion has reached the well. That the action may be safely transmitted through the keel to the water is evident; it is, in fact, by the metallic fastenings, which allow the electric matter a free passage, that most of the ships struck by lightning are protected from damage in the hull. We find this peculiarly the case in his Majesty's fleet, where the metallic fastenings are in abundance, and which being as it were connected with each other by means of the mass of copper expanded over the bottom, the whole action becomes rapidly equalized: it is not a little remarkable, that the most common cases of damage in the hull have occurred in merchant vessels, where such metallic protection is not common. In further illustration of this protection, we may cite the cases of his Majesty's ships London and Thetis, both of which had their fore-masts shivered from the head to the heel: now, as the electric matter did not stay in the ship, how is it to be accounted for that the keelson and keel were not split open as well as the mast, except for the reasons already assigned? At the step of the mast we have immediately all the keelson bolts to operate as conductors, and which connect with the copper expanded over the bottom. Even in merchant ships, protection is derived near the keel in a similar way by such me-

* This is also well shewn by small lines of gold leaf stamped on strips of paper, so as to place the strips one over the other.

tallic fastenings as are near, and by the water which is usually found in the vessel, and which operates as a conductor both inside and out, to equalize and disperse the action. The following is an interesting case.

(*m*) In August 1790, a schooner, on board which Captain White had taken a passage from Quebec to Halifax, experienced a storm of thunder and lightning, in which the foremast of the vessel was struck, and shivered from the top to bottom. Captain White immediately requested the people to sound the well, in order to ascertain if the vessel leaked, not doubting but that the electric fluid must have escaped through the bottom below the line of flotation; but it did not appear that any damage had been done below.

37. That our conductors pass *near* the magazines is allowed, but such is the case in every magazine in Europe defended by lightning-rods, and can be no objection whatever; indeed, it renders the protection still more effectual, for we well know that the electric matter will never leave a *good conductor in the line of action*, to pass out of it upon *detached or imperfect conductors out of that line* *. We may therefore infer, that whenever the electric matter is fairly led to the keel, the danger is passed.

38. The sum of what has been advanced concerning the conducting power of bodies, then, amounts to this,—conductors of electricity remove by the aptness of their parts that resistance to the passage of the electric agency which it would otherwise experience; that, consequently, their action is purely passive; and that they can no more be said to attract or draw down lightning upon a ship, than a dike can be said to attract the water which of itself finds its way through it; that such *passive* attraction as this cannot fairly be urged as an argument against lightning conductors, which operate only in conveying away the electric matter when it falls on them; that we must, therefore,

* On this principle, Dr Franklin found that a *wet* rat could not be killed by a discharge of artificial electricity, but that a *dry* one might; and, on the same principle, it seems desirable to pass some stout copper round and across barrels of gunpowder, so as to facilitate the passage of the electric matter over the surface, and not give it the chance of finding its way through the barrel.

make a complete distinction between *lightning-attractors* and *lightning-conductors;* that inasmuch as all the materials of which a ship is composed are calculated to transmit electricity, and that detached masses of *metal are necessarily* found amongst them, and that too in a prominent way, such as studding-sail boom-irons, spindles, iron-hoops, &c. &c., therefore we have these passive metallic attractors of lightning *already* present; that if we were even to remove them, the next best conducting body, such as the pointed yards and masts, would supply their place (23); that finally, the *continuous lightning-conductor* is made complete, to prevent that mischief which otherwise *must* occur, in consequence of the electric matter making its way by main force in an irregular and incomplete manner (10); and that since we have no power to *resist* a stroke of lightning, it must be considered as extremely fortunate that we have a power to *control* it.

39. That it is of importance to a maritime country to give ships this chance of escaping damage by lightning is very apparent, as for example:—In the course of the last war great part of the Mediterranean fleet, consisting of 13 sail of the line, employed in blockading an enemy's port under Lord Exmouth, were disabled by lightning; at this time there were no lightning conductors in the fleet; but, in consequence of the damage sustained, *every ship was ordered to be furnished with them from Malta dock-yard.* His Majesty's ship Glory was in great measure disabled by lightning a few days before the ships under the command of Sir R. Calder met the combined fleets. His Majesty's ship Duke, of 90 guns, had her main-top-mast shattered by lightning, beside other damage, *whilst in action* under a battery. His Majesty's ship Russel, was so disabled by lightning on an enemy's coast in October 1795, that, if the squall had lasted but a very short time longer, she must have been lost, since no sail could be carried either on the main or mizen masts.

40. It is needless to adduce further evidence on this point, and it *must* be admitted, that, in the present exposed state of shipping to the effects of lightning, there is no fatal consequence incident to their situation by which they may not be suddenly and unexpectedly surprised. The importance of this question

therefore, to a naval country like Britain, whose pre-eminence on the sea is quite essential to its existence, cannot for a moment be disputed:—certainly its fleets should comprise in their equipments all the advantages which science can obtain for them.

41. Although this subject has not been fully appreciated by many persons, under an impression that the chances of damage from lightning are too few and inconsiderable, even to warrant the little trouble and expense necessary to avoid them, yet on a careful examination of the logs of His Majesty's ships for a few years only, it will be seen that such opinions are by no means founded on reflection, and a judicious application of lightning *protectors* on shipboard, is not only desirable for shipping generally, but that in many cases it is absolutely essential to their preservation.

On the Measurement of the Height of Carnethy, one of the Pentland Range of Hills, in the vicinity of Edinburgh, and of the Peake of Teneriffe. By Mr William Galbraith, M.A.

Since my last communication on the measurement of heights by the barometer, I have reconsidered the whole, and have given here a more accurate investigation of the formula of which I had then chiefly indicated the general principles, in order to deduce an approximate rule that might be readily applied, easily recollected, and sufficiently accurate for moderate heights. Indeed, it might be employed for any heights, if observations were made at intermediate points; or by subdividing the observations, as has been suggested by Professor Leslie in a neat practical rule which he has given in the notes appended to his Elements of Geometry. This method, however, by the additional observations or computations required to be made, would give more trouble than the introduction of one or two more terms of the series which will presently be given; and to make observations at intermediate points, might, from circumstances, be sometimes impracticable. As the shifting of the decimal point and multiplication by the length of the mercurial column, to obtain the necessary reduction of the mercury in the upper barometer to the same temperature as that of the lower, might prove a little troublesome to persons not very conversant with such calculations, and the use of the centesimal thermometer also, which it requires, is not very general in this country, it appears that a formula, or rule deduced from it, depending upon calculations of an easy nature, and adapted to Fahrenheit's thermometer, avoiding the tedious process of obtaining the correction for the mean temperature of the air employed by Roy, &c. would be useful to travellers who might not have access to tables, or when the operation is performed both ways, the one might be a check upon the other.

General Investigation.

In most works which treat of the properties of logarithms, it is shown that

$$\log\frac{1+n}{1-n} = 2\,\mathrm{M}\left(n + \tfrac{1}{3}n^3 + \tfrac{1}{5}n^5 + \tfrac{1}{7}n^7 + \&c.\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad (1.)$$

Now, if $\frac{1+n}{1-n} = \frac{\mathrm{B}}{b}$; then $n = \frac{\mathrm{B}-b}{\mathrm{B}+b}$; whence by substitution,

$$\log\frac{\mathrm{B}}{b} = 2\,\mathrm{M}\left\{\frac{\mathrm{B}-b}{\mathrm{B}+b} + \tfrac{1}{3}\left(\frac{\mathrm{B}-b}{\mathrm{B}+b}\right)^3 + \tfrac{1}{5}\left(\frac{\mathrm{B}-b}{\mathrm{B}+b}\right)^5 + \&c.\right\} \quad . \quad . \quad . \quad (2.)$$

in which B expresses the height of the barometer in inches at the lower station, b that at the upper, M is the logarithmic modulus, and consequently $2\,\mathrm{M} = 0.868589$.

In order to simplify, let $\frac{\mathrm{B}}{b} = \alpha$, $\frac{\mathrm{B}-b}{\mathrm{B}+b} = \beta$, and $2\,\mathrm{M} = m$; then

$$\log\alpha = m\left\{\beta + \tfrac{1}{3}\beta^3 + \tfrac{1}{5}\beta^5 + \&c.\right\} = m\,\beta\left(1 + \tfrac{1}{3}\beta^2 + \tfrac{1}{5}\beta^4 + \&c.\right) \quad . \quad . \quad . \quad (3.)$$

To abridge, let $1 + \frac{1}{3}\beta^2 + \frac{1}{5}\beta^4 + \&c. = s$, and equation (3) becomes

$$\log\alpha = m\,\beta\,s \quad . \quad (4.)$$

If e denote the expansion of air for 1° of Fahrenheit's thermometer, in which the freezing point is at 32°, then formula (4) must be multiplied by

$$1 + e\left(\frac{t+t'}{2} - 32^\circ\right) = 1 + \tfrac{e}{2}\left(t + t' - 64^\circ\right) = 1 - 32\,e + \tfrac{e}{2}(t+t') \quad . \quad . \quad . \quad (5.)$$

in which t and t' are the temperatures of the air at the bottom and top, by the detached thermometers.

Let $c = 60155$ English feet, the factor nearly constant by which $\log\alpha$ must be multiplied at 32° to convert it into English feet, then $\log\alpha \times c = \mathrm{H}$, the height in feet; consequently at any other temperatures of which the mean is $\frac{t+t'}{2}$

$$\mathrm{H} = c\,m\,\beta\,s\left\{1 - 32\,e + \tfrac{e}{2}(t+t')\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6.)$$

This may be put in a different form:—

$$\mathrm{H} = c\,m\left\{1 - 32\,e + \tfrac{e}{2}(t+t')\right\}\beta\,s \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7.)$$

Now $c \times m = 60155 \times 0.868589 = 52250$ feet.

According to Roy, ...	$e = 0.00245$
.... Laplace, ...	0.00222
.... Deluc and Saussure, ...	0.00223
The mean of these gives	0.00230

Wherefore substituting these values of c, m and e in formula (7), then

$$H = 52250 \left\{1 - 0.0736 + 0.00115\,(t + t')\right\} \beta s =$$
$$52250 \left\{0.9264 + 0.00115\,(t + t')\right\} \beta s =$$
$$\left\{48404 + 60\,(t + t')\right\} \beta s \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (8.)$$

in which such a number of terms of s or of $1 + \frac{1}{3}\beta^2 + \frac{1}{5}\beta^4 + \frac{1}{7}\beta^6 +$ &c. may be taken as are thought necessary.

This formula (8.) gives the height when the mercury in the barometer is reduced to the same temperature at both stations, either by a formula or appropriate tables. The absolute dilatation of mercury from the recent determination of Dulong and Petit is $\frac{1}{5550}$* for one degree of the centigrade scale, or $\frac{1}{9990}$, equal to $\frac{1}{10000}$ nearly of Fahrenheit. Whence if τ be the temperature of the mercury at the lower station by the attached thermometer, and τ' that at the upper, then $\frac{(\tau - \tau')\,b}{10000}$ must be added to the height of the barometer at the colder station (generally the upper) to reduce it to the same temperature as that of B at the warmer station.

Now, this correction is in general a small fraction of an inch of mercury, and it would simplify the operation to obtain its equivalent in feet to be applied to the approximate height, by finding the variation for 1 inch of mercury, and of this taking a proportional part for the expansion for 1° of Fahrenheit. Thus $K \times \frac{B - b}{B + b} = H'$ will give a result in any circumstances sufficiently correct for the difference of an inch between B and b, in which $K = 48400 + 60\,(t + t')$; therefore $\frac{(\tau - \tau')\,b}{10000}$ will give the fractional part of H' in feet, required to correct the result from formula (8) also in feet, for the difference of the temperature of the mercury at the two stations.

Therefore $\qquad 1 \text{ inch} : \frac{(\tau - \tau')\,b}{10000} :: H' : H' \times \frac{(\tau - \tau')\,b}{10000}$; that is

$$K \times \frac{B - b}{B + b} \times \frac{(\tau - \tau')\,b}{10000} = \frac{K}{10000} \times \frac{B - b}{B + b} \times (\tau - \tau')\,b.$$

Now, $B - b$ and $\tau - \tau'$ being each assumed at unity,

$$\frac{K}{10000} \times \frac{B - b}{B + b} \times (\tau - \tau')\,b \text{ becomes } \frac{K\,b}{10000\,(B + b)} \quad . \; . \; . \; . \; . \quad (9.)$$

But in this case also B, differing only by unity from b formula (9), becomes without sensible error,

$$\frac{K}{10000} \times \frac{b}{2\,b} = \frac{K}{20000} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (10.)$$

or $\frac{K}{20000} = \frac{48400 + 60\,(t + t')}{20000} = \overset{\text{Feet.}}{2.42} + \frac{t + t'}{333}$, or, which will be found sufficiently accurate in practice, $\varkappa$ being the co-efficient of $\tau - \tau'$, then

$$\varkappa = 2.42 + \frac{t + t'}{300} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (11.)$$

Whence the complete formula will become

* Laplace made this $\frac{1}{5412}$, which has been corrected as above.

$$H = \{48400 + 60\,(t+t')\}\,\beta s - \left\{2.42 + \frac{t+t'}{300}\right\}(\tau - \tau') \quad . \quad . \quad (12.)$$

The terms of s will be readily obtained for heights exceeding 2000 or 3000 feet when they begin to become sensible, by deducing them from each other.

Thus $\frac{B-b}{B+b} = \beta$, whence is derived β^2, and $-\frac{\beta^2}{3} = \gamma$,

Multiply by β^2, . $\frac{\beta^4}{5} = \delta$,

$\frac{\beta^6}{7} = \varepsilon$, &c.

Hence $\gamma + \delta + \varepsilon +$ &c. $= s =$ the decimal by which the first approximation must, when necessary, be multiplied to obtain the correction for great heights, where alone they are required.

The formula in my last paper may be deduced from (12) by rejecting s, and assuming $\frac{t+t'}{300} = \frac{180^\circ}{300} = 0.6$, which gives $2.4 + 0.6 = 3$, the coefficient of $(\tau - \tau')$. It is obvious that 180° for the sum of the temperatures, or 90° for the mean, will generally be too great. Indeed, $\frac{t+t'}{300}$ will at a medium be about $\frac{100^\circ}{300} = 0.33$, and $2.42 + 0.33 = 2.75$ feet, about a quarter of a foot less than 3 feet, so that the error from this source must be small. By making these changes, formula (12) will become nearly the same as formerly, or

$$H = \{48400 + 60\,(t + t')\}\,\frac{B-b}{B+b} - 3\,(\tau - \tau') \quad . \quad (13.)$$

In the former paper 48000 was obtained partly by being derived from Roy's expansion of air, and partly by rejecting the three last significant figures, from a desire to select round numbers easily recollected. However, if the figures 48 be repeated, thus making the constant 48480, it would be as easily recollected, and the results, if under 3000 or 4000 feet, would be sufficiently correct for most purposes, if the computer finds it inconvenient to use the more complete formula (12).

General Rule.

This rule is derived from formula (13), and is intended for those only who are not very conversant with algebraic symbols.

Those who are, will, in all considerable heights, prefer formula (12).

1. Take the sum of the temperatures of the air at both stations, as shown by the *detached* thermometers, and multiply that sum by 60.

2. To this result add the constant number 48400, (or even 48480 as mentioned above), the sum will be the correct coefficient.

3. Multiply the correct coefficient just found by the difference of the heights of the mercurial columns in the barometers at the two stations, and divide the product by their sum, the quotient will be the approximate height.

4. Take the difference of the temperatures of the mercury at the top and bottom indicated by the *attached* thermometers, which multiplied by three, will give the correction to be subtracted, if, as is generally the case, the temperature of the upper station be the colder, otherwise it must be added, and the result will be the true height.

In this rule no notice is taken of the terms in the series above the first, as it is supposed that the heights to which it is applied are moderate, such as 2000, or 3000 feet. If the height exceed this, but not much surpass 5000 feet, the second term ought to be retained, which may be easily done in round numbers, in the following manner:—

Suppose that the barometer at the lower station is about 30 inches, and that at the upper 25 inches, then the fraction formed from their difference divided by their sum, simplified if possible, being squared, and the denominator of this multiplied by three, will give a fraction, of which the value being taken of the approximate height already found, and added to it, will give the true height.

Thus, $$\frac{30-25}{30+25}=\frac{5}{55}=\frac{1}{11}, \text{ and } \frac{1}{11}\times\frac{1}{11}\times\frac{1}{3}=\frac{1}{363}.$$

Hence, if $\frac{1}{363}$ part of the approximate height be added to itself, the sum will be the true height sufficiently near for almost any purpose. It will generally be found, however, that this last correction in most cases that occur in practice, is too small a quantity to merit much attention.

The following examples are given for the purpose of illustration:—

Example I. The following observations to determine the height of the Peak of Teneriffe, were made on the 8th of September 1824, by Lord Napier, Captain R. N., and communicated by Captain William Robertson, R. N.

Height of the barometer at Santa Cruz, 40 feet above the level of the sea, ...	30.164 inches.
Attached and detached thermometers, ...	80° Fahr.
At the summit of the Peak, the barometer stood at . .	19.530 inches.
Attached and detached thermometers, ...	55° Fahr.

$B = 30.164$, $\tau = 80°$, $t = 80°$

$b = 19.530$, $\tau' = 55$, $t' = 55$

$B - b = 10.634$ $\quad \tau - \tau' = 25$ $\quad t + t' = 135$ . . . 135°

$B + b = 49.694$

$$\begin{array}{r} 0.45 = \\ 2.42 \\ \hline x = 2.87 \\ \tau - \tau' = 25 \\ \hline 1435 \\ 574 \\ \hline \text{correction} = -71.75 \end{array} \qquad \frac{135}{300}$$

$$\begin{array}{r} 135° \\ 60 \\ \hline 8100 \\ 48400 \\ \hline 56500.0 \\ B - b\ 436.01 \text{ reversed.} \\ \hline 565000 \\ 33900 \\ 1695 \\ 226 \\ \hline \end{array}$$

$$\begin{array}{rl} B + b = 49.694)600821(12090.4 & \\ 49694 & -\ 71.8 \\ \hline & +\ 40.0 \\ 103881 & \overline{\qquad\quad} \\ 99388 & 12058.6 \\ \hline & \text{Appr. height.} \\ 4493 & \\ 4172 & \\ \hline 21 & \end{array}$$

This result 12058.6 feet is the approximate height without the smaller corrections depending on the remaining terms of the series, or the effects of a change of gravity depending on the latitude or the height of the upper barometer. The effect of the remaining terms of the series may be found as follows:—

$$\frac{10.634}{49.694} = 0.214 = \beta \text{; therefore } \frac{\beta^2}{3} = 0.015265 = \gamma$$

$$\frac{\beta^4}{5} = 0.000419 = \delta$$

$$\frac{\beta^6}{7} = 0.000014 = \varepsilon$$

$$\text{Sum,} \quad = 0.015698 = \gamma + \delta + \varepsilon$$

Whence $12060 \times 0.015698 = 189.79$ feet. As the coefficients in the formula are derived from measurements adapted to the mean latitude of 45°, the effect of the change of gravity depending upon the latitude should also, strictly speaking, be allowed for, which is derived from the factor $1 + 0.00268 \cos 2\lambda$, where λ is the latitude of the place of observation. Since the latitude of the Peak of Teneriffe is about 28½° N., this factor becomes $1 + 0.00268 \times \cos 57° = 1 + 0.00268 \times 0.545 = 1.00146$. But $12058.6 + 189.8 = 12248.4$; hence $12248 \times 0.00146 = 17.9$ feet to be added to 12248.4, making 12266.3 feet.

If an allowance be made for the diminution of the force of gravity of the air on account of the height of the upper barometer above the lower, it would be a third proportional to the radius of the earth and the approximate height*; or if k be the correction on this account, r the radius of the earth, and h the approximate height, $k = \frac{h^2}{r}$, r may in general be taken at 20887680 feet. Hence $k = + 7.2$ feet, which being applied, the height is 12273.4 feet. The last correction is the diminution of the gravity of the mercury for the height. It is a fourth proportional to the radius of the earth, the approximate height, part of formula (8.) or $48400 + 60\,(t + t')$. Let k' be this correction; then $k' = \frac{h\,\{48400 + 60\,(t + t')\}}{r}$. Now, h is about 12270, and $48400 + 60\,(t + t')$ is 56500; whence $k' = \frac{12270 \times 56500}{20887680} = 33.2$ feet, which added to 12273.4, gives 12306.6 feet for the total height.

It is therefore evident, that in great heights, where all the more minute corrections are sensible, the operation becomes very tedious. It would then be more convenient to have logarithmic and special tables calculated expressly for the purpose. But in all moderate heights, where these smaller corrections become nearly insensible, the formula or rule may be very advantageously employed. It may be interesting to show the correspondence between different methods of calculation by various authors.

* Playfair's Works, vol. iii. page 70.

Height by the formula above, ...	12307
By the tables of Biot, ...	12334
.... Oltmanns, ...	12274
.... Baily	12278
By a set of tables computed by myself, including dew points, latitude, &c. and adopting Dalton's hypothesis of the expansion of air,	12357
By that of an equable expansion adopted by Gay Lussac, Dulong, &c.	12463
Mean of the whole, . .	12335.5

Whence it appears that Biot's tables and my tables and formula agree in giving the same height nearly, while those of Oltmanns, Baily, and mine, adapted to an equable expansion of air, differ somewhat considerably, the former in defect, and the last in excess. I suspect that the barometric observations, and the trigonometrical operations, that have been made to determine this height, have not been sufficiently numerous to show which of all these methods is the more accurate.

A few determinations of the height of this Peak may be stated here, which appear most worthy of confidence, as many of them seem to be performed in such a manner, that the results can be only tolerable approximations.

Barometrical Measurements of the Height of the Peak calculated from the Formula of Laplace.

Father Feuillé, in 1724, ...	12957 feet.
M. Borda, in 1776, ...	12646
MM. Lamanon and Monges, in 1785, ...	12179
M. Cordier, in 1803, ...	12284
Professor Smith, in 1815, ...	12188
Baron Von Buch, calculated by Dr Savinon, ...	12131
Mean of the whole, .	12397.5

This result does not differ considerably from the last; but the degree of confidence to be placed in a mean from which the extremes differ so much as 266 feet, cannot be very great.

From the observations of Martiniére, who accompanied Lapeyrouse, I found by a mean of my tables . . . . 12345 feet.

Several geometrical measurements of this Peak have been made, but those taken under sail cannot be much depended on, nor can several of the more early, from bases frequently too short that have been taken on shore. The one most to be trusted, perhaps, was that by Borda in 1776, which gave 12188 feet, about 150 feet less than any of those means, and proves how difficult it is to arrive at the truth, or to render the result of one observation strictly conformable to that of another, except by a process of *cooking*, as Mr Babbage appropriately terms such admirably consistent results.

Example II. Required the height of Carnethy, one of the highest of the Pentland hills, from the following observations, being the means derived from a series continued for several hours, on the 2d of August 1828, on the top of Carnethy, and the Caltonhill of known height, 355 feet above the mean tide at Leith, and the upper barometer 3.5 feet under the summit?

By formula (12),

$B = 29.339$, $\tau = 66°.2$, $t = 63°.7$
$b = 27.745$, $\tau' = 55.1$, $t' = 55.4$

$B - b = 1.594$, $\tau - \tau' = 11.1$, $t + t' = 119.1$ . . 119.1

```
B - b =  1.594, τ-τ', = 11.1  t+t' = 119.1 . .  119.1
                        2.8            119.1        6
B + b = 57.084         ----   0.4 =  -----      -----
                        888   2.4      300       7146
                        222   ---               48404
                       ----   2.8               -----
      correction = —31.08             B — b =  55550 reversed
                                                 495.1
                                                 -----
                                                 55550
                                                 27775
                                                  5000
                                                   222
                                                 -----
                               B + b = 57.084)88547(  1551.2
                                              57084 +  355.0
                                              ----- +    3.5
                                              31463 —   31.1
                                              28542 +    0.5
                                              -----   ------
                                               2921   1879.1
                                               2854
                                               ----
                                                 67
                                                 57
                                                 --
                                                 10
```

Now, $\frac{1.594}{57.084} = 0.03$ nearly, and

$\frac{0.03 \times 0.03}{3} = 0.0003$, therefore

$0.0003 \times 1551 = 0.5$ foot nearly

The true height is therefore 1879 feet.

So that the terms of the series formerly alluded to are in this case unnecessary, and the effects of latitude and height would be nearly insensible. The calculation becomes in consequence remarkably simple.

The following are the heights of the same points, by a concise set of tables accompanying this paper, which to those not fond of formulæ, and the arithmetical operations thence required, will be useful:—

1. $B = 30.164$, $\tau = 80°$, $t = 80°$
$b = 19.530$, $\tau' = 55$, $t' = 55$

$\tau - \tau' = 25$, $t + t' = 135$

```
B = 30.100 gives, in Table I.  . . . . . .   20335 feet.
       60 proportional parts,  . . . . . .      52
        4 . . . . . . . . . . . . . . . . .      3.4
   ------                                    -------
   30.164 gives . . . . . . . . . . . . . .  20390.4
b = 19.500 gives 8993 feet
        30 p. pts.   40
   ------          ----
   19.530 gives    9033
τ — τ' = 25° Table II. + 67.1
                   ------
         Sum,      9100.1 . . . . . . . . .   9100.1
                                             -------
Approximate height or difference,  (Carried forward,)  11290.3
```

Approximate height or difference, (Brought over,)	11290.3
$t + t' = 135°$ gives factor (Table III.) reversed, . . .	6180.1
	112903
	9032
	113
	67
Product,	12211.5
To latitude $28\frac{1}{2}°$, and height 12211 feet, Table IV. gives	+ 56.5
True height of the Peak of Teneriffe, ...	12268.0

2. $B = 29.339$, $\tau = 66°.2$, $t = 63°.7$
$b = 27.745$, $\tau' = 55\ .1$, $t' = 55\ .4$

$\tau - \tau' = 11.\ 1$ $t + t' = 119.1$

B = 29.300 gives in Table I., ...		19631 feet.
30 prop. parts, ...		+ 27
9		+ 8
29.339		19666
$b = 27.000$ gives	18164	
40 ...	38	
5 ...	5	
$\tau - \tau' = 11°.1$	29	
	18236	18236
Approximate height or difference, . . .		1430 feet.
$t + t' = 119.1$ gives factor (Table III.) reversed, . . .		2360.1
		1430
		86
		4
Height of the upper barometer above the lower, nearly .		1520 feet.
Height of the upper barometer above the Calton Hill barometer, nearly		1520 feet.
To latitude 56°, and height 1520, Table IV., . . .		+ 3
Calton Hill above the sea, ...		+ 355
Carnethy Cairn height, ...		. 3
Total height, .		1881

Or about two feet more than that found by the formula.

The correction from Table V. is insensible in these examples.

Having been desirous of applying the sympiesometer to the determination of this height, the following observations were made with two instruments; one the same which I had carried without injury some hundred miles, and had used on Ben Nevis in August last, was made some years ago, and had not been examined since by the maker; the other was quite new, and indicated, as will be seen by the following observations, a constant difference of 4 or 5 fathoms. Designating the former by

A, and the latter by B, the succeeding observations were made at Edinburgh, after standing together during the night, and on the top of Carnethy after standing half an hour.

A. *On Carnethy.*

At $1^h\ 10^m$ P. M.	S = 421 fathoms,	$t = 32°.4$
1 20 ...	S = 422 ...	$t = 32.0$
Means, 1 15	421.5	32.2

A. *Near Edinburgh, 290 Feet above the Sea.*

At $8^h\ 30^m$ A. M. $S' = 164$ fathoms, $t' = 44°.4$

Hence, ... $S = 421.5$ $t = 32°.2$

$S' = 164.0$ $t' = 44.4$

$S - S' = 257.5$ $t + t' = 76.6$, and $m = 1.015$

Whence, $257.5 \times 1.015 \times 6 =$	1568 feet.
Correction for height of S′ above the sea, . . .	+ 290
True height by A,	1858 feet.

It was thought advisable to try whether, by exposing one of the instruments, while the other was protected as much as conveniently could be, any very decided difference in the altitude would be found, the temperature being the same nearly, and the sun partially covered with clouds. The instrument denoted by B was placed in a tolerably well protected position, along with A, for the first set of observations on the summit of Carnethy, when the same difference nearly was observed. That denoted by B was then suspended on the top of a small cairn on the other, exposed to a pretty strong north wind, and both instruments were then read a second time without any relative variation.

B. At $8^h\ 30$ A. M. $S' = 426$ fathoms, $t' = 31°.8$

1 15 P. M. $S = 169$ ... $t = 44.4$

$S' - S = 257$ $t' + t$ 76.2

gives $m = 1.015$

Therefore $257 \times 1.015 \times 6$, ...	1566 feet.
Correction as before, ...	290
True height of Carnethy by B,	1856

These differ 20 or 30 feet from the former, which is regarded as correct, because cotemporaneous observations were then made at the top and bottom, which was not done here, though the barometer was observed to stand steady during the interval.

From the method of graduating the sliding scale of the sympiesometer adopted by the inventor, the divisions are not quite theoretically exact. In fact, there are only such a number of points found by calculation and experiment in general as may be thought necessary, and the intermediate spaces are then divided into equal parts nearly, as the deviation from perfect accuracy would, in most cases, be insensible, or at least less than the errors arising from other sources, which cannot easily be avoided. Indeed, the correction of part of the error of graduation is in some degree obviated by a sort of tentative process; and, consequently, as appears both by the former examples and the present, the errors of the practical conclusions generally fall within the usual errors of observation; and the results may, I think, be estimated to be equal in accuracy to those by the Englefield barometer, while the instrument itself is much lighter, and considerably more portable.

I have been inclined to think that it requires rather more attention to operate accurately with the sympiesometer in certain cases, especially in ravines, or water-courses thickly wooded. In particular, I recollect that, in attempting to measure the height of the romantic banks of the Esk, at the old mansion-house of Hawthornden, the first observations appeared to be tolerably correct, when both the upper and lower observations were made near the house; but as soon as I had gone down the river side to a small field surrounded with wood, by some irregular influence, perhaps from strata of air of different densities, or temperatures more loaded with aqueous vapour in that confined situation, I soon found that it required the instrument to be protected, otherwise errors to a considerable amount would be produced, and that such a situation was very unfavourable for these operations. As my observations were made in the company of a friend from Liverpool, I had not sufficient leisure to examine the causes of this circumstance; but concluded, rather hastily perhaps, that it agreed partly with a remark of Professor Babbage of Cambridge, " That when the lower observation is made in a narrow or deep valley, situated at the foot of a mountain range, the upper observation being made on an exposed summit, the elevation thus determined falls short of its true height." Dr Anderson of the Academy of Perth, attempts to explain this in the following manner :—" In such a case, it is evident that the intermediate strata between the two stations are placed in circumstances to be powerfully affected by humidity; of course, the great dilatation which they suffer from the influence of aqueous vapour, tends to increase the altitude of the mercury in the barometer at the upper station ; and by thus bringing the ratio of the pressures nearer to equality, diminishes in a corresponding degree the computed heights by the common formula."

This seems, at least, to be a rational explanation of the difficulty. However, it is proposed to continue our observations, in order to throw some light, if possible, upon such anomalies, arising, in a considerable degree, I am persuaded, from local circumstances, or the partial effects of temperature.

It has already been observed, that the older made sympiesometer stood at a height somewhat different from the new, and may possibly be ascribed to a gradual deterioration of the instrument. No doubt the oil must thicken ; and in the course of a few years its motion must become more tardy. In this case, the only remedy will be a removal of the oil, and a re-adjustment of the instrument. But the sympiesometer is not the only instrument which suffers deterioration by time. It has been repeatedly asserted that the mercurial thermometer, and barometer also, become affected by causes for which it is difficult to account, after a lapse of some years. In particular, Mr Daniell, in his Meteorological Essays, appears to prove from numerous registers, that the mercury stands lower in barometers in proportion to the age of the instrument, and proposes a ring of platina, with which the mercury has the property of coming in perfect contact, to prevent the air from insinuating itself between the mercury and the glass, and rising into the vacuum above, thereby shortening the proper height of the mercurial column. It will require some time to verify this satisfactorily perhaps, though the proposer seems, from his own experience, to have sanguine expectations of success.

It has already been remarked, that the observations by the barometer should be made simultaneously at the top and bottom of the height to be measured, otherwise great errors may be committed in the determination of the final results, if the barometer be changeable.

I cannot illustrate this better, than by the measurement of Ben Nevis, communicated in my last paper. On the morning of the day preceding the day of ascent, on the morning of the day of ascent, and on the evening after descent, from a number of observations in the month of August 1830 :—

On the 28th, at $6^h\ 37^m$ A. M. $B = 29^{in}.587$, $\tau = 51°.0$, $t = 51°.0$
29 ... 6 0 A. M. $B = 29\ .889$, $\tau = 50\ .4$, $t = 50\ .9$
29 ... 8 15 P. M. $B = 30.\ 112$, $\tau = 53\ .0$, $t = 53\ .0$
29 ... 1 15 P. M. $b = 25\ .466$, $\tau' = 37\ .7$, $t = 37\ .0$

Now, on comparing the observations made on the 28th, at $6^h\ 37^m$ A. M., with those on the 29th at $6^h\ 0^m$ A. M., and $8^h\ 15^m$ P. M., it will be found that the rise of the barometer was tolerably regular, and that a mean between the two last made on the morning and evening of the same day in which the observations were made on the top at nearly equal intervals of time, cannot be far from the truth. But if I had taken either of these observations made at Fort William Inn, it is evident that their height, resulting from a comparison with that on the top, must have been erroneous to a considerable amount, either in defect or excess, according as I had adopted 29.889, or 30.112 for the term of comparison.

Let $B = 29.889$, $\tau = 50°.4$, $t = 50°.9$
$b = 25.466$, $\tau' = 37\ .7$, $t' = 37\ .0$, then the resulting height will be . . . . 4270 feet.
Again, let $B = 30.112$, $\tau = 52°.7$, $t = 53°.0$
$b = 25.466$, $\tau' = 37\ .7$, $t' = 37\ .0$
The height will be . . . . . 4476 feet.
The difference of these results is . 206 feet.
And therefore the half or error of each, is 103 feet.

From this examination, it appears that the difference of these determinations is no less than 206 feet, giving a mean error of 103 feet for each.

In like manner, the sympiesometer observations made simultaneously with the above, will,

By the first, give	4220 feet.
By the second set, ...	4488
Difference, ...	268
Half, or mean error, ...	134

Or only differing 31 feet from the other, by an excellent mountain barometer of the best construction.

Without due caution, therefore, these unavoidable errors arising from single sets of observations made after the lapse of some hours, when the barometer is changing somewhat rapidly, may easily, though improperly, be imputed to the faulty construction of the instruments employed instead of the proper source.

Lastly, I may remark, that it is of importance, for the sake of accuracy too, that the lengths of the mercurial columns should be correctly reduced to the same standard temperature which, in a continued series of observations, is generally taken at the freezing point, or 32° of Fahrenheit's scale. I have therefore given concise tables for that purpose in a former Number of this Journal, for 1828, because such reductions are often inaccurately made by allowing the expansion of mercury in glass, instead of the absolute expansion of mercury in barometers of the common construction. In mountain barometers, the expansion of the brass tube enclosing the glass one, on which brass tube the scale for measuring the height is engraved, must also be taken into account, which in these tables has likewise been attended to.

To enable observers to make a proper and accurate allowance for capillary action, I have there likewise given a table, computed from Mr Ivory's formula, to every hundredth of an inch, because by the irregular variation, interpolation for intermediate points cannot be accurately made by even proportion. I have been induced to notice this here, because in books of some reputation, and in cotemporary Journals, these reductions are made erroneously,—by that means forcibly bringing about coincidences of apparent accuracy, when no such thing could be said either of the instruments or the observations.

EXPLANATION OF THE TABLES.

Table I. The numbers in this table are derived from a table of logarithms adapted particularly to barometric observations. It is on the same principles as that of Oltmanns', in English feet, with proportional parts annexed. Since the numbers are given to inches and tenths, the proportional parts for hundredths are conveniently placed on the left, opposite the tenths.

The same proportional parts answer for thousandths, by striking off a figure from the right, increasing the last or units figure remaining by 1, if the figure struck off exceeds 5. Thus in all cases, the numbers corresponding to inches, tenths, hundredths, and thousandths of an inch of the height of each barometer, may be readily found by simple addition, of which the difference forms the approximate height as shown in the examples, p. 323, 324.

A very extensive table of this kind has also been published by Mr Thomas Jones, the eminent mathematical instrument-maker, Charing Cross, London, extending from 15 to 31 inches of the barometer, and giving every thousandth part of an inch. To those who use Fahrenheit's Thermometer, our Tables II. III. Part I. may be convenient, as the tables given by Mr Jones are adapted to the centesimal thermometer alone, both for reducing the mercury in the barometers to the same temperature, and for making allowance for expansion of the air by heat.

Table II. The second table is computed from the formula (11.) adapted to a mean state of the atmosphere, and properly varies according to the sum of the detached thermometers; but as the variation from this cause is small, it need hardly be attended to, unless very great precision be required. There are two parts, one adapted to Fahrenheit's scale, the other to the centesimal scale, so that either may be used as required.

As the method of computing the correction for the difference of the mean temperature of the air from that of the freezing point is somewhat troublesome, especially if Fahrenheit's thermometer be used,

Table III. has been computed to facilitate this process, and the value was derived from formula (7).

It may be remarked, that this table is now engraved on Mr Adie's sympiesometer, for the purpose of saving trouble, as the only arithmetical calculation now required is the multiplication of the difference of the numbers found from the sliding-scale adapted to that useful instrument, by this factor, to give the final result.

Table IV. gives the necessary allowance for the change of gravity, depending upon the latitude of the place of observation, and the height of the elevation measured.

Table V. gives the correction for the elevation of the lower barometer above the sea, when the height of the upper above the lower is 10,000 feet, and consequently that for any other number different from 10,000 by taking proportional parts. It will always be a small quantity, however, and, in general, when the lower barometer is not elevated considerably above the level of the sea, it may be neglected.

TABLE I.

P. P.	B.	Feet.	P. P.	B.	Feet.	P. P.	B.	Feet.	P. P.	B.	Feet.
+	15.0	2138	+	19.0	8314	+	23.0	13305	+	27.0	17496
17	1	2311	13	1	8451	11	1	13419	9	1	17592
34	2	2483	27	2	8587	22	2	13532	19	2	17688
51	3	2655	40	3	8723	33	3	13644	28	3	17784
68	4	2826	54	4	8859	45	4	13756	38	4	17880
85	5	2995	67	5	8993	56	5	13868	47	5	17975
102	6	3163	81	6	9127	67	6	13979	57	6	18070
119	7	3331	94	7	9261	78	7	14089	66	7	18164
136	8	3497	108	8	9393	89	8	14199	76	8	18258
153	9	3662	121	9	9525	100	9	14308	85	9	18352
+	16.0	3826	+	20.0	9656	+	24.0	14417	+	28.0	18446
16	1	3988	13	1	9787	11	1	14525	9	1	18539
32	2	4149	26	2	9916	21	2	14633	18	2	18632
48	3	4310	38	3	10045	32	3	14741	28	3	18724
64	4	4470	51	4	10173	43	4	14849	37	4	18816
80	5	4628	64	5	10301	53	5	14956	46	5	18908
96	6	4786	77	6	10428	64	6	15062	55	6	19000
112	7	4943	90	7	10554	75	7	15168	64	7	19091
128	8	5099	102	8	10680	86	8	15274	73	8	19182
144	9	5254	115	9	10805	96	9	15379	83	9	19272
+	17.0	5409	+	21.0	10929	+	25.0	15484	+	29.0	19372
15	1	5563	12	1	11053	10	1	15588	9	1	19452
30	2	5715	24	2	11177	21	2	15692	18	2	19542
45	3	5866	37	3	11300	31	3	15796	27	3	19631
60	4	6017	49	4	11422	41	4	15899	36	4	19720
75	5	6167	61	5	11544	51	5	16002	44	5	19808
90	6	6315	73	6	11665	62	6	16104	53	6	19896
105	7	6463	85	7	11786	72	7	16206	62	7	19984
120	8	6610	98	8	11907	82	8	16308	71	8	20072
135	9	6756	110	9	12026	93	9	16409	80	9	20160
+	18.0	6902	+	22.0	12145	+	26.0	16510	+	30.0	20248
14	1	7047	12	1	12263	10	1	16610	9	1	20335
28	2	7191	23	2	12381	20	2	16710	17	2	20422
43	3	7335	35	3	12498	30	3	16810	26	3	20508
57	4	7477	46	4	12615	40	4	16909	34	4	20594
71	5	7618	58	5	12731	49	5	17008	43	5	20680
85	6	7759	70	6	12847	59	6	17106	52	6	20766
99	7	7899	81	7	12962	69	7	17204	60	7	20851
114	8	8038	93	8	13077	79	8	17302	69	8	20936
129	9	8176	104	9	13191	89	9	17399	77	9	21020

FAHRENHEIT'S THERMOMETER.

Table II.								Table III.			
$\tau-\tau'$	Feet.	$\tau-\tau'$	Feet.	$\tau-\tau'$	Feet.	$\tau-\tau'$	P. P.	$t+t'$	Factor.	$t+t'$	P. P.
1°	2.7	11°	29.3	21°	56.1	0.1°	0.3	50°	0.9839	1°	11
2	5.4	12	32.0	22	58.7	0.2	0.5	60	0.9954	2	23
3	8.1	13	34.7	23	61.4	0.3	0.8	70	1.0069	3	34
4	10.8	14	37.4	24	64.1	0.4	1.1	80	1.0184	4	46
5	13.4	15	40.0	25	66.8	0.5	1.3	90	1.0299	5	57
6	16.1	16	42.7	26	69.4	0.6	1.6	100	1.0414	6	69
7	18.8	17	45.4	27	72.1	0.7	1.9	110	1.0529	7	80
8	21.5	18	48.1	28	74.8	0.8	2.2	120	1.0644	8	92
9	24.2	19	50.7	29	77.4	0.9	2.4	130	1.0759	9	103
10	26.7	20	53.4	30	80.1			140	1.0874		
								150	1.0989		
								160	1.1104		

CENTESIMAL THERMOMETER.

$\tau-\tau'$	Feet.	$\tau-\tau'$	Feet.	$\tau-\tau'$	Feet.	$\tau-\tau'$	P. P.	$t+t'$	Factor.	$t+t'$	P. P.
1°	4.8	11°	52.8	21°	100.8	0.1°	0.5	-10°	0.9793	1°	21
2	9.6	12	57.6	22	105.6	0.2	1.0	0	1.0000	2	41
3	14.4	13	62.4	23	110.4	0.3	1.4	+10	1.0207	3	62
4	19.2	14	67.2	24	115.2	0.4	1.9	20	1.0414	4	83
5	24.0	15	72.0	25	120.0	0.5	2.4	30	1.0261	5	103
6	28.8	16	76.8	26	124.8	0.6	2.9	40	1.0828	6	124
7	33.6	17	81.6	27	129.6	0.7	3.4	50	1.1035	7	145
8	38.4	18	86.4	28	134.4	0.8	3.8	60	1.1242	8	166
9	43.2	19	91.2	29	139.2	0.9	4.3	70	1.1449	9	186
10	48.0	20	96.0	30	144.0			80	1.1656		

Table IV.

Height.	Latitude.						
Feet.	0°	10°	20°	30°	40°	50°	60°
1000	5.6	5.6	5.0	4.3	3.4	2.6	1.7
2000	11.3	11.3	10.0	8.6	6.7	5.2	3.4
3000	16.9	16.9	15.0	13.0	10.3	7.7	5.2
4000	22.8	22.5	20.0	17.4	13.9	10.4	7.0
5000	28.9	28.2	25.5	21.8	17.4	12.8	8.6
6000	34.7	33.9	31.0	26.4	21.0	15.3	10.3
7000	40.7	39.9	36.4	30.8	24.5	17.8	11.9
8000	46.7	46.1	41.7	35.3	28.1	20.5	13.7
9000	53.1	52.5	47.2	40.3	32.1	23.6	15.9
10000	59.7	58.7	52.8	45.4	36.0	26.7	17.9
11000	66.1	64.9	58.2	50.6	40.0	29.7	19.9
12000	72.7	71.3	64.6	55.7	44.5	32.8	22.1
13000	79.8	77.6	70.7	60.7	49.0	36.2	24.5
14000	86.7	84.6	76.9	66.6	53.8	40.1	27.6
15000	94.1	91.7	83.7	72.6	58.5	44.0	30.6
16000	101.5	98.7	90.5	78.2	63.3	47.8	33.4
17000	107.8	104.9	97.0	83.6	67.9	51.3	36.0
18000	114.5	111.9	102.8	89.1	72.5	54.9	38.4
19000	121.3	118.2	108.7	94.6	77.3	58.3	40.8
20000	128.2	124.9	114.6	100.1	82.4	62.0	43.2

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Fig. 1. Section of the coast at the base of the citidale of Napoli di Romano

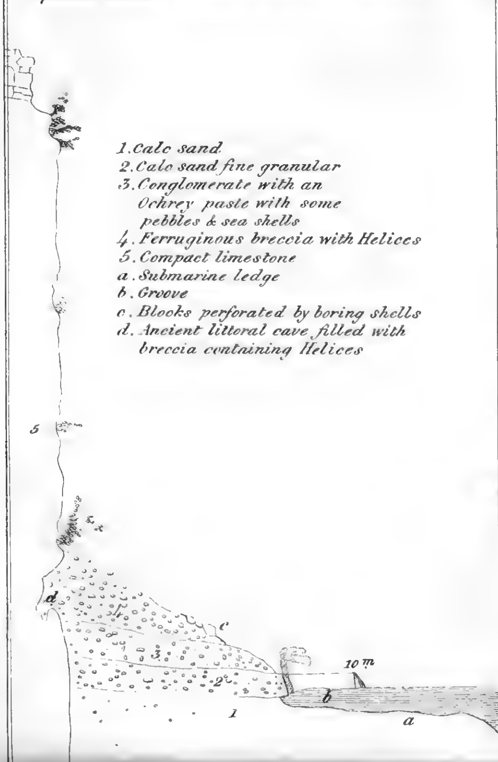
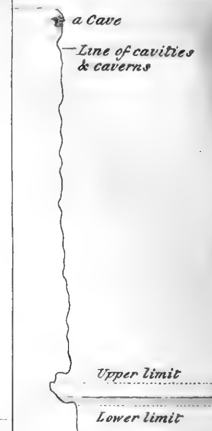
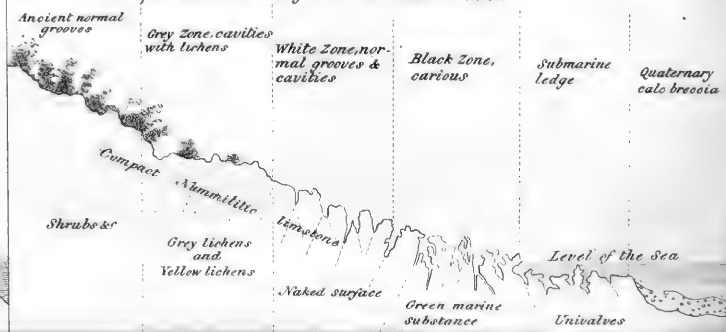


Fig. 2. Elevation of part of Cape Gros

Fig. 3. Profile of part of Cape Gros



Comparative section of the shore near Modon



R. Mitchell Sculpt.

Table V. For 10,000 Feet.							
Argument.—Height of Lower Barometer.							
B.	Feet.	B.	Feet.	B.	Feet.	B.	Feet.
15	18.2	19	11.8	23	6.9	27	2.7
16	16.5	20	10.5	24	5.8	28	1.7
17	14.8	21	9.3	25	4.7	29	0.7
18	13.3	22	8.1	26	3.7	30	0.0

An Account of the Tidal and other Zones observed on the surface of the Limestone Rocks on the Shores of Greece. By Staff-Captain Puillon-Boblaye. With a Plate *. (Pl. V.)

The study of the action of the sea on the rocks of the shore will explain in a simple manner a phenomenon which has been hitherto but little studied.

The following observations on this subject apply to the limestones of the Grecian shore, and, of them, to marbles, dolomites and compact limestones. The coarse limestones (calcaire grossiere) present facts sufficiently different to require being treated separately.

In these researches I have paid that attention to the subject which it appeared to me to merit; but leisure, health, and security were so often wanting to the observer, that the inquiries still remain very incomplete. Presuming, nevertheless, that they deserve the attention of geological travellers, I venture to recommend them to those who shall visit the south of France and the Apennines: they will find on its shore the same geological relations, and be enabled to finish at leisure what I have only glanced at.

Fig. 1. The calms so frequent in the seas of Greece, principally during the summer months, permit the steepest shores to be approached without danger; there then appears delineated at their surface horizontal bands or zones of different colours. An azure line sparkling with light marks the shore,

* Translated by Rev. Mr Ettershank from Boué's "Journal de Geologie," Feb. 1831.

and makes the dark colour of the zone, which exists immediately above the tides, more distinct. Numerous asperities, clefts, and caverns contribute to make its base appear of an intense black. Above the tint is softened, but the transition to the succeeding zone remains always strongly delineated.

The latter is generally of a dazzling white, yet, as it impresses its colour on the rocks themselves, it shows in some localities the blood-red colour, or flower of the peach, or the straw-yellow of lithographic limestones. Above, there appears a zone of a uniform grey, whatever be the nature of the rock: vegetation there commences, and is pointed out by some patches of a dark green colour.

Finally, at an elevation much higher than the shore, where much exposed to the violence of the tides, an elevation that rarely surpasses from thirty-five to forty yards, there appears a vegetation of a brilliant green, although a little dark, which extends even to the summits of the mountains, if the rapidity of their acclivity does not prevent it. These are the different zones which I am now to describe.

The Zone of the Tide.

The tides in the Mediterranean are so inconsiderable, that we cannot distinguish by observation their effects from those of the diurnal influences of breezes and variable winds, at least the attempts that I have made in this respect have been fruitless. Yet no one can doubt the existence of these tides, when in calm weather he sails along the shore.

In fact, it appears that the tide balances itself constantly between the limits of a little zone which is not three decimetres in height, but which is defined in a manner so conspicuous, that it announces the influence of a permanent and regular cause.

In the localities where the tide has little energy, as in the ports of Napoli and Navarino, it is characterised by a marine vegetation of a yellow colour, which detaches itself in a very conspicuous manner on the dark colour of the lower part of the shore. On the contrary, wherever the mechanical action of the tide, doubtless seconded by chemical actions, has been able to attack the limestone, and this is a very general case, this little zone is delineated in a manner still more evident. It is a groove more or less deep, and in which the rock is naked; its height is not so uniform as in the preceding case, because it is often formed by the reunion of little caverns or cavities, and thus its height is elevated or depressed with them; yet seen at a certain distance, we recognise a constant mean height, and that within the limits which I have assigned to it, a certain indication of a permanent phenomenon, and of determinate limits.

The result of the breaking of the tides upon the shore produces, on the contrary, effects which are not well defined, are without a determinate elevation, and, as we shall soon see, altogether different from the former.

(Fig. 1. *a*). The lower part of this groove, of which I have not yet spoken but to demonstrate the existence of a Mediterranean tide, is attached to a nearly horizontal ledge or table, which prevails at some centimetres beneath the level of the sea, extends some yards in breadth, and terminates abruptly by a sudden increase of the depth of the waters.

This ledge exists generally wherever the shore is rocky, yet it is sometimes concealed by descending debris, and is scarcely perceptible in very inclined shores, where it is confounded with the submarine prolongation of these debris.

On the other hand, in the localities where the rocks are easily destructible, as when *greensand* and its clays bound the sea, this submarine horizontal ledge extends very far forward from almost vertical beaches. I have observed it in the bay of Modon. There it extends out from 50 to 200 and 300 yards from the shore, slopes gradually, and then it sinks rapidly to a great depth. At its surface the sea is often only some inches in depth. The bottom, perforated by funnels in which the tide seems to produce the effect of a wimble, is again covered with slimy soft argillo-calcareous mud, which often leaves bare the vertical sections of the greensand strata; thus it is not a slope slightly inclined, formed by debris produced by the tide, but the result of an action of long continuance. This table or ledge forms a submarine bank on which the tide breaks, and of which it weakens the force; consequently, the destruction uniformly tends to cease, and we are convinced that it has attained its limits in many places.

On the shores where the old limestones prevail, which principally form the subject of this notice, the submarine table is never more than some yards in breadth. Its surface is covered with little rough inequalities, bent back on every side, and fretted in such a manner as only to adhere to the rock in some points. It is, besides, pierced through by deep cavities and sinuosities, directed almost always in the plane of the fissures. I have found some localities chiefly on the east side of *Magna*, where the groove and the submarine table which reattaches itself to its lower part were almost wholly wanting, and of which I was not able to give a reason, the shore being otherwise rocky, steep, and exposed to the violence of the sea. I should have been inclined to attribute it to the recent subsidence of the land, and the more so as the sea is very shallow, notwithstanding the steepness of the shore, had not the following observation made me discover that it must be attributed to another cause. There is deposited in these localities a concretionary limestone which encrusts the rocks, however much they may be inclined, even to the superior limit of the tide. Its surface is white, mammillated, and covered with serpulæ, with corals and other madrepores. The interior is often formed by a mass of little tubes, as those of serpulæ, but of which the cavities penetrate even to the interior of the crystalline limestone. This deposite which I had not been accustomed to see formed abundantly, but in those places where the sea is little agitated, could it be here the cause of the preservation of the littoral rocks? or rather, could not these two effects result from the same cause, the rarity and the feebleness of the winds in the easterly direction *?

* This depot of concretionary limestone occurs wherever the sea is tranquil, and wherever sands and muds do not change their natures, as in road-steads and mouths of rivers. In the remote and shallow parts of rocky bays, it envelopes many univalve shells to the superior limit of the tide. It is more abundant the calmer and the deeper the sea. Thus, in the road-stead of Navarino, the wreck of the fleet of Ibrahim, raised from a depth of from five to six fathoms, was encrusted with it to a thickness of many millimetres, after about eighteen months' immersion; oysters, serpulæ, &c. were adhering to it. Leaving out the sands and madrepores, there is a rising of the bottom of nearly five millimetres in two years, which would give ten metres of calcareous deposite during our historical period. We ought also to add, that, in the same place, there is formed enormous muddy and sandy depositcs, which have already obstructed two of the entrances of the road-stead.

When the shore is composed of breccias, or of puddingstones cemented with ferruginous matter, the groove acquires a great depth, as at the foot of the *Palamede de Napoli;* the tide disintegrates and undermines to a great depth, and penetrates underneath, even to a distance of eight or ten yards from the shore. Thence there results very extensive fissures parallel to the sea, and outlets through which the tide, after having broken itself under your feet, escapes in *jets d'eau.*

(Figs. 2 and 3.) Perpendicular shores present some peculiar circumstances in this zone. I shall take for example *Cap-Gros,* the most remarkable place of this nature that I have had occasion to observe. Its description belongs to the physical geography of the Morea; it will be sufficient to state here, that it is a rock of grey marble, a league long, 200 yards high, and cut perpendicularly on the sea side and on the land side, and truncated besides at its summit by a nearly horizontal plane. It is very seldom that it can be approached without danger. The meeting of contrary winds in the gulfs of Messina and Laconia, excite violent tempests there, and rapid currents sweep along their banks, where, in case of shipwreck, there could be no hope of safety. If we add to these causes of fear, the continual noise which the waters of the sea make by engulfing themselves into the numerous caverns which open at the foot of the rocks, a noise that can be compared only to the distant rolling of thunder or artillery, we shall be disposed to believe, that Cape-Tenares, which borders on it, has usurped to itself the terrible reputation of the former*. In a first voyage I was obliged to shear off, and could only recognise the existence of this line of caverns and cavities which prevails at the level of the tide, and in which the sea then roared in a terrific manner. Afterwards, in the month of June a perfect calm permitted me to follow the foot of this enormous mass, and to penetrate into the interior of one of those caverns inhabited by pigeons as in the time of Homer, (Messa abounding with pigeons).

I observed here a submarine step or ledge, which in this place

* This succession of groanings or murmurings which issue from the interior of the caverns of Cape-Gros, is undoubtedly that which the ancients meant to express by the barking of the many heads of Cerberus.

was only from one yard to one and a half in breadth. I saw, besides, that the *groove* hollowed at the base of the rock joined every where at the level of the tide a succession of caverns and cavities more or less deep, which the dimensions alone distinguished; that to the one as well as to the other corresponded the lines of fissures crossing in different directions, and that their meeting in a greater number seemed only to have promoted their enlargement, or the passage from the state of a cavity, partly submarine, to the state of a *littoral cavern*.

An observation already made at Napoli, at the foot of the fortress of Itskalé, was confirmed here. Cavities which were only a yard in length, with a sinuous and rounded outline, attained a height of from 30 to 40 yards. Their great axis, constantly placed in the plane of a scarcely perceptible fissure, offered no trace of erosion, nor the cavities any apparent continuity. I mention them here for the purpose of noticing their relation to the fissures, for I do not believe that they could otherwise be the result of littoral influences. I believe them rather analogous to bone-caves, produced partly by the flowing of continental waters. The interior of the cavern presented some peculiar circumstances, which I have no doubt will be found in all the littoral caverns. The rounded form of the inferior part of its vault and its walls, showed that the fissures had only acted by facilitating the chemical and mechanical action of the tide, and afterwards hastening the fall of some angular parts of the vault. The rock was grey marble, in thick layers almost vertical, and perfectly homogeneous. We found at the surface of the rock parts decayed, and again covered with black testaceous matter, of which I shall speak soon.

No opening could be discovered either at the summit, or at the most remote part where the rock was bare; in a word, it did not differ from the numerous cavities of the line of the tide, but only by its greater dimensions.

The bottom, which rose quickly towards the interior, was covered with sea-weeds, pieces of wood, and other bodies capable of floating, and some rolled pebbles, all identical with the rock on which they rested, a character very essential to be remarked.

It is not, then, one of those caverns of erosion, with successions of chambers and galleries, and with smooth walls, filled either by ancient or modern alluvium; caverns as numerous in the Morea as everywhere else, but which it is very difficult to observe, because they still serve as an issue to the waters of basins shut up in the interior, and because their opening is almost always beneath the level of the sea. It is not one of those caverns produced by falling in of rocks, so common in the sides of valleys, a result of the destruction of loosely aggregated strata, and which present in their roof the surface of more durable strata, and in their walls surfaces constantly angular. It is a third sort of cavern, which we may designate under the name of *littoral cavern*, and which we ought to find in the interior of up-raised continents *. Their characters will be to exhibit, in the same country, a nearly uniform level, walls rounded in their lower part, and rocks decayed or rotten without being angular, solid vaults, no communication by successive chambers or galleries, but only by fissures widened at the bottom; finally, a demi-vault cut through the face of the rock rather than a complete one. They should doubtless likewise exhibit peculiar zoological characters.

The limestone rocks are, then, everywhere hollowed at the level of the tide; there thence results either a groove or a series of cavities and caverns with peculiar forms; and, in consequence of this action, whatever it may be, continued since the sea assumed its present limits, a submarine table, but narrow in marbles and compact limestones, and much more extended in the more easily decomposed greensand. These characters, and particularly the last, should be found in the old shores of our recent formations. I believe I am able to refer to it a remarkable fact, to which I call the attention of geologists who shall visit the Mediterranean basin. It is the existence of four or five horizontal steps or ledges, perfectly delineated on the littoral rocks

* I could cite many other localities where I have observed *littoral* caves. One of the most remarkable and best known is the Island of Sphacterie, and particularly the long and narrow rock which forms the entrance of Navarino. One of these caverns traverses the rock, and joins the ocean and the roadstead by a rounded vault, fifty feet high. Large boats might pass through it, if the shallowness did not prevent them. Saussure mentions caverns of the same description in the environs of Nice; he is the first geologist, and nearly the only one, who mentions grooves on limestone rocks.

of Greece, whatever may be their nature in other respects,—a fact which seems to announce as many up-raisings of the continent, or depressions of the level of the sea, with a prolonged continuance at each of these levels. It will not perhaps be impossible to connect the littoral alluvium of Argolis, the fahluns of Toryne, and some other small deposites, with recent movements of the land; perhaps even one day we may be able to recognise their coincidence with some of the historic deluges of the Mediterranean, as that of Ogyges or Attica, for example. The deposites of shells of St Hospice, near Nice, those of the borders of the Hellespont observed by M. Olivier, and a great many more in the basin of the Mediterranean, belong probably to the same phenomenon; but I do not know if terraces or ledges such as those of which I have spoken have been observed in these localities.

The Black Zone.

Above the superior limit of the tide, in its calm state, there is a band of a very deep colour, passing from black to greenish-brown. Its elevation varies according to the localities; it rises much more in those places where the shore is most violently beaten by the tide. At Cape Matapan it attains a height of from seven to eight yards. It is the part of the shore washed by the wave after it has been broken. In every part of this zone, but chiefly in its inferior part, the rocks are so corroded, that they appear only as rough branches twisted, and connected together by some points. Towards the points where these branches again join to the mass of the rock, the tortuous cavities, although always situated in the planes of the fissure, sink to the depth of many yards. Although the traces of the fissures may have almost entirely disappeared, so much are they widened and broken up, it is evident that they have exerted a great influence over the destruction of the limestone rock. This destruction is more complete the nearer we approach to the level of the sea; again some efforts, and all this part destroyed will join itself to the submarine slope on which it rests.

It is at this elevation that we remark, on all the sharp asperities which again cover the limestone, a smooth mammillated substance, harder than limestone, of a shining blackish-brown, waxy fracture, radiated, slightly translucent. It is found equally at the surface of marbles, dolomites, and compact limestones. Its brown colour contrasts in an evident manner with that of the marbles, which afford no alteration at the point of contact.

When we have carefully examined this part of the shore, we cannot fail to compare it to certain bands or zones of limestone, perforated with cavities almost cylindrical, but sinuous and irregular, which we meet at great heights in the interior of continents. They only differ from the former by the destruction of the little asperities and sharp ridges which the rubbing of alluvial matters, and the action of atmospheric agents, have doubtless destroyed. We shall be much more induced to acknowledge in it the trace of ancient shores, as these cavities are always superficial, exist independently of the nature of the rock, and accompany other incontestible proofs of the sojourning of the sea.

The White Zone.

Continuing to ascend, we enter into a zone which the broken waves could not have reached, unless in the form of fine rain carried by the wind. It may be designated the *white zone*; indeed all vegetation there terminates, the brown colour of the lower zone having disappeared by degrees, and given place to the white tint natural to the rocks.

Everywhere the surfaces are unstained; so that between the part occupied by the marine vegetation, and that where the lichens begin to appear, the first trace of terrestrial vegetation, there is a zone entirely bare. It is divided in every direction by very wide fissures, and, although far from being so deeply decayed as the preceding zone, it exhibits such asperities that it is difficult to walk over it, and above all to press the hand upon it.

The examination of the surface shews that it is everywhere perforated with little rounded cavities, of various depths, but which never exceed from six to eight millimetres. They are hollowed from beneath; the entire surface is covered with them, but the greatest are always observed on the little lines of fissures. It is important to remark, that these cavities are found as frequently on the vertical faces as on the horizontal or inclined;

which demonstrates that the first cause of the phenomenon is independent of gravity.

The same surfaces present a phenomenon still more interesting; it is that of the numerous grooves rigorously directed according to the lines of the greater declivity. We see them arise upon every culminating ridge, scooped out and widening as they descend towards the extremity of the inclined plane. The ridges which separate the principal grooves become themselves the point of the departure of new grooves, which converge towards the bottom of the former. We cannot better compare these surfaces than to the plane *in relievo* of a mountainous country.

The little cavities of from one to two millimetres, which cover all the surfaces, are, in general, a little greater in the bottom of the grooves than on the ridges. Some cavities, much larger than all the others, but yet on a fresh surface, appear disposed upon the lines of fissures, sometimes perpendicular to the direction of the grooves. Finally, and this observation is essential, while the little cavities appear on all the faces, the normal grooves, or those of the greater declivity, are not observed but upon inclined faces; the horizontal planes are almost entirely without them, and it is almost the same with the vertical planes.

The immediate cause of the formation of the grooves cannot escape us, for the phenomenon passes under our eyes. We see each of them forming itself by the union of cavities situated upon the same line of the greater declivity. We may affirm that the vicinity of the sea is a necessary circumstance, for the phenomenon *in action* presents itself nowhere in the interior of the earth (not even in the vicinity of fresh waters, nor upon high snowy peaks), and as, moreover, its sphere of action does not extend on littoral rocks to more than 40 yards above the level of the sea, and to 1000 or 1500 yards distance from the shore. We can have little doubt, as shewn by these circumstances, that the *aura maritima*, or the particles of the tide carried by the wind, could have been the first cause of the phenomenon; that they act mechanically by absorption and crystallization, in the manner of concentrated saline solutions upon the frozen rocks, and, besides hygrometrically, by fixing humidity in the parts which they penetrate. Cavities are thus formed on all the faces, and afterwards the rain-waters and dews produce grooves, by flowing according to the direction of the greater declivity, and carrying along with them the disunited parts.

The phenomenon is thus explained in a manner altogether mechanical. Yet it might be possible that the waters of the sea might have had a chemical action upon these limestone rocks, which are almost all more or less mixed with magnesia, and doubtless deposited in the waters under very different circumstances.

The Grey Zone.

When we ascend the upper part of this zone, we observe that the bottom of the cavities begin to be covered with a greyish lichen, with little scattered black globules, resembling grains of powder; and if we break the rock, we very often see, at about a millimetre under the surface, an embroidering of beautiful emerald-green, which surprises us the more as between it and the lichen the rock is not altered. One might be tempted to see, in these circumstances, the proof of a destructive action, which the lichens would exert on the limestones; but there is nothing of the kind. A more attentive observation shews that this green matter occupies only fissures invisible to the naked eye, where it ceases at a certain depth. Thus vegetation here exerts a conservative action; it opposes the destructive action of the *aura maritima*, and terminates by vanquishing it; quickly every trace of erosion ceases, and the rock, still deprived of other vegetation, is covered with a uniform grey tint.

I do not believe, after what has just been stated, it can be supposed that the corrosion of these littoral rocks commenced at an epoch anterior to ours; from those times, "when, according to some geologists, acid rains washed the surface of the rocks, or torrents of acid water rushed from the bosom of the earth, dissolved every thing in its passage, gave rise to diluvium, and scooped out valleys;"—opinions which appear to me to belong rather to the geology of the eighteenth than the nineteenth century. Besides, the examination of historical monuments would refute this objection. (I might cite many of these, but these details will be placed with greater propriety in a work upon the Morea.) A great number of monuments, of high antiquity, of Cyclopean or Hellenic construction, situated within the limits which I have assigned to the *aura maritima*, exhibit traces of a deep erosion, while those of the same age built in the interior are unaltered, as at the period of their erection; and, on the other hand, the monuments of the epoch of the Crusades, or of the French domination, situated on the shore, already exhibit marks of erosion.

Some have been able to observe the effect of this action in the same place, and on the same materials *, impressed at once on monuments 600 and 3000 years old; and upon the rocks on which they are built, rocks which in this place become to us the historic monuments of the last Mediterranean movement, or of the period of the settling of this sea into its present basin. This order of phenomena, notwithstanding the smallness of its effects, seems to me favourable for the estimation of time, because the effect being simple and constant, the effects ought evidently to be proportioned to the time, while the phenomena of land gained by the continued formation of alluvium depend on variable causes, and causes which uniformly tend to annihilation, and which can with great difficulty lead us to any approximation.

Grooves and Decayed Rocks of Ancient Shores.

My observations relative to the grooves of the greater declivity, have hitherto been extended only to littoral rocks, and to the actions exerted in our times. We shall find in the interior of the continent, and even to the elevation of a thousand yards, effects of the same nature, which will completely establish the analogy which I have already hinted at between the ancient shores and those of the present sea.

The action of atmospheric agents upon compact limestones and marbles of the interior of the Continent, appears at this time to reduce itself to fissures, which at length cause the destruction of some projecting parts, but otherwise there is no erosion such as that on the shore. Yet we observe in many places, and at great heights, grooves directed according to the line of the greater declivity, analogous in all their characters to

* It is to be recollected that we here speak only of marbles and compact limestones. The *calcaire grossiere*, or coarse limestone, of which the greater number of the monuments of the Morea are formed, experience in every position a rapid destruction through atmospherical agency.

those above described. The circumstances which distinguish this phenomenon from the analogous one upon the present shores, are, 1*st*, the existence of a cuticle of lichen uniformly covering the rock, which announces that the action that produced the erosion has ceased; 2*dly*, the obtuse form of the ridges and of the borders of the cavities; 3*dly*, the much greater dimensions of the normal grooves.

These groves, which on the border of the sea scarcely exceed a few millimetres in depth, present in some localities in the interior, principally upon the low valleys which border in the sea, a breadth of from 1 to 2 decimeters, with a corresponding depth.

These grooves, in their course, often meet with cylindrical irregular holes, which belong constantly to the limestones in the same locality; then they penetrate the limestone, and are delineated at its surface. Thus those cavities had already been produced when the action which gave rise to the grooves still existed. The great dimensions of the ancient grooves would be explained by the long continued action, and perhaps by different atmospherical circumstances; the elevation and extent of the surfaces upon which we observe them, by the movements of the land and of the tide, as powerful then upon the Mediterranean shores as upon those of the present ocean. In every place where these normal grooves exist, you will be sure to find beneath, and in general at a small distance, certain signs of the existence of ancient shores. These are either the superior limits of the tertiary district resting upon the ancient district, or lines of pebbles and rocks *in situ* perforated by boring mollusca; or, finally, surfaces of decayed limestones perforated with numerous tortuous cavities with rounded surfaces. I believe that it may be established with certainty, that there is an analogy between these surfaces, covered with grooves of the greater declivity, and the white zone of the shore. I would now establish the same analogy between the surfaces with tortuous cavities of which I have just spoken, and the decayed zone, in some manner beaten by the tide. Both sorts present the same kinds of destruction, only the rocks of the interior have lost their asperities; the cavities are not only rounded but sometimes even polished. In supposing them to have the same origin, we ought not to be astonished at this difference; it results principally from the action of atmospheric agents, and from that of alluvial waters, which has filled them with ochrey clay. The position in which these surfaces is observed is a new proof of their origin; we see them either on the flat lands (plateaux) at the foot of the mountains that constitute the limit of the tertiary district, or at the summit of passes (cols), and seldom on the sides of valleys. Besides, they are always superficial, and I have never happened to see them in the interior of the limestone, although I have travelled during a period of two years through a country where we meet everywhere naked sections, many hundred yards in height. The soil of Modon and that of Navarino, as well as the pass which separates these towns, and above all the ditches of their citadels, show that these cavities, scooped here in the *nummulitic chalk*, are superficial, and that their level is superior to that of the tertiary district, notwithstanding the contrary appearance produced by the dislocation of the soil. I have already stated that I have never seen these cavities filled with any other substance than ochrey clay mixed with pebbles; the tertiary district has never appeared to me to extend so far, and there is likewise in it a breccia with a crystalline cement, which we meet always in the vicinity of these decayed surfaces, and which I believe to be of the tertiary epoch *.

These last observations would require to be verified with the more care, as they alone would be sufficient to determine the epoch of the excavating of these cavities, always nevertheless attending to the difference of the levels, for they could not have been filled, either because they are posterior to the deposition of the recent formations, or because they occupied, at the time of their formation, a higher level.

In recapitulation, we must conclude, from the existence of normal grooves, or those of the greater declivity, that the

* Figure 1. shews a littoral cave near to Napoli, elevated from 5 to 6 fathoms above the present level of the sea, filled with a ferruginous breccia; this breccia belongs to the present epoch. It contains fragments of antique pottery, and the cave itself belongs to a slight and very recent upraising of the coast of this part of Argolis.

rocks on which they are found, if they are sharp and stripped of all vegetation, appertain to the sphere of action of the *aura maritima;* that if they are edged with moss and again covered with lichens, analogy induces us to suppose that, at an anterior period, they were continental and littoral surfaces. We shall then be able, by means of this character, in spite of all the dislocations of the soil, the absence of pebbles, and cavities formed by boring shells, and the frequent disappearance of recent districts, to discover the trace of sea-shores at different periods. This fact being undeniably established will, moreover, serve to throw light on the question of the return of the sea upon surfaces which it had abandoned. Indeed this character is not susceptible of being destroyed by the violent return of the sea to the surface of continents.

The direction of the grooves should be observed, if the surface of the rock has permitted them to be developed to a great extent. They will be in a normal direction to its horizontal section, if the soil has not experienced great movements since their formation. On the other hand, if their deviation be well defined, it will enable us to discover the direction of the upraising disengaged from all the effects of anterior upraisings. The examination of the surfaces of blocks imbedded in breccias or of ancient alluvials, will demonstrate if already they had belonged to a terrestrial or a littoral surface. Touching inductions relative to the time, which we can draw from the phenomenon of the erosion of the marbles and compact limestones, by the effect of the *aura maritima*, I believe that, by reason of the simplicity and the permanence of the phenomenon, they can acquire a degree of probability as satisfactory as those derived from a phenomenon operating on a greater scale, it is true, but much more complex. It will be inferred, from the existence of small horizontal terraces, lines of boring shells, and carious limestones, imprinted on the more recent tertiary deposites, that the sea has occupied many successive levels in the *clysmian or diluvian period,* which had not been acknowledged owing to particular systematic and religious opinions. The comparison of the black or deeply carious littoral zone, with surfaces analogous in the interior, will offer means still more evident of discovering traces of ancient shores, of separating ancient littoral caverns from continental caverns, whether formed by erosion, or by falling in of rocks. Finally, these observations will do away with the necessity of having recourse to hazardous hypotheses for explaining certain phenomena which are in great part conformable with the present order of things. Notwithstanding, I shall repeat that I am very far from wishing to attribute to marine and littoral influences all the cavities of ancient limestones.

I have mentioned, as a proof of the contrary, the caverns with bones, of which the Morea demonstrates the mode of formation, and above all of the filling up, better than any other country. Indeed in each of the inclosed basins in the interior, the torrential waters engulf themselves, and do not again appear but at a great distance, and the greater part of the time beneath the level of the sea. Numerous caverns with bones are filled up in our times, and the gulfs or *katavothrons* of the Plain of *Tripolitza*, have swallowed up, in these last years, thousands of human bones, mixed at the same time with ochrey clay, which envelopes the clysmian or diluvial bones.

We may also cite certain cavities, partly empty and partly filled with tertiary alabasters and breccias, which appear owing to the renewing of the same, which, in the same localities, had before produced gypsums, iron-glance, and magnesian limestones variously cracked or fissured. There are still acid emanations and acidulous springs, of which M. Hoffman has shewn the connection with the upraising of certain valleys, without describing their effects upon the limestones which they traverse; it is a cause still producing mineralogical modifications, if not geognostical, analogous to those which I have described, but which doubtless ought to exhibit distinct characters.

My observations apply, then, but to a part of the phenomenon of erosion, which I have endeavoured to explain by the effects produced by it on our shores. If any one should think that I have not attained this end, these last observations would remain susceptible of new explanations, new inquiries, and interesting applications, to which I call the attention of geologists.

TABLES of the Population, *and of the* Stock *of* Cattle, Sheep, *&c. of Suderöe and Wagöe, two of the Faroe Islands, in the year* 1821. Communicated by W. C. Trevelyan, Esq. M. G. S., M. W. S., &c.

Island of Suderöe. Villages.	Inhabitants in 1821.	Males above 15 years.	Males under 15 years.	Females above 15 years.	Females under 15 years.	Births in 5 years, 1816–1820.	Deaths in 5 years, 1816–1820.	Oldest Persons in 1821.	Milch Cows.	Calves, Oxen, Heifers, Bulls.	Stock of Sheep.	Sheep and Lambs Slaughtered in 1821.	Boats of 8 Oars.	Boats of 6 Oars.	Boats of 4 Oars.
Qualböe,	233	86	34	85	28	38	7	93	150	23	1850	930	7	14	8
Frodböe,	149	53	24	54	18	11	7	92	80	11	2072	941	4	7	5
Porkerig,	170	63	25	59	23	25	18	90	90	15	1762	720	4	8	6
Waaÿ,	113	37	22	40	14	20	9	93	56	12	1390	432	3	5	7
Sumböe,	151	50	30	52	19	28	16	89	63	13	1683	606	1	8	6
Famien,	51	19	8	18	6	6	3	91	28	6	875	311	1	3	1
	867	308	143	308	108	128	60	In 1821 a man died at the age of 103.	367	80	9632	3940	20	45	33
		451		416		5 still born.									
Island of Waagöe.	511	188	67	183	73	44	29		254	Oxen, ... Heifers, 92 Bulls. 10	6800	5620	Used in Winter, 15	Seldom used.	Used in Summer. 32
		255		256		1816, 7	1816, 5					1816, 1610			
						—17, 7	—17, 11					—17, 3010			
						—18, 9	—18, 3					—18, 3510			
						—19, 10	—19, 1					—19, 4260			
						—20, 11	—20, 9					—20, 5220			
												17610			

The above return for the Island of Suderöe, I copied from one made by Mr Schroter, the Clergyman of that Island; the other from a return made by Jacob Zacharieson, Syselman of Waagöe.

Notice of New Bone Caves discovered at Salleles-Cabardes, in the Department of Aude, in France, shewing that Man was probably contemporaneous with the extinct Mammalia found in them.

These caves, lately discovered by MM. Marcel, de Serres and Pitorre, and described in Boué's Journal de Geologie, occur in transition or mountain limestone. The bones found in them are fractured, but not water-worn. They lie as usual in a reddish coloured marly mass, like those in the caves of Bize. The bones are irregularly heaped together; thus along-side a bear or a fox, we find bones of a deer or a horse. The population of these caves, like those of Bize, appears essentially characterized by remains of deers and horses. These domestic races, like the wild races with which they are associated, are found of different ages. This circumstance, joined to many other circumstances, announce that the carrying so many bones into the fissure of rocks has been purely accidental. For the diluvial currents that carried in the mud, the fragments and pebbles, may also have carried in such bones as they met with in their way. It is at least certain that, at Salleles and Bize, the carnivora could not have assembled all the bones we find there; because remains of such animals are very rare in these caves, and those that are met with do not belong to such species as have the habitude of carrying into their retreats the animals on which they feed. Bears and wolves, particularly the first, have not this practice, yet they are the principal carnivora met with there. It is true the tooth of a hyæna was found at Salleles, but this was the only tooth met with; and, notwithstanding extensive researches, only two pieces of *album græcum* were found. It may, it is true, be objected that the carnivora of the present time, that carry into their dens animals and their remains, on which they feed, do not always leave traces of their existence in these subterranean places. In regard to the *album græcum* or *coprolite*, found lately in the caves of Bize, it does not belong to the hyæna, but to wolves and foxes.

The following is a list of animal remains found in the caverns of Salleles and Bize.

Caves of Salleles.—*Ursus* Pittorii, spelæus, arctoideus, and meles. *Hyæna*, var. spælæa. *Canis* lupus and vulpes. *Lepus* timidus and cuniculus. *Mus* species not determined. *Equus* caballus. *Cervus* Reboulii and Dumasii. *Capreolus* Tournalii and Leufroyi. *Antilope* Christolii. *Bos* taurus and urus. *Bird* size of *sparrow hawk*; another resembling the *golden pheasant*. The shells were *Natica* millepunctata, *Helix* nemoralis and aspersa.

Caves of Bize.—*Vespertilio* murinus and auritus. *Ursus* arctoideus. *Canis* lupus and vulpes. *Felis* serval. *Lepus* timidus and cuniculus. *Mus* campestris. *Sus* scropha. *Equus* caballus. *Cervus* Destremii, Reboulii, and a species not determined. Capreolus Tournalii, Leufroyi, and a species not yet determined. *Antilope* Christolii. *Capra* ægagrus. *Bos* taurus and urus. Of birds one species was the size of *common owl*, another that of the *sparrow hawk*, a third resembling the *common pheasant* in size, and another the *partridge* and the *Anas olor* *. The shells—*Natica* millepunctata. *Buccinum* undatum. Pectunculus glycimeris. *Pecten* jacobæa. *Mytilus* edulis. *Helix* nemoralis, hortensis, lucida, and nitida. *Bulimus* decollatus. *Cyclostoma* elegans. Lastly, that which proves the recent age of these deposites is, that the same mud which cements together the bones, &c. of species considered as extinct, and therefore viewed as antidiluvian, contains also *human bones* and *works of art*, or, lastly, the bones of extinct animals that appear to have been fashioned by man. To make our comparison of the two sets of caves complete, the following may be added.—

Caves of Salleles.—Bones of supposed extinct species, fashioned, it would appear, by man. *Pottery* of very ancient dates.

Caves of Bize.—Bones of animals supposed to be extinct; bones fashioned by man. *Pottery* of ancient date. *Human bones.* —Vide *Boué's Journal de Geologie for particulars.*

* The occurrence of fossil remains of birds resembling the common and golden pheasant is a very curious fact: if they should be proved to belong to these birds, the age of the deposite containing them will be made out, because these birds are not natives of Europe, having been introduced by man from the east. It still remains to be ascertained whether these bones, &c. have been brought into their present situation at one or at different times.—Edit.

The Mastodon formerly extended over the entire surface of the American Continent, and the Horse was probably an original inhabitant of the New World ?*

The committee beg leave respectfully to report, that these bones having been landed only within a few days, sufficient time has not been afforded them for the accurate determination of every imperfect or mutilated fragment. The greater part, however, belonging to well known animals, were immediately recognized, and it is not believed that any thing of much importance will be hereafter observed. They therefore submit, this evening, a general account of this collection, reserving for a future occasion such further particulars as may be deemed of sufficient interest.

The remains of the *great mastodon* compose more than one-half the entire quantity of which this collection consists. Among them is a head, which, though not entire, is in better preservation than any of this animal heretofore discovered. It enables us to form a better idea of the figure of this important part than could hitherto be obtained. It is found to have the cranium *much depressed*, in which it deviates remarkably from the elephant. Both the tusks are preserved, one having been found still in the socket, and the other lying at a short distance off. Of other large tusks, there are besides, five that measure from six and a half to twelve feet in length, and many more large fragments of others. Six portions of upper jaws, all containing teeth. Fifteen portions of lower jaws, twelve of which contain from one to three grinders each. Besides these there are seventy-three detached molar teeth of all sizes, some of them as large as any yet discovered. Of the large bones of the anterior extremity, there are five *scapulæ*, seven *humeri*, three *ulnæ*, and one *radius*, more or less perfect. Of the posterior extremity, six *ossa innominata*, ten *femora*, and five *tibiæ*. Some of these are almost entire, others are much mutilated.

* The above is a Report of Messrs Cooper, J. A. Smith, and De Kay, read on the 30th May 1831 to the Lyceum of Natural History, on a collection of *fossil bones*, disinterred at Big Bone Lick, Kentucky, in September 1830, and recently brought to New York.

It is necessary to observe, that although these large bones, as well as the detached tusks, have been provisionally referred to the mastodon, yet it is not improbable that, on a further comparison, a part may be found to belong to the fossil elephant. The mutilated condition of some renders it extremely difficult to pronounce with certainty upon a slight examination.

The remains of the *fossil elephant* comprised in this collection, are next in interest and number to those of the mastodon. The first that we shall notice is a head of a young individual, more complete than any known to your committee to have been obtained in North America. It consists of the upper and lower maxillary bones, with six molar teeth in good preservation. Isolated grinders have been discovered in the United States in numerous instances, but generally without any portion of bone adhering to them. There are also of the elephant, in this collection, several other fragments of jaws, and twenty separate molar teeth.

Of the *horse*, there are perfect teeth, and other portions found under circumstances that favour the belief of their being of equal antiquity with the extinct animals whose remains are associated with them in the collection. The teeth are remarkably large and sound.

Of ruminating animals, there are skulls and some other parts of the *buffalo, Bos americanus ;* of the extinct species named by Dr Harlan, *Bos bombifrons ;* and of a large species of *Cervus*, resembling *C. Alces.*

Finally, we have also discovered among these interesting relics some considerable portions of the *Megalonyx*, whose osteology is still so imperfectly known. The most important of these is a right lower maxillary bone, with four teeth in the sockets, and another detached tooth which appears to have come from the upper jaw. There is also the tibia of the right leg, and perhaps some other bones which may prove to belong to the same animal.

Remarks by Professor Silliman.—Having (since the above account was received) seen this collection of bones, so accurately described above, I cannot refrain from attempting to convey to others something of the impression made upon my own mind on entering the room containing this astonishing assemblage of bones, many of which are of gigantic size. They produce in the beholder the strongest conviction that races of animals formerly existed on this continent, not only of vast magnitude, but which must also have been very numerous; and that the *mastodon*, at least, ranged in herds over probably the entire American continent.

It is stated by the person who exhibits this collection, that the skull, and tusks which it contains, weigh upwards of five hundred pounds; that a pair of tusks now lying in the room, and supposed to belong to the same species, weighed six hundred pounds when taken from the ground, and these are nearly perfect; and when we regard them as being merely appendages, and sustained by the animal at a great mechanical disadvantage, since they do not, like horns, rest upon the head, but project from it laterally forward, we can easily imagine that it would require the most powerful muscles to sustain and wield the entire cranium, tusks, muscles and integuments. We shall be happy to see additional illustrations from the able committee to whom we are indebted for the previous statement of facts. We will, however, venture to mention the *extraordinary curvature* of the tusks. Those of the elephant, we believe, are always in the form of a bent-bow, but these have almost the shape of a sickle, with the blade curved to one side; they are sharp and pointed. Many of the molar teeth of the mastodon in this collection, as we have often observed elsewhere, are much worn by grinding, and possess a high lustre from the polish produced by friction; they appear to have belonged to animals of very various ages, and the smaller teeth are generally little or not at all worn; in some of the teeth, the processes or ridges which are so remarkably prominent in the mastodon, and so remarkably contrasted also in this respect with those of the elephant, are entirely worn away, and are replaced by a deep, egg-shaped cavity, of extreme polish, as if it were varnished.

It is stated that this collection of bones contains upwards of three hundred in number, besides twenty-two tusks, and that it weighs in all *five thousand three hundred pounds.* The bones were obtained by Captain Finnel, at the Big Bone Lick, twenty miles south of Cincinnati, in Kentucky. The deposite was twenty-two feet below the surface, but bones appear to have been found at various depths, as may be observed in the notice of the Reverend Layres Gayley *, vol. xviii. p. 137 of this Journal †. *The discovery of bones of the horse is very extraordinary, as this animal had been supposed not to be a native of America, and the committee believe that they are of equal antiquity with the other bones; the great size of the teeth implies very large individuals, if not a large species, in analogy with similar facts on the eastern continents.*

Silliman's Journal, vol. xx. p. 370.

Observations on the History and Progress of Comparative Anatomy. By David Craigie, M. D., &c. (Continued from page 56.)

Section IV.—*Italian Zootomical School.—Columbus, Fallopius, Aranzi, Varoli, Bittner and Coiter.*

The cruelty of fortune, I have already shewn, deprived Eustachio of the place to which his researches entitled him among the anatomists of the 16th century. Unpropitious, however, as this circumstance was to him, it was in several respects fortunate for two anatomists nearly contemporaneous, and whose services, though highly meritorious, are certainly considerably enhanced by the accidental obscurity in which those of Eustachio were involved. I allude to Columbus and Fallopius:—though not the first anatomists of the Italian school, yet certainly the first in whose time that school can be said to be firmly established.

The period of the birth of Matthew Realdus Columbus is unknown; but he was a native of Cremona, where he pursued the occupation of a druggist, and he was the pupil and friend, and eventually the successor, of Vesalius, when that anatomist

* Then anonymous, but since acknowledged by the reverend gentleman who visited the spot.

† This collection is at present shewn at the corner of Broadway and Pearl Street, New York; but it is understood that it will ere long be transferred to London or Paris.

went to the court of Charles V. in 1542*. From a passage in the 15th book of his treatise *De Re Anatomica*, in which he states that he had taught at the date of its publication, 1559, for fifteen years, it must be inferred that he did not enter on the duties of professor at Padua till 1544. Here he appears to have continued for two years only, when he was appointed, in 1546, to the Theatre of Pisa, and where he was still teacher in 1548. After this period he is stated by some to have taught in Florence, but this is doubtful; and all that can be regarded as certain, is, that he was invited to Rome, where he taught for several years, and while resident at which, he published at Venice, in 1559, the work above mentioned, inscribed to Paul IV. Not much less doubt hangs over the period of his death than over that of his birth. The Abbe Marini has adduced a strong body of evidence to show that he died the very year in which he published his treatise, 1559, even before the impression was completed; and to this opinion Tiraboschi is inclined. Fabrucci, on the other hand, proves that he was living in 1564; and by others, as Haller and Portal, he is said to have died only in 1577. These circumstances, though insignificant in themselves, it is important to determine; with the view of estimating the justice of his claims to certain discoveries. The principal point to be kept in view is, that his treatise was first published, not at Rome, as stated by Tiraboschi, but at Venice in 1559.

The assiduity of Columbus in the acquisition of anatomical knowledge was very great; and he assures us that in the course of a single year he dissected fourteen bodies*,—a very great number for that period, and considering the prejudices which still existed against the dissection of the human subject. In these researches he studied not only healthy anatomy, but allowed no morbid deviation, or anomaly in structure, to escape his notice. He is further distinguished for his assiduous study of physiology by the dissection of living animals.

* "Etenim cum Vesalius abesset ac diutius in Germania detineretur, ut opus suum de humani corporis fabrica imprimendum curaret; me tum Venetiis primario chirurgo ac præceptori meo Joanni Antonio Leonico, gravi morbo laboranti, omni officio ac potius pietate assistentem, universa schola Patavina dignum judicavit quem in Vesalii locum sufficeret, ac non contemnendo præmio accersivit."—Lib. i. cap. 19.

† "Anno uno quatuordecim cadavera mihi dissecare contigit."—Lib. xv.

Columbus, though chiefly devoted to the study of the human structure, which he laboured to render precise and accurate, has nevertheless made some valuable observations in animal anatomy and physiology. In the first book, which is devoted to a more minute and accurate system of osteology than had been previously given, among other observations, we find that he remarks, that the superior jaw is fixed in man and all animals except the crocodile, in which it moves on the lower, and that in the parrot both are moveable *. The former observation, however, is neither new nor accurate. It was originally made by Aristotle, and has been adopted or repeated by succeeding authors without examination of its justice. It is known that in the crocodile and other reptiles, excepting the poisonous serpents, the lower jaw alone is moveable, as in the mammiferous animals. The second peculiarity, which is to a certain extent common to the whole feathered class, is, however, most conspicuous in the psittacoid tribe, by reason of the elastic plates by which the upper jaw is articulated to the frontal bone. The claim of the discovery of the *stapes* rests on very slender grounds; for that bone was previously described by Ingrassias, and nearly about the same time was recognised by Eustachio and Fallopius. He gives a good description of the bones and different apertures of the cranium, and impresses the necessity of preserving the turbinated bones of the nasal cavities, which had been overlooked by Vesalius. He gives the first minute description of the *sacrum* and coccygeal bones. A mistake of Aristotle, who insisted that the bones of the lion were void of marrow, he rectifies, by showing the large cavities in the bones of that *genus*, and which he maintains can be for no other purpose than containing marrow. (cap. xix.) In opposition to the opinion of all previous and most subsequent anatomists, he represents the larynx as consisting of a series, not of cartilages, but of bones; and this idea he maintains on the ground, that, because in advanced life the laryngeal cartilages are ossified, the natural state of these cartilages is the osseous in the human subject. It is in monkeys only, and other lower animals, he argues, and in early life in the human subject, that these constituent parts of the larynx are cartilaginous.

In describing the human liver in the sixth book, he remarks

* Lib. i. cap. 8.

the multifid arrangement of that organ in quadrupeds, and the bifid arrangement in birds. The accuracy of these observations will be recognised by the comparative anatomist. In most of mammiferous quadrupeds, excepting a few of the monkey tribe, the liver consists of four or five lobes, separated by very deep fissures, so as to be completely detached from each other; and in birds, the same organ consists of two lobes, which are generally nearly equal in size. But in his further account of the organ, he is led to give a description of the venous system, in which he repeats most of the errors of the ancients.

The account of the anatomy of the heart and brain is greatly better, and indeed is the best part of the treatise of Columbus, excepting one passage, where, in accordance with his views in the sixth book, he represents the arterious vein to arise, not from the heart, but from the liver. While he falls into this error, however, he has the courage to show, in opposition, not only to the authority of Galen, but of most anatomical teachers at that time, that this vessel contains not air, but blood mixed with air, which it receives from the lungs, and thus conveys to the left ventricle. To these views he appears to have been led chiefly by opening the bodies of living animals, and observing the heart and vessels in action. He contends, in opposition to Aristotle, that the blood is not formed in the heart; and he justly remarks, that no bone is found in the human heart, as in those of the ox, buffalo, horse, elephant, and other large animals.

His sketch of the distribution of the arteries is correct, and that of the course of the circulation shews that he was the first who had formed ideas of that function rather more distinct than those of Servet. He distinguishes two kinds of blood, natural (*sanguis naturalis*), and aerated or prepared (*sanguis spirituosus vel paratus*); the first corresponding to the venous or circulated, the second to the arterial or respired blood of modern physiology. The first, he says, is received from the *vena cava* into the right ventricle, while the second is received from the venous artery into the left ventricle, while the membranous folds or valves yield and allow its entrance. On the contraction of the heart, these valves are again shut, to prevent the blood from receding; and at the same time the valves both of the large artery, *aorta*, and of the arterious vein (pulmonary artery), are opened, and at once allow the aerated blood (*sanguis spirituosus*) to escape and be distributed over the system, and the natural blood to be conveyed to the lungs. It is further remarkable that, in his subsequent account of the structure and uses of the lung, he shews that he had formed a very distinct, and on the whole, accurate idea of the nature of the process of respiration. " All these uses of the lung," he continues, " my predecessors knew; but I add another of very great moment, to which they have not even alluded;—and this is the preparation and almost generation of the vital spirits, which are finally completed in the heart. The air inspired by the nostrils and mouth is conveyed by the windpipe through the whole lung, in which it is mixed with that blood which, proceeding from the right ventricle of the heart, is conveyed by the pulmonary artery (*vena arterialis*); for this arterial vein is so large that it conveys blood for other purposes as well as its own nourishment. (This, it may be remembered, is one of the arguments already used by Servet to demonstrate the true use of the pulmonary artery). The blood thus conveyed is agitated by the constant motion of the lung, attenuated and mingled with the air, which also in this collision and refraction undergoes some preparation; so that the mingled blood and air are received by the branches of the venous artery (*arteria venalis*) and are at length conveyed by its trunk to the left ventricle of the heart; and so well are they mingled and attenuated, that little is left for the heart to do; and after this slight elaboration, as if it put the final hand to the vital spirits, it then distributes them by means of the aorta to all parts of the body *." In his further prosecution of the subject, he entreats his reader not to be influenced by the authority of Aristotle, but to consider the size of the lung and the pulmonary artery and veins, the last of which is evidently made, he argues, to convey blood not *from* the heart but *to* that organ. To these arguments, he adds the fact that blood is known to proceed from the lungs not by coughing only, *sed etiam quia floridus est, tenuis et pulcher, ut de sanguine arteriarum quoque dicere consueverunt medici.* He concludes by recommending the candid reader who searches for truth, to study the subject in the bodies

* De Re Anatomica, lib. xi. cap. 2.

of brute animals opened alive, "for in these," he adds, "you will find the venous artery (the pulmonary) full, not of air or smoky fumes, as the Aristotelians assert, but of natural blood."

In the same book he describes accurately the distribution of the peritoneum, and is the first who recognises its twofold arrangement. He gives a good description of the situation, figure, and structure of the womb, and rectifies some mistakes of Mundino, who had represented it as containing seven chambers or cells.

The fourteenth book is exclusively devoted to the subject of vivisection, and the facts thus to be determined. If neither ape nor bear nor lion is to be got, he prefers the dog to the hog, *first*, because the latter are less convenient for distinguishing the use of the recurrent nerves; *secondly*, because they are too fat; and, *thirdy*, because the grunting noise of the animal is extremely disagreeable. Columbus, therefore, had recourse to the dog, in which he recognised the motion of the larynx in voice, the alternate descent and ascent of the diaphragm in inspiration and expiration, the motion of the heart and arteries, which are dilated, he says, while the former contracts, and contracted during the dilatation of the heart,—and the alternate heaving and sinking of the brain, *quod paucis notum est.* He describes with some minuteness the process for exposing the recurrent or laryngeal nerves; the division of which, he observes, is followed by loss of voice. And to prove that voice depends on the larynx and its nerves, and not on the heart, as asserted by Aristotle, after tying the large vessels, he cut out the heart of a dog, and shewed that the animal still barked and walked. On these animals, also, he practised artificial respiration, with the effect of exciting the action of the heart. Lastly, he recognised the motion of the brain, which depends on arterial and cardiac pulsation.

In his fifteenth book he records all the singular deviations of structure with which he had met; but these, as belonging rather to pathology, it is unnecessary to specify.

On the whole, it may be inferred that the great merit of Columbus consists in demonstrating the small or pulmonary circulation, and making a very near approach to the true doctrine of respiration, by means of the experiments which he performed on living animals.

Gabriel Fallopius of Modena, born in 1523, and cut off in his fortieth year, in 1563, appears to have been teaching in Ferrara in 1547. In 1548, he informs us himself, he was appointed to the office of Professor in Pisa; and, in 1551, he was invited to Padua, where he continued till the period of his death, which took place in 1563. He is chiefly known for his researches in human anatomy, in which he studied with great success, the organ of hearing, the carotid and vertebral arteries, the venous sinuses, both of the brain and spinal chord, the *vena azygos* and its relations, the umbilical vein, the *ductus arteriosus*, the renal *papillæ*, the utero-peritoneal tubes, since named from him, and the distribution of the nervous system. In the organ of hearing, his discoveries are most important; for, independent of the tortuous canal, which has since been distinguished by his name, he first recognised and described the cavity named the vestibule, between the *tympanum* and labyrinth; the three semicircular canals; the two *fenestrae*, or apertures between the *tympanum* and vestibule and *cochlea;* the nervous filament named the *chorda tympani;* and, finally, the *cochlea* itself. The discovery of the *stapes*, a third tympanal bone, he assigns to Ingrassias, although he himself had recognised it without being aware of the discovery. He, nevertheless, has the merit of demonstrating the mutual articulations of these bones with the greatest clearness and precision. He describes more accurately than any of his predecessors the process of dentition, and the relation between the temporary and the permanent set. The anatomy of the muscular system also he rendered more accurate than before, and first shewed that the internal intercostals only are found at the *sternum*, and that both orders have the same action. He discovered the ileo-colic valve in the monkey.

Julius Cæsar Aranzi, born at Bologna in 1530, and professor of anatomy in that university, and Constantio Varoli, of the same city, born in 1543, though chiefly known for their researches in human anatomy, did not neglect that of the animal world generally. Both these anatomists supplied, by their researches, much anatomical information to Ulysses Aldrovandus. Aranzi describes the structure of the bustard (*Otis tarda*), (Ornithologiæ, lib. xiii.); and Varoli, with Flaminius Rota, has given that of the Bohemian chatterer; (lib. xii.) In this bird Varoli recognised the horny structure of the inner membrane of the gizzard, and the facility with which it is detached from the muscular layer, as also the hard and bony structure, with the bifid appearance of the tongue. He remarks the great size of the liver, and ascribes to this circumstance the voracity of the animal. He observes also the great extent of the lungs, and the peculiar arrangement of the *trachea*, which is capacious and oval above, narrow in the middle, and becomes again more capacious below.

Nearly about the same period, John Bittner, a Silesian by birth, investigated, with much care, the structure of the parrot family. In his account of the cranium, he demonstrated the peculiar manner in which the upper jaw bone is articulated to the frontal, so as to produce motion of the former on the latter. He seems also to have been well impressed with the peculiar situation and connections of the quadrilateral bone (*os quadratum*), and the lever effect of its motion; but it is not to be wondered at that his speculations on this subject are imperfect and unsatisfactory. (Aldrovandi, lib. ix.)

The most diligent comparative anatomist of this period appears to have been Volcher Coiter or Koyter, who, though a native of Groningen in Friseland, yet, as a pupil of Fallopius at Padua, of Eustachio at Rome, and of Aranzi at Bologna, and afterwards as a coadjutor of the indefatigable Aldrovandus, may be regarded as one of the anatomists of the Italian school. Born in 1534, after studying successively at Paris, Padua, Rome, and Bologna, he taught, in the latter city, the structure of the human body, and cultivated the study of animal anatomy with extreme assiduity, in concert with Ulysses Aldrovandus. From Bologna he proceeded to Montpellier, where he contracted an intimate friendship with Rondelet, and continued to cultivate his favourite pursuit of animal anatomy. After some time spent in this agreeable manner, he obeyed an invitation of the municipal government of Nurnberg, that he would undertake the office of public physician. Here, however, he did not long remain. Coiter was incapable of living an idle life, and his passion for incessant activity, with his desire of exploring the seats of disease by dissection, found a ready gratification in the office of military physician which the French armies then afforded. Coiter, however, lived not to realize his hopes; and he died in 1600, ere he had accomplished his schemes.

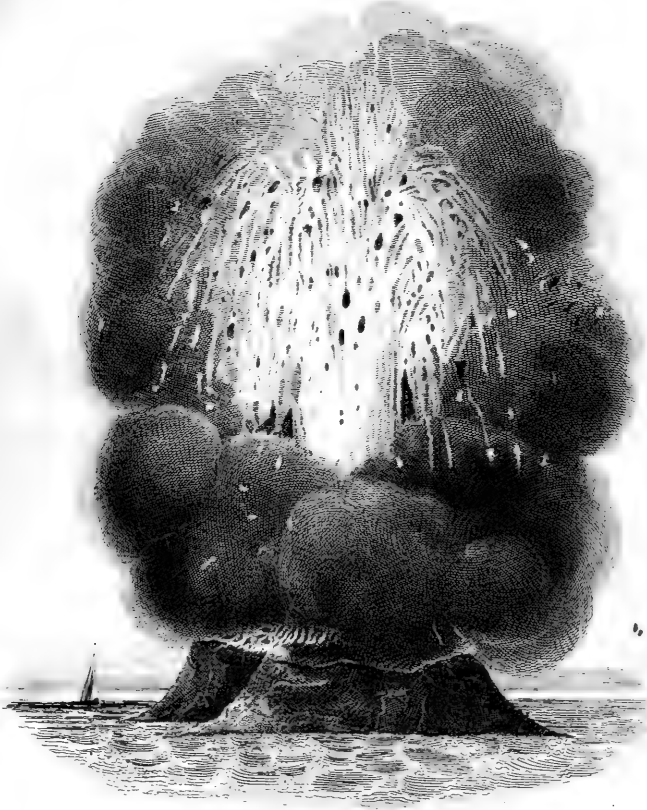
We are indebted to this anatomist for several valuable facts in animal anatomy and physiology. He was among the first who shewed the development of the chick in *ovo*, and distinguished the different parts of the fœtus as they come into view. He has traced also, with great accuracy, the growth of bone, the junction of the *epiphyses*, and the different stages of the process of ossification. He recognised the canal of the spinal chord, and shewed that the matter of which it consists, though white at the sides, is gray or cineritious in the centre, as well as its fibrous structure. He distinguished the nerves of the spinal chord into anterior and posterior rows. He discovered two muscles of the nose. He described the quadruple stomach of the ruminating animals, and the lungs of the oviparous quadrupeds, as the turtle, tortoise, and crocodile, were then named. He gives minute accounts of the anatomical structure of the tortoise, hedgehog, and bat; dissections of several birds, with an account of their tympanal cavity, and remarks that they have only one tympanal bone. He describes the tongue of the woodpecker, its stomach, crop, &c.; and, in investigating the anatomy of the serpent tribe, he is the first who describes the poison-vesicles or glands,—a discovery, the merit of which has been unjustly ascribed to Rhedi.

He had made numerous experiments on living animals to determine the motion of the heart; and he found himself justified in concluding that dilatation of the ventricles succeeds contraction of the auricles, and the converse; that the apex approaches the base during systole, and is removed during the diastole; and consequently that the heart is shortened during contraction. Two facts also, not unworthy of the attention of modern physiologists, he recognised in these experiments. The first, the well known fact, that the right ventricle continues to contract long after the death of the left; and the second, that the base of the organ continues to move long after all motion has ceased in the apex. By exposing the brain in animals, as he occasionally saw done by accidental injury in man, he recognised, with Columbus, the fact, that the pulsatory motion of that organ depends on the action of its arteries. He had also remarked in injuries of the head in the human body, that portions of brain might be removed without serious injury to the functions. In imitation of these effects, he removed successive portions of the brain in the lower animals, and shewed that so long as the origins of the nerves are unaffected, the great functions of the system are unimpaired, and therefore that life is, within certain limits, independent of the influence of the brain. "Quod summa admiratione dignum existit," says Coiter, in the genuine spirit of an enthusiastic votary of science, "brutorum viventium cerebra detexi, vulneravi, et intactis nervis eorundemque principiis, et ventriculis mediis illaesis, exemi; at nullum vel vocis, vel respirationis vel sensus, vel motus offensionis signum in iis deprehendi. Aves absque cerebro aliquandiu vivunt, ut quilibet in gallinis vel pullis gallinaceis, si rostrum superius cum dimidia capitis parte absciderit, cerebrique majorem exemerit partem, experiri potest." In these experiments and deductions, Coiter anticipates Haller, Zinn, Flourens, and Magendie; and, even by the conclusions which he has established, he throws nearly as much light on this obscure subject as has been done by all the researches of modern times.

His pathological observations equally demonstrate the acuteness and originality of his mind. Besides observing the palsy which follows severe and probably lead colic, he had remarked in persons who die of fever, with delirium, convulsive, or paralytic symptoms, not only that the cavities of the brain contained limpid watery fluid, and its substance a watery and bloody infiltration, but that the space between the membranes of the spinal cord round the origins of the nerves, was distended with the same limpid watery fluid. This may be regarded as the first authentic instance in which proof was adduced of changes in the cord, or its membranes, being the cause of convulsive or paralytic symptoms. Coiter further distinguishes dropsical infiltration of the pulmonic tissue from effusion into the pleura, or ordinary dropsy of the chest, and traces several instances of dropsy to induration, or as he terms it, scirrhus of the viscera.

Coiter is the first who gives figures of the skeletons of several quadrupeds, birds, and reptiles. On the whole, he appears to have been a person of great enterprise, indefatigable application, and very considerable originality. All his observations bear the impress of an observing, original, and inventive mind.

(To be continued.)



HOTHAM ISLAND.

37° 7′ 30″ N Lat 12° 41 E Long

Drawn by Dʳ. Greville from a sketch by one of the officers of the Philomel

On the new Insular Volcano, named Hotham Island, which has just appeared off Sicily; with a View of the Volcano, by one of the Officers of the Philomel *. Plate VI.

Although Europe at an early period was much convulsed and changed through volcanic agency, at present these subterranean actions are comparatively feeble. When therefore any igneous matter is sent from below, its appearance does not fail to excite a great degree of interest. Ætna, Vesuvius, and Hecla, during our own times, have had repeated eruptions; but no new island has been formed in the European seas, nor in any neighbouring ocean, with exception of that off the coast of St Michael's, when the temporary island of Sabrina rose from the deep. It first showed itself above the sea on the 13th of June 1811, and continued to increase for several days, when it attained a circumference of one mile, and a height of 300 feet. It had a beautiful crater, with an opening 30 feet wide to the south-west, from which hot water poured into the sea. Captain Tillard, who visited the island on the 4th of July, has published a drawing, with an account of it. In the month of October of the same year, the island began gradually to disappear, and, by the end of February 1812, vapour only was occasionally seen rising from the spot where the island formerly stood.

On the 11th July last, an island very much resembling Sabrina, being composed of vesicular lava, scoriæ, and volcanic ashes, and which may have the same fate, made its appearance off the coast of the island of Sicily. Several accounts of this interesting phenomenon have reached us, which, although but imperfect, cannot fail to interest our readers.

The first notice of this new insular volcano was published in the following terms, in the *Messager des Chambres*:—" Towards 11 o'clock of the 10th of July 1831, Captain John Corrao, commander of the brig Thérésine, going from Trapani to Girgenti, in Sicily, at the distance of about twenty miles from Cape St Mark, perceived at the distance of a gun-shot a mass of water, which rose 60 feet above the level of the sea, and pre-

* The accompanying engraving (Pl. VI.) is from a drawing by Dr Greville, from the sketch by one of the officers of the Philomel.

sented a circumference of nearly 400 fathoms; a smoke proceeded from it, exhaling an odour of sulphur. The preceding day, in the Gulf of *Trois Fontaines* (Three Fountains) he had seen a great quantity of dead fish and of black matter floating on the water, and he heard a noise like that of thunder, which the captain attributed to a volcanic eruption. He continued his voyage to Girgenti; and all the time that he was occupied in lading his ship, he saw a thick smoke rise incessantly from the same point, before which he arrived on the 16th, on his return from Girgenti. A new spectacle was then presented to him, namely, a tract of land, of the same circumference as that of the mass of water which he had observed on his first voyage. This island, which we shall call Corrao, from the name of him who saw it formed, is elevated twelve feet above the level of the sea; it has in the middle a kind of plain, and the crater of a volcano, whence a burning lava is seen to proceed during the night. The island is bordered by a girdle of smoke. The sounding all around the island gives a depth of 100 fathoms. The Lat. is 37° 6′ N., and Long. 10° 26′ E. from the meridian of Paris."

In a letter from Dr Turnbull Christie to us, dated Malta, 23d July 1831, we have the following additional particulars:—

"I have much pleasure in communicating to you the highly interesting intelligence of a new volcano having made its appearance only a few days ago, in the Mediterranean, and at no great distance from this place. It is situated about half way between the small island of Pantellaria and the adjoining coast of Sicily. It has been preceded by several violent shocks of earthquakes, one of which threw down some houses, and killed several people at Sciacca. From the accounts which have been already received, it would appear that the volcano commenced on the 11th instant, when it was seen by the master of a small vessel sailing towards Terra Nova, who describes it as having had "the appearance of a large rugged island, coming up and falling with force back into the sea, so that the sea flew up to a great height, and fell down in the form of foam." This was seen to be repeated, at short intervals, for nearly two hours. The masters of two small vessels, one from Sardinia, and the other from Palermo, saw it on the 13th, and gave the following account of it: 'On the 13th instant, about two o'clock P. M., being between Sciacca and Pantellaria, twenty-five miles to the southward of Sciacca, we discovered three columns of smoke, apparently issuing from the sea, which cannot but be considered as a new volcano. On approaching it we heard a great noise, like the rolling of the wheels of a steam-vessel. In consequence of the continuance of calm weather, we remained in that vicinity for three days, during which we constantly observed the same appearance, and heard the same noise; and we only lost sight of it when about fifteen miles to the north-east of Gozo.' Vice-Admiral Sir Henry Hotham immediately sent off the tender of the flag-ship, commanded by one of the lieutenants, and afterwards sent the Philomel, commanded by Captain Smith, to examine and ascertain the exact position of the new volcano. Several other vessels, with a number of passengers, are preparing for an excursion to it. You may easily conceive how exceedingly disappointed I am at not being able to visit it, being obliged to set sail to-morrow for Alexandria."

"*P. S.*—Since closing my letter, I have received the annexed sketch of the volcano (Pl. VI), brought by the Philomel, which has just returned. It has been named *Hotham Island*, in honour of Vice-Admiral Sir Henry Hotham. It is completely circular, with an opening in the one side, which admits the sea, and which is indicated in the drawing. The highest point of the island was found to be eighty feet above the level of the sea, and the circumference three-quarters of a mile."

"*Report of Commander C. H. Swinburne, of his Majesty's Ship Rapid, to Vice-Admiral the Honourable Sir Henry Hotham K. C. B.*

His Majesty's Sloop Rapid, at Malta,
July 22. 1831.

"Sir,

"I have the honour to inform you that, on the 18th of July 1831, at 4. P. M., the town of Marsala bearing by compass E. half N. nine miles, I observed from on board his Majesty's sloop Rapid, under my command, a highly irregular column of very white smoke or steam, bearing S. by E. I steered for it, and continued to do so till 8^h 15^m P. M., when having gone about thirty miles by the reckoning, I saw flashes of brilliant light mingled with the smoke, which was still distinctly visible by the light of the moon.

"In a few minutes the whole column became black and larger; almost immediately afterwards several successive eruptions of lurid fire rose up amidst the smoke; they subsided, and the column then became gradually white again. As we seemed to near it fast, I shortened sail and hove-to till daylight, that I might ascertain its nature and exact position. During the night the changes from *white* to *black* with flashes, and the eruption of fire, continued at irregular intervals, varying from half an hour to an hour. At daylight I again steered towards it, and about 5 A. M., when the smoke had for a moment cleared away at the base, I saw a small hillock of a dark colour a few feet above the sea. This was soon hidden again, and was only visible through the smoke at the intervals between the more violent eruptions.

"The volcano was in a constant state of activity, and appeared to be discharging dust and stones, with vast volumes of steam. At 7^h 30^m the rushing noise of the eruptions was heard. At 9, being distant from it about two miles, and the water being much discoloured with dark objects at the surface in various places, I hove to, and went in a boat to sound round and examine it. I rowed towards it, keeping on the weather-side, and sounding, but got no bottom till within 20 yards of the western side, where I had 18 fathoms *soft bottom*; this was the only sounding obtained, except from the brig, one mile true north from the centre of the island, where the depth was 130 fathoms *soft dark brown mud.* The crater (for it was now evident that such was its form) seemed to be composed of fine cinders and mud of a *dark brown colour*; within it was to be seen, in the intervals between the eruptions, a mixture of muddy water, steam, and cinders dashing up and down, and occasionally running into the sea, over the edge of the crater, which I found, on rowing round, to be broken down to the level of the sea, on the W.S.W. side, for the space of 10 or 12 yards. Here I obtained a better view of the interior, which appeared to be filled with muddy water, violently agitated, from which showers of hot stones or cinders were constantly shooting up a few yards, and falling into it again; but the great quantity of steam that constantly rose from it, prevented my seeing the whole crater.

"A considerable stream of muddy water flowed outward through the opening, and mingling with that of the sea, caused the discoloration that had been observed before. I could not approach near enough to observe its temperature, but that of the sea, within 10 or 12 yards of it, was only one degree higher than the average; and to leeward of the island, in the direction of the current (which ran to the eastward), no difference could be perceived, even where the water was most discoloured; however, as a 'mirage' played above it near its source, it was probably hot there. The dark objects on the surface of the sea proved to be patches of small floating cinders. The island or crater appeared to be 70 or 80 yards in its external diameter, and the lip as thin as it could be consistent with its height, which might be 20 feet above the sea in the highest, and 6 feet in the lowest part, leaving the rest for the diameter of the area within. These details could only be observed in the intervals between the great eruptions, some of which I witnessed from the boat. No words can describe their sublime grandeur. Their progress was generally as follows:—After the volcano had emitted for some time its usual quantities of white steam, suddenly the whole aperture was filled with an enormous mass of hot cinders and dust, rushing upwards to the height of some hundred feet with a loud roaring noise, then falling into the sea on all sides with a still louder noise, arising in part, perhaps, from the formation of prodigious quantities of steam which instantly took place. The steam was at first of a brown colour, having embodied a great deal of dust; as it rose it gradually recovered its pure white colour, depositing the dust in the shape of a shower of muddy rain. While this was being accomplished, renewed eruptions of hot cinders and dust were quickly succeeding each other, while forked lightning, accompanied by rattling thunder, darted about in all directions within the column, now darkened with dust and greatly increased in volume, and distorted by sudden gusts and whirlwinds. The latter were most frequent on the lee side, where they often made imperfect water-spouts of curious shapes. On one occasion some of the steam reached the boat; it smelt a little of sulphur, and the mud it left became a gritty sparkling dark brown powder when dry. None of the stones or cinders thrown out appeared more than half a foot in diameter, and most of them much smaller.

"From the time when the volcano was first seen till after I left it, the barometer did not fall or rise; the sympiesometer underwent frequent but not important changes; and the temperature of the sea did not bespeak any unusual influence.

"After sunset, on the 18th, soundings were tried for every hour, to the average depth of 80 fathoms; no bottom. The wind was NW., the weather was serene.

"On the forenoon of the 19th, with the centre of the volcano bearing by the compass S. by W. ½ W. one mile distant, good sights, for the chronometer gave longitude 12° 41′ E.; and at noon on the same day, when it bore W. by N. ½ N. by compass, the meridian altitude of the sun gave the latitude 37° 7′ 30″ N.; an amplitude of the sun the same morning gave the variation of 1½ point westerly. *It is worthy of remark, that on the 28th of June last, at* 9^{h} 30^{m} P. M. *when passing near the same spot in company with the Britannia, several shocks of an earthquake were felt in both ships.* I have the honour to be, &c.

"C. H. Swinburne, *Commander.*"

In a letter to Professor Daubeny of Oxford, from Captain Ballingal of the Royal Marines, dated "H. M. S. St Vincent, Malta, 27th July 1823," which the Professor had the goodness to send to us, is the following account of the volcano:

"The situation of the volcano is = Lat. 37° 10′ N., Long. 12° 44′ E.; the crater of which above water is about 70 or 80 yards in external diameter, and about 20 feet in height from the surface of the sea, lying between the Island of Pantalleria and Cape Granitula, on the south-west coast of Sicily. The eruption is in a state of great activity. Large columns of fire, dust, and dense smoke, are constantly emitted, accompanied every hour and a half with an eruption of great velocity, throwing masses of stone of several tons weight, with cinders and jets of mud and water, to a height equal to the mast-head of a first rate man-of-war. Prospero Schiffino, the master of the Santa Arona, a coasting vessel from Sardinia, arrived here, and reported to our Admiral that three days before, while off Cape Bianco, in Sicily, he discovered the extraordinary phenomena of *three* distinct columns of smoke issuing from the sea, accompanied by a submarine noise, which he compared to that made by the "wheels of a vast steam-vessel." In the evening of the same day, a second report was brought by a vessel from London. No appearance of lava was to be seen. The Admiral instantly directed two officers to proceed and verify the report. On the night of Wednesday the 20th instant, while proceeding on their voyage, they first discovered it at 25 or 30 miles distant, shooting upwards rays and flashes to a great height. The next day, observing that the intervals between the eruptions occupied almost a *correct uniformity of time*, viz. from an hour and a half to an hour and a quarter, afforded them the chance to approach at one time within 60 yards of the crater, where they *sounded*, and *found* the *side* of the *cone* in 33 FATHOMS, the armory of the lead bringing up a small piece of black stone, being the only substance, we got during three days' constant perseverance, whose specific gravity was greater than water, which I am sorry it is not in my power to transmit; but I have secured some cinders and ashes, which I shall have the pleasure to send home in the Melville, which will leave this shortly for England. Since writing the above, I have just learned that Lord William Thynne, on the morning of the 19th, on his return from Gibraltar to this place, was enabled to approach within 20, and to sound in 18 fathoms. At this time the island was just above the surface, and on the 21st my friend found it 20 feet in height; and I have now learned that the day before yesterday, viz. the 25th instant, it had acquired the height of 40 or 45 feet. Any further information you may wish to acquire I shall be able to collect, as I shall in a day or so visit the scene."

The following report by the officers of the Philomel, has been published at Malta, by Admiral Hotham:—" The Philomel brig of war, which left Malta Harbour on Tuesday afternoon, the 19th of July, with the masters of the St Vincent and Ganges, to ascertain the correct particulars, &c. of the new volcano island forming off Sciacca, in Sicily, discovered the object at 1 A. M. on Thursday the 21st. At 3, spoke an Austrian ship, from

Algiers, bound to Alexandria, the master of which reported, that he had seen dense smoke and much fire issuing for the last three days. At 6, observed a thick smoke issuing apparently from the sea, the spot bearing north-west $\frac{3}{4}$ west; and, on steering in that direction, fell in with the Hind cutter at 9, which vessel had left Malta on Sunday the 17th, but had not yet reached the new volcano, owing to calms. The island then bore north-west by west, six or eight miles distant. At 9^{h} 45^{m} the Philomel hove to three miles to windward. Captain Smith, with the two masters, and Colonel Bathurst, a passenger, left the vessel in boats for the purpose of taking soundings as near as they could approach with safety, but had scarcely got one mile away, when the volcano burst out with a tremendous explosion, resembling the noise of a very heavy thunder-storm, and flames of fire, like flashes of lightning. The boats were covered with black cinders, which also fell on board the vessel, and all around, to a distance of at least three miles from the volcano. The eruption lasted in all its fury seven minutes, and when the smoke had somewhat cleared away, the island had increased in size twofold.

" The volcano bursts out regularly at about every two hours, and emits all around it a suffocating sulphureous stench. On first making it at a long distance, it resembles a cluster or grove of cypress trees. The English brig Bootle of Liverpool, an American, and one or two foreign vessels, were off the place.

" Its precise latitude is 37° 7′ 30″ north, and longitude 12° 44′ east; the soundings in the vicinity, say eighty yards off the island, bearing north-east, are seventy to seventy-five fathoms; west, a quarter of a mile, seventy-two to seventy-six fathoms. At five and six miles distance they vary from seventy to eighty fathoms. The volcano appears composed mostly of cinders of a rusty-black colour, having only a sprinkling of lava, of an oblong shape; and the island, as last seen on Friday the 23d, was not less than three quarters of a mile in circumference. The north-west point is the highest, say about eighty feet above the level of the sea, and gets lower towards the southern extremity. The south-east side of the crater has fallen in to the side of the sea. The sea is drawn in with a very loud noise, and occasions an immense volume of white vapour to rise up in the air, curling and spreading high and wide; then succeeds rapidly the eruption of cinders and lava, thrown to the height of from 400 to 500 feet, and on some occasions to 1000 feet, forking and branching out in all directions in its ascent, and afterwards falling and pouring down in stupendous masses, with such violence as to cause a noise like heavy thunder, and making the sea, for a considerable distance around, one entire sheet of foam—altogether a sight not to be imagined."

Malta, August 4.—Our reports respecting the volcano, since the foregoing, are very unsatisfactory. There can be little doubt, however, that the island continues to increase in size. A boat, with five or six officers, returned yesterday afternoon, and they assert that the island is at least three miles in circumference, and from 200 to 300 feet high. They landed upon it, and, for ostentation's sake I suppose, hoisted the Union flag. The other stories, as to the increasing dimensions of the place, are too vague to speak on.

We learn from the coast of Sicily, that the town of Sciacca has been entirely abandoned by its inhabitants, the reported shocks, and trembling of the earth, leading to a belief that it will sink into the sea.

Notice of Plants observed in an Excursion made by Dr Graham with part of his Botanical Pupils, accompanied by a few Friends, in August last.

The greater number of the party went to Forfar, and from thence through the valley of Clova. One division then crossed the Capel Munth, and went by Glen Meik and Abergeldie to Castleton of Braemar; another followed the White Water to its source, and crossing the ridge to Glen Callader, proceeded down that valley to Castleton. A few gentlemen went by the steam-boat to Aberdeen, and thence up the Dee to Braemar. From this, as our head-quarters, we walked in various divisions to Glen Callader, Ben-na-buird, Lochnagar, and the hills around the head of Glen Shee. Some went through Glen Tilt to Blair, others returned by Clova to Edinburgh, having been absent from the 29th July to 10th August. The weather was clear, calm, and intensely hot, with occasionally very heavy thunder showers. The following is a list of the more important plants observed; the whole route abounds in the ordinary alpine vegetation of the Scottish mountains.

Ajuga alpina.—Stream falling into White Water, Clova, above the Falls. Dr Hooker states, on the authority of Mr D. Don, that this is not uncommon in Aberdeenshire, but he himself never saw a British specimen, and this is the first time I ever gathered it. I found only two specimens.

Alopecurus alpinus.—This very rare grass was first observed by Mr Hewett Watson on the sides of a stream leading from the South into the White Water, above the Falls. On following up the stream, we observed it in great plenty, and it was afterwards found scattered along the course of the White Water nearly to its source, and on various streams falling over the ridge above Glen Callader. I had never before seen it excepting at Loch Whorol, the station alluded to by Dr Hooker in his British Flora.

Apargia Taraxaci.—White Water, Clova. We found also on the White Water the form considered on the Continent as *A. alpina*, which I had never observed except in Sutherlandshire, and a remarkable variety in which the hairs of the involucrum were yellow.

Azalea procumbens.—This is a very common plant on Scottish mountains; but Mr Macnab found on the top of the mountain forming the south boundary of the valley of Clova, the larger variety with more loose habit, which is in cultivation from America.

Carex atrata.—Sparingly on a cliff south side of Glen of Dole, Clova.

Carex rariflora.—In the old station in Clova. Mr Watson and Dr Macfarlane also found it on high ground about two miles to the south-west of this.

Carex Vahlii.—This was found in much larger quantity than last year, but only on the same station, from top to bottom of a high cliff, but extending only a few feet laterally, at the top of Glen Callader.

Eleocharis multicaulis.—Gathered by Dr Greville in abundance in a bog behind the Invercauld Arms, Castleton.

Epilobium alsinifolium.—This, though less common than *E. alpinum*, is still by no means rare in the alpine districts of Scotland. Perfectly distinct as the extremes of this and *Epilobium alpinum* are, I picked specimens in several parts of our route which I find it difficult to distinguish from either.

Erigeron alpinum.—In considerable quantity on cliffs south side of Glen of Dole, Clova.

Galium pusillum.—Stony bank, south side of Glen of Dole, Clova.

Juncus castaneus.—In considerable quantity, especially along the upper part of the White Water, and in the streams leading over the edge of the cliffs in Glen Callader.

Juncus triglumis.—This is a very frequent plant in alpine districts. Besides the equal elevation of its flowers, it is generally at first sight distinguished from *J. biglumis* by these overtopping the bracteæ; but I found near the source of the White Water several specimens in which the bractea is as long as in *J. biglumis*. The same variety I have from Feroe, through the kindness of Mr Trevelyan.

Linnæa borealis.—Gathered in flower by Mr Brand and Mr Barry at the very edge of the precipice overhanging the south side of the White Water, growing among short *Vaccinia*.

Malaxis paludosa.—A single specimen was picked by Dr Greville on the side of the hill above the village of Kirkton, Clova.

Phaca astragalina.—The addition of this genus to the British Flora, formed the principal event in the botanical excursion of this season. It was discovered on the same day (30th July) on a cliff near the head of the Glen of the Dole, Clova, by Mr Brand, Dr Greville, and myself. The station is circumscribed, but, on recollection, after the plant was ascertained, it was believed by Mr Watson and Dr Greville that they subsequently saw it in the station of *Oxytropus campestris,* though only in leaf.

Phleum alpinum.—This grass we found to be common on Ben-na-Buird, Lochnagar, cliffs and banks of Glen Callader, but no where so abundant as on the White Water above the Falls, and, above all, profuse on the sides of the stream already mentioned, leading into this from the south. Here we found it to grow in the wet ground at the edges of the swamps immediately without the *Eriophora,* and immediately without this, on rather drier ground, and among less coarse herbage, was the *Alopecurus alpinus.*

Polytrichum septentrionale.—We went to the same spot on Ben-na-Buird where I had found this so abundantly in fruit last year, and there we found a profusion of the plant; but the warm season, so different from the cold wet weather of last year, had removed the snow, and only two capsules were to be found, picked by Mr Christy.

Salix lanata,—we found to be very abundant on the south side of the Glen of the Dole, and in Glen Callader.

Trifolium pratense.—A variety with a large pale rose-coloured flower is common at the road side towards Glenshee.

Veronica alpina,—is a very common plant on the south side of the Glen of the Dole; in Glen Callader; on Ben-na-Buird; and on Lochnagar.

Veronica saxatilis.—Abundant, especially on the cliff with the *Phaca,* and on others in the south side of the Glen of the Dole.

Woodsia hyperborea.—Mr Brand gathered this in small quantity above the station of *Oxytropis campestris.*

We looked—but looked in vain—for the *Saxifraga cæspitosa,* in the station on Ben-na-buird, where Mr Macnab found it last year. The plant picked at that time is now perfectly established in the Botanic Garden.

The unwearied zeal of Mr Barry has carried him, accompanied by Mr James Macnab, back again to the country, from whence he had just returned with the party. They have found abundance of *Phaca astragalina,* in the station on which it was first observed, and *Juncus castaneus* in the course of the White Water, above the Falls, in such abundance that 250 specimens were gathered on one little spot. Opposite to Kirkton, Clova, and a little higher up the Esk, they have also found *Malaxis paludosa* in considerable abundance, and in excellent condition; *Woodsia hyperborea* and *Carex rariflora* sparingly, in the stations already mentioned.

The above had scarcely gone to press, when Mr Barry did me the favour to call at my house, having just returned from his second visit to the mountains. Mr James Macnab had been obliged to come home earlier. He has brought *Saxifraga* *cæspitosa,* having gathered it on Ben-Avon, and requests me to say, that the first specimen was picked by John Mackenzie, gardener at Invercauld, who accompanied him as guide. The plant grew on the west side of Slock More, chiefly among moss, on disjointed portions of rock, in a sheltered spot, about half-way up the cliff. Mr Barry likewise found *Alopecurus alpinus* in endless profusion, by a stream, which, from his description, I think must lead from the hill to the south-west of the White Water into Glen Prosen.

R. G.

Description of several New or Rare Plants which have lately flowered in the neighbourhood of Edinburgh, and chiefly in the Royal Botanic Garden. By Dr Graham, Professor of Botany in the University of Edinburgh.

10*th Sept.* 1831.

Alstrœmeria Neillii.

A. *Neillii;* caule erecto, flaccido folioso; foliis spathulatis, obtusis, glauco-pruinosis, apice lateribusque reflexis, integerrimis; petalis tribus, exterioribus obovatis emarginatis æqualibus crenatis, interioribus paulo longioribus spathulatis subintegerrimis; pedunculis umbellatis, bifloris.

Alstrœmeria Neillii, *Gillies* MS.

Description.—*Stem* simple, many from the same root, erect, flaccid, round, very leafy, subglauco-pruinose, especially towards the top, more green below. *Leaves* spathulate, reflected at the apex and sides, undulato-pruinose, succulent, green, quite villous at the margin and particularly at the apex, about 7-nerved, central rib hardly prominent behind, except in the lower narrower half. *Peduncles* (3 or 4) forming a terminal umbel, 2-flowered, dull purple, little longer than the leaves, which are gathered in form of an involucre round their base. *Perianth* segments unequal, greatly attenuated, succulent, involute and ciliated at the base, each with three primary nerves prominent behind, and 2 or 4 secondary nerves, scarcely reticulated; three outer segments equal, of nearly uniform pale rose colour, rather darker in the middle of the outside, obovate, crenate, with a central green concave callous point; three inner segments rather longer than the outer, spathulate, with a green callous apex, and oblong deep rose-coloured spots in the upper half; the lowest is rather the shortest of the three, nearly flat, and arched backwards; the two others project in the centre of the flower, nectariferous at the base, straight, except near the apex, where they are bent backwards, and immediately below this point they are marked by a broad yellow transverse band. *Stamens* laid along the lower petal till the pollen is ripe, when they become straight, nearly parallel to and almost of equal length with the two central petals; filaments rose-coloured, slightly tapering, pubescent at the base; anthers greenish rose-coloured, flattened, and, as in the other species, when the loculaments burst, becoming flattened in the opposite direction; pollen reddish, granules very small and oblong. *Stigma* trifid, rose-coloured as well as the prismatic *style*, which is only green at its persisting base. *Germen* purple, obovato-turbinate, covered with minute shining tubercles, ribs strong and prominent, 3-locular. *Ovules* numerous, attached in two rows within each loculament to the central receptacle.

This extremely handsome plant flowered for the first time in Mr Neill's greenhouse at Canonmills, Edinburgh, in June 1831 *. Mr Neill is uncertain from whom he received the seed; but as seeds of *Alstrœmeria pallida* were sent in the same packet, and as we have this, at the Botanic Garden, collected by Dr Gillies at Los Ojos de Agua, it is probable that *A. Neillii* was from him also. Dr Gillies believes he did send it, and is of opinion that this is the species which at Mendoza is called *Pelegrina*, and of which he has various specimens in his herbarium. It is possible that these are identical, though in the native specimens the segments of the perianth are perfectly entire, the inner lanceolate, not spathulate, the outer acute, not emarginate, and the peduncles single-flowered. Dr Gillies found it on both sides of the Cordillera of the Andes, between Chile and Mendoza. I alluded to it in the description of *A. pallida* in the Edin. New Phil. Journal for September 1829, and conjectured that when it flowered it might prove to be a variety of *A. pallida*. The inflorescence, habit, and colouring give support to this conjecture; and increasing acquaintance with South American genera throws increasing scepticism into all inquiries as to the natural boundaries of species; but, till the period arrive when a revision of the whole genus *Alstrœmeria* shall warrant our greatly reducing the species, the characters noted above will be considered as giving this form a better title to a specific name than several others which are now held to be specifically distinct.

I lately (Ed. New Philosoph. Journ. May 1831) mentioned the confusion into which the species, or supposed species, of *Calceolaria*, were falling, by the multiplication of mules in cultivation. Another South American genus has run wild from another cause. *Salpiglossis* seems to require no admixture of pollen to produce great variety of form. It sports, to use the language of florists, into many shapes and colours, from mere instability of character. I now entertain no doubt that we have but one species in cultivation. I have now (June 1831) flowering in the Botanic Garden many seedling plants from *S. atro-purpurea*, which are precisely *S. straminea*, though the size of the flower varies in the different specimens. I have also seedling plants of *S. picta*, in some of which the corolla, though perfect, is not above a quarter of an inch long, and pure white; in others, the corolla never appears at all, yet, both last year and this, specimens of this description have produced abundance of seed. I hope these blunders are excusable on the first introduction of a little known genus into cultivation, as I myself contributed to the confusion; but the persevering in them would be without apology. I learn from my accurate friend Mr Cruckshanks, that the forms in *Salpiglossis* vary greatly in their wild state.

Gardoquia Gilliesii.

G. *Gilliesii;* foliis lineari-spathulatis, integerrimis, utrinque glabris; pedunculis subtrifloris.

Description.—*Stem* fruticose (about 2 feet high) much branched, branches spreading, 4-sided, scabrous. *Leaves* opposite, linear-spathulate, concave, entire, glabrous, dotted, shining and dark on the upper surface, paler below, avenous, middle rib distinct. *Peduncles* axillary, generally 3-flowered, leafy, pedicels shorter than the peduncles, and like them slightly villous. *Calyx* cylindrical, slightly curved, 13-ribbed, bilabiate, $\frac{3}{2}$-toothed, glabrous, naked within. *Corolla* lilac, twice the

* This very interesting establishment has recently sustained a great loss in the removal of the gardener, Alexander Scott, whose professional talent and patient industry has been transferred to a situation of more extensive usefulness. He has been appointed foreman to Mr Knight's Exotic Nursery, Chelsea, a situation for which he is especially fitted by his quiet unassuming manner, and uniformly steady conduct.

length of the calyx, throat slightly ventricose, bearded within, sprinkled with numerous minute darker-coloured spots, lower lip of three nearly equal entire lobes, those at the side reflexed; the upper lip nearly straight, slightly emarginate, edges folded back. *Stamens* dark lilac, scarcely projecting beyond the upper lip; filaments straight, distant, but not spreading, glabrous, compressed; anther-lobes diverging, naked. *Stigma* bipartite, segments acute, the upper rather the shorter. *Style* filiform and glabrous, rather longer than the stamens. *Germen* 4-lobed, erect, on a small disk.

This species was raised by Mr Neill from seeds communicated from Chile by the gentleman to whom I have dedicated it, and by whom, in conjunction with Mr Cruckshanks, so new an appearance has within these few years been given to our greenhouses.

Nierembergia linariæfolia.

N. *linariæfolia;* foliis spathulato-linearibus cauleque glanduloso-pubescentibus; caule herbaceo, erecto, ramoso.

Description.—*Root* fibrous, annual? *Stem* herbaceous, erect, slender, much branched, glanduloso-pubescent. *Leaves* very numerous, scattered, spreading, flat, slightly channelled, spathulato-linear, the upper smaller, and lanceolato-linear, middle rib prominent behind, scarcely veined, glanduloso-pubescent. *Flowers* solitary, opposite to the leaves, peduncled. *Peduncle* erect, nearly as long as the leaf, glanduloso-pubescent. *Calyx* 5-cleft, tube 10-ribbed, the alternate ribs going to the apex of the segments, or parted to go along the edges of the contiguous segments; segments lanceolate, concave, spreading. *Corolla* hypocrateriform, glanduloso-pubescent on the outside, glabrous within; tube (8 lines long) very slender, purplish; limb slightly concave, of five unequal, irregular, broad, short, overlapping, somewhat cordate segments, white, lilac plicate and 3-ribbed in the middle; throat yellow. *Stamens* 5, arising from the throat of the corolla, erect, included, unconnected, but contiguous and closing the throat, unequal, 3 short, 2 long, one of the short ones being placed between these last, and reflected; filaments slightly pubescent on the outside; anthers yellow, bilocular, bursting along their edges; pollen paler, granules spherical. *Pistil* single; germen ovate, seated in a thin cup-shaped white disk with ragged edges, purple, glabrous, 4-sided, with four prominent furrowed ridges, 4-valved, bilocular, septum in the very young state double, placenta large, central, at length free; style slender, dilated flattened and kidney-shaped at the apex, along which the broad green shining linear stigmatic surface is marginal. *Ovules* numerous.

A native of Chile, raised in Mr Neill's garden at Canonmills, from seeds sent by Mr Tweedie of Buenos Ayres.

Lobelia robusta.

L. *robusta;* caule suffruticoso; foliis obovato-lanceolatis, acuminatis, grosse dentatis, glabris, nitidis; racemis terminalibus, simplicibus.

Description.—*Root* perennial. *Stem* very stout, erect, half woody, branched, green and glabrous, irregularly winged with the persistent decurrent occasionally wavy bases of the leaves. *Leaves* numerous, scattered, crowded towards the apex, falling off below, obovato-lanceolate, acuminate, attenuated at the base, and decurrent for a little way along the stem, glabrous, pale green and shining, waved, coarsely and sharply toothed, veined, middle rib and veins prominent behind, and, especially when young, lilac-coloured. *Raceme* terminal, gradually elongating, supported on a naked, slightly villous stalk. *Flowers* large, very numerous, secund, crowded. *Pedicels* (1 inch long) compressed, finely villous, each with one bractea at the base, and two nearly opposite below the middle. *Bracteæ* linear, acute, villous, entire or sparingly toothed, the lowest nearly as long as the peduncle, and decurrent, the others shorter. *Calyx* 5-parted, green, villous, persistent, segments deltoideo-linear, acuminate, serrated, at length reflected at the apex. *Corolla* deep and dull purple, before the separation of the segments falcate, segments linear, acute, the two upper becoming reflected laterally, the others scarcely altering their form. *Filaments* pink, straight, flattened, ciliated, ciliæ colourless. *Anthers* leaden-coloured, cernuous, the two upper ciliated for half their length. *Stigma* bilobular, pubescent, scarcely ciliated, pink. *Style* (1 inch long) filiform, glabrous, slightly coloured. *Germen* inferior, ovules numerous.

A native of Hayti. A plant was received at the Botanic Garden, from our excellent friend Dr Fischer of St Petersburgh, in 1830. It flowered in August 1831.

Torenia? fimbriata.

T. *fimbriata;* caule erecto, subglabro; foliis ovato-lanceolatis, medio serratis, glabriusculis; calyce quinque-partito.

Torenia fimbriata, *Hooker* MS.

Description.—*Root* slender, tapering, having many branching lateral fibres, annual? *Stem* erect, with very short, harsh, slightly reflected pubescence at its base, perfectly glabrous above, channelled on two sides, alternating at the joints. *Leaves* ovato-lanceolate, acutely serrated, entire at the apex and base, subciliated, veined, scabrous along the veins, behind soft, and subglabrous in front. *Inflorescence* a few-flowered terminal cyme; *peduncles* erect, ebracteate, stout. *Calyx* smooth, regular, 5-parted, persisting, segments acute, mucronulate, spreading in their upper half, closely imbricated below. *Corolla* (1 inch long, 1 inch across) lilac and white, striated, glanduloso-pubescent, ringent, its limb dilated, spreading, crenate, the upper lip two-lobed, the lower three-lobed, the central lobe being the largest, and emarginate; tube campanulate, dilated on its lower side, somewhat flattened above, contracted and having two pits without on each side towards its base, again dilated as it covers the germen. *Stamens* didynamous; filaments hairy distant, near the base, adhering to the corolla nearly as far as the throat, there suddenly bent, the longer at right angles, the shorter at an obtuse angle; the longer filaments, each having a clavate tooth at this angle, pass horizontally round the throat of the corolla, and meet under the stigma; the shorter, having a much smaller tooth at the angle, pass obliquely upwards to the style, and meet below the others; anthers bilobular, divaricating, lilac, at first free, afterwards cohering in pairs, and bursting along the front. *Stigma* exserted, of two ovate, subacute, diverging plates, the lower rather the largest. *Style* glabrous, filiform, slightly flattened near the stigma, as well as the filaments and stigma colourless, marcescent. *Germen* green, conical, slightly furrowed in the sides. *Ovules* very numerous, attached to a large central receptacle. *Capsule* ovate, tumid, tipped by the persisting base of the style, bilocular, bivalvular, valves entire, dissepiment parallel to the valves. *Seeds* very numerous, ovate, dotted.

Seeds of this very pretty plant were sent from New Holland by Mr Fraser last year, and communicated to the Botanic Garden, Edinburgh, both directly from himself and by Sir T. Brisbane, in October and November. They were marked "*Ruellia*, sp. nov. from the banks of the river Brisbane, Morton Bay." It is after a comparison which Mr Brown kindly allowed me of his New Holland specimens, and chiefly on account of the depth of the calyx-segments, that I have added the mark of doubt regarding the genus.

Trichocladus crinitus.

Dahlia crinita, *Thunberg,* Dissert. Ed. Pers. 1. 108.—*Id.* Prodr. Fl. Capens. 1.—*Id.* Fl. Capens. 1. 35.

Trichocladus crinitus, *Pers.* Synop. 2. 598.—*Spreng.* Syst. Veget. 3. 899.

Description.—*Stem* woody, erect, branched; young shoots and petioles covered with dark brown tomentum. *Leaves* petiolate, opposite, lanceolato-elliptical, acuminate, peltate and rounded at the base, undulate, veined, coriaceous, slightly hairy above, densely so below, hairs slightly ferruginous, stellate. *Capitulum* spherical, terminal, solitary, nearly sessile. *Flowers* diœcious? sessile. *Calyx* 5-parted, segments ovate, acute, spreading, recurved at the points, hairy especially on the back, shining and nearly glabrous in front. *Petals* 5, pale yellowish-green, linear, spathulate, folded and twisted, recurved, glabrous, scarcely ciliated, fleshy, especially at the base. *Stamens* 5, opposite the segments of the calyx, and alternating with the petals; filaments very short, thick, and fleshy, glabrous; anthers pale red, and equal in length to the filaments, bilocular, cells opening longitudinally by two unequal valves, the larger of which spreads outwards, connective blunt and slightly projecting beyond the anther-cells. *Styles* 2, channelled, and ragged along their inner side, upper half glabrous, lower half (abortive germen?) hairy.

This curious plant, the structure of whose flowers appears to me to have been misunderstood *, we received from Kew, through the kindness of Mr Aiton. It is a native of the Cape of Good Hope, and flowered in the greenhouse in the Botanic Garden during the summer and autumn.

* On reading this statement, Mr Brown did me the favour to refer me to his observations in Abel's Voyage to China, p. 374. I was not before aware that he had noticed the plant, but there, with his uniform accuracy, he gives a just view of the parts, in the establishment of the natural order *Hamamelideæ*, in which he placed it.

Celestial Phenomena from October 1. 1831 *to January* 1. 1832, *calculated for the Meridian of Edinburgh, Mean Time.* By Mr George Innes, Astronomical Calculator, Aberdeen.

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

OCTOBER.

D.	H.	′	″	
2.	11	54	6	☌ ☽ α ♌
2.	23	2	1	☌ ☽ ρ ♌
3.	9	32	44	☌ ☽ ♄
3.	21	40	27	☌ ☽ σ ♌
4.	14	56	–	☌ ☽ ☿
5.	11	28	38	☌ ☽ ♂
5.	19	46	13	☌ ☽ ♀
5.	21	19	45	● New Moon.
6.	20	9	29	Em. I. sat. ♃
8.	12	26	–	Inf. ☌ ☉ ♀
9.	4	2	48	☌ ☽ γ ♎
9.	7	26	–	☌ ♀ ♂
9.	15	20	53	☌ ☽ ψ ♎
10.	7	33	37	☌ ☽ φ Oph.
12.	4	18	–	☿ greatest elong.
12.	9	51	54	☌ ☽ μ ♐
13.	15	37	58	☌ ☽ d ♐
13.	22	5	16	Em. I. sat. ♃
13.	23	33	10	☽ First Quarter.
14.	4	1	–	☿ near η ♍
15.	17	11	36	☌ ☽ ♅
15.	21	4	40	☌ ☽ ♃
16.	20	18	41	Im. IV. sat. ♃
17.	0	36	–	☌ ☿ ♀
18.	7	13	58	☌ ☽ φ ♒
18.	9	43	–	☌ ♂ ϑ ♍
18.	11	33	–	☌ ☿ 1 γ ♍
21.	1	44	1	☌ ☽ ν ♓
21.	8	14	8	○ Full Moon.
21.	21	44	22	☌ ☽ 2 ξ Ceti.
22.	4	44	36	☌ ☽ μ Ceti.
22.	18	30	4	Em. I. sat. ♃
22.	23	38	37	☌ ☽ f ♉
23.	8	44	–	☌ ☿ ϑ ♍
23.	19	13	0	☌ ☽ γ ♉
23.	19	26	14	Em. II. sat. ♃
23.	20	24	49	☌ ☽ 1 δ ♉
23.	20	51	33	☌ ☽ 2 δ ♉
24.	1	34	39	☌ ☽ α ♉
24.	3	35	15	☉ enters ♏
25.	21	40	45	☌ ☽ ν ♊
26.	11	27	30	☌ ☽ ζ ♊
26.	19	32	–	☌ ☿ ♂
27.	23	33	33	☾ Last Quarter.
28.	4	29	57	☌ ☽ δ ♋
29.	17	18	55	☌ ☽ α ♌
29.	20	25	53	Em. I. sat. ♃
30.	4	34	17	☌ ☽ ρ ♌
30.	20	20	41	☌ ☽ ♄
31.	3	32	18	☌ ☽ σ ♌

NOVEMBER.

D.	H.	′	″	
1.	13	0	8	☌ ☽ ♀
1.	19	27	56	☌ ☽ γ ♍
2.	19	15	18	Em. III. sat. ♃
3.	5	49	32	☌ ☽ ♂
3.	15	22	–	☌ ☿ λ ♍
3.	17	39	12	Im. III. sat. ♃
3.	21	11	19	Em. III. sat. ♃
3.	21	46	–	☌ ☽ ☿
4.	13	9	3	● New Moon.
5.	11	18	37	☌ ☽ γ ♎
6.	14	48	43	☌ ☽ φ Oph.
8.	16	43	–	☌ ☿ 2 α ♎
8.	17	3	17	☌ ☽ 2 μ ♐
9.	22	16	28	☌ ☽ d ♐
12.	1	40	35	☌ ☽ ♅
12.	2	50	25	☌ ☽ ϑ ♑
12.	8	37	4	☌ ☽ ♃
12.	18	17	6	☽ First Quarter.
13.	9	46	–	Sup. ☌ ☉ ☿
14.	16	40	–	☌ ♂ λ ♎
14.	18	46	24	Em. I. sat. ♃
16.	16	48	–	☌ ☿ κ ♎
17.	12	30	20	☌ ☽ ν ♓
18.	8	33	16	☌ ☽ 2 ξ Ceti.
18.	11	36	–	☌ ☿ λ ♎
18.	15	31	34	☌ ☽ μ Ceti.
19.	10	13	4	☌ ☽ f ♉
19.	12	37	–	☌ ☿ δ ♏
19.	18	30	7	○ Full Moon.
20.	5	22	28	☌ ☽ γ ♉
20.	6	29	33	☌ ☽ 1 δ ♉
20.	6	56	36	☌ ☽ 2 δ ♉
20.	11	34	27	☌ ☽ α ♉
21.	20	42	10	Em. I. sat. ♃
22.	6	11	41	☌ ☽ ν ♊
22.	17	44	–	☌ ♀ ϑ ♍
22.	19	29	27	☌ ☽ ζ ♊
23.	0	8	1	☉ enters ♐
24.	11	5	41	☌ ☽ δ ♋
24.	19	9	5	Em. II. sat. ♃
25.	23	0	26	☌ ☽ α ♌
26.	10	2	10	☾ Last Quarter.
26.	19	33	–	☌ ♂ 2 α ♎
27.	5	16	42	☌ ☽ ♄
27.	8	51	35	☌ ☽ σ ♌
30.	2	52	37	☌ ☽ ♀
30.	17	6	50	Em. I. sat. ♃

DECEMBER.

D.	H.	′	″	
1.	17	48	–	☌ ☿ ϑ Oph.
2.	2	23	32	☌ ☽ ♂
2.	9	52	–	☌ ☿ B Oph.
2.	17	36	15	☌ ☽ γ ♎
4.	7	25	16	● New Moon.
5.	9	33	17	☌ ☽ ☿
5.	22	44	1	☌ ☽ 1 μ ♐
5.	23	26	29	☌ ☽ 2 μ ♐
6.	7	48	–	☌ ♅ ϑ ♑
7.	1	26	41	☌ ☽ π ♐
7.	5	15	47	☌ ☽ d ♐
7.	19	2	27	Em. I. sat. ♃
9.	9	22	1	☌ ☽ ϑ ♑
9.	9	47	40	☌ ☽ ♅
9.	17	19	45	Em. III. sat. ♃
9.	22	42	41	☌ ☽ ♃
11.	11	35	–	☌ ☿ λ ♐
12.	11	2	55	☽ First Quarter.
14.	22	26	53	☌ ☽ ν ♓
14.	23	38	–	☌ ♂ κ ♎
15.	15	39	–	☌ ☿ σ ♐
15.	19	16	16	☌ ☽ 2 ξ Ceti.
16.	2	25	17	☌ ☽ μ Ceti.
16.	17	51	27	Im. III. sat. ♃
16.	21	29	16	☌ ☽ f ♉
17.	16	51	32	☌ ☽ γ ♉
17.	18	1	55	☌ ☽ 1 δ ♉
17.	18	29	5	☌ ☽ 2 δ ♉
17.	23	4	34	☌ ☽ α ♉
18.	23	52	–	☌ ♂ λ ♎
19.	1	56	–	☌ ☿ ψ ♐
19.	4	54	23	○ Full Moon.
19.	10	54	–	♀ greatest elong.
19.	17	12	53	☌ ☽ ν ♊
20.	6	10	36	☌ ☽ ζ ♊
21.	20	26	17	☌ ☽ δ ♋
22.	12	51	30	☉ enters ♑
23.	6	58	54	☌ ☽ α ♌
23.	17	22	18	Em. I. sat. ♃
24.	13	38	27	☌ ☽ ♄
24.	15	42	52	☌ ☽ σ ♌
25.	9	40	–	☿ greatest elong.
25.	23	56	5	☾ Last Quarter.
29.	18	55	44	☌ ☽ ♀
29.	23	28	4	☌ ☽ γ ♎
31.	1	45	42	☌ ☽ ♂
31.	3	15	4	☌ ☽ φ Oph.

Times of the Planets passing the Meridian, and their Declination.

OCTOBER.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′
1	11 17	0 16 S.	12 18	14 52 S.	11 43	1 20 S.	20 23	18 3 S.	10 8	9 34 N.	20 14	18 13 S.
5	10 56	1 27 N.	11 54	13 51	11 37	2 24	20 7	18 3	9 54	9 24	19 58	18 14
10	10 45	1 50	11 24	12 10	11 30	3 43	19 46	18 3	9 37	9 12	19 39	18 15
15	10 45	0 11	10 55	10 14	11 22	5 2	19 27	18 1	9 19	9 1	19 19	18 15
20	10 52	2 34 S.	10 29	8 20	11 14	6 20	19 8	17 59	9 1	8 50	18 58	18 15
25	11 1	5 54	10 7	6 43	11 7	7 37	18 49	17 54	8 44	8 39	18 39	18 15

NOVEMBER.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′
1	11 17	10 42 S.	9 41	5 8 S.	10 56	9 23 S.	18 24	17 40 S.	8 19	8 26 N.	18 12	15 14 S.
5	11 26	13 19	9 30	4 38	10 50	10 23	18 9	17 40	8 4	8 19	17 56	15 13
10	11 37	16 21	9 17	4 24	10 44	11 36	17 51	17 31	7 46	8 10	17 37	15 12
15	11 47	19 2	9 8	4 34	10 37	12 47	17 34	17 21	7 28	8 3	17 17	15 10
20	12 2	21 21	9 1	5 5	10 30	13 56	17 17	17 10	7 10	7 56	16 58	15 8
25	12 15	23 13	8 55	5 53	10 23	15 2	17 0	16 57	6 51	7 51	16 38	15 6

DECEMBER.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′
1	12 31	24 49 S.	8 50	7 8 S.	10 16	16 18 S.	16 39	16 41 S.	6 28	7 45 N.	16 16	18 3 S.
5	12 43	25 26	8 48	8 6	10 11	17 7	16 26	16 29	6 13	7 42	16 1	17 59
10	12 56	25 43	8 46	9 27	10 5	18 5	16 9	16 13	5 54	7 40	15 42	17 56
15	13 10	25 19	8 46	10 51	10 0	18 59	15 53	15 56	5 36	7 38	15 23	17 53
20	13 21	24 20	8 46	12 18	9 55	19 49	15 38	15 39	5 17	7 37	15 4	17 49
25	13 26	22 53	8 47	13 47	9 49	20 35	15 22	15 20	4 56	7 38	14 45	17 44

On the 24th of October, there will be an occultation of *Aldebaran* by the Moon:

	D.	H. ′
Immersion, ...	24.	0 45, at 75°
Emersion, ...	...	1 53, at 286

On the 25th of November, there will be an occultation of *Regulus* by the Moon:

	D.	H. ′
Immersion, ...	25.	... ... under the horizon.
Emersion, ...	...	22 29, at 210°

On the 27th of November, there will be an occultation of *Saturn* by the Moon:

	D.	H. ′
Immersion of *centre*, ...	27.	4 16, at 28°
Emersion, ...		5 26, at 248

On the 17th of December, there will be an occultation of *Aldebaran* by the Moon:

	D.	H. ′
Immersion, ...	17.	22 38, at 68°
Emersion, ...	...	23 35, at 330

On the 23d of December, there will be an occultation of *Regulus* by the Moon:

	D.	H. ′
Immersion, ...	23.	7 17 at 104°
Emersion, ...	...	8 18 at 282

The *angle* denotes the point of the Moon's limb where the phenomena will take place, reckoning from the *vertex* of the limb towards the right hand round the circumference, as seen with a telescope which inverts.

SCIENTIFIC INTELLIGENCE.

METEOROLOGY.

1. *On Change of Climate.*—The principal apprehension at present in Norway arises from the too rapid destruction of their forests, to the existence of which they attribute, with apparent reason, the superior mildness of their climate to countries under the same latitude. (*Life of Bishop Heber*, vol. i. p. 80). " The resemblance of the Tanais (Don) to the Nile has been remarked by many writers; but that these ample downs, whither its fertilizing waters cannot extend, have not since degenerated into a desert, like those of the Thebais, must be ascribed to the

difference of latitude, and the beneficial effects of a *four months' continued snow.* This rigour of climate is so greatly at variance with those interested reports which, in the hope of attracting settlers to her new dominion, were circulated by the Empress Catherine; and it differs so widely from that temperature, which might be supposed to exist in the latitude of forty-six, in the same parallel with Lyons and Geneva,—that, though the ancients observed and recorded it, the fact has been very slowly admitted by the generality of modern inquirers. Even among those who yield a respectful attention to the authority of poets and historians, many have been anxious to suppose, that the peculiarity they describe has long since ceased to exist; and they have deduced from this supposed difference between the ancient and modern climate of Scythia, a proof that, by the destruction of forests, the draining of marshes, and the triumphant progress of agriculture, the temperature not only of certain districts, but of the earth itself, has been improved *. But how far all or any of these changes may be able to produce effects so extensive, as it may reasonably admit of doubt, so it is in the present instance superfluous to inquire; since in Scythia these causes have never operated, and no apparent melioration of the climate has taken place. The country still continues, for the most part, in the wild state painted by Herodotus and Strabo; and all the countries bordering on the Euxine Sea are still subject to an annual severity of winter, of which (though in a far higher latitude) the inhabitants of our own country can hardly form an idea. That water freezes when poured on the ground; that the ground is muddy in winter only where a fire is kindled; that copper kettles are burst by the freezing of their contents; that asses, being animals impatient of cold, are found here neither in a wild nor tame state,—are circumstances no less characteristic of modern Scythia, than of Scythia as described by Herodotus and Strabo †. Nor do I question the authority of the latter, when he assures us, that the Bosphorus has been sometimes so firmly frozen, that there has been a beaten and miry high-way between Panticapæum and Phanagoria; or that one of the generals of Mithridates gained there, during the winter, a victory with his cavalry, where, the preceding summer, his fleet had been suc-

* Howard's Theory of the Earth.

† Herodo. Melpom 28.—Strabo, L. vii.

cessful. In the neighbourhood of the latter of these towns, by the Russians since called Tmutaracan, a Slavonic inscription has been discovered, which records the measurement of these straits over the ice, by command of the Russian prince Gleb, in the year 1068. But such events must, from the force of the current, have at all times been of rare occurrence. By the best information which I could procure on the spot, though the straits are regularly so far blocked up by ice as to prevent navigation, there is generally a free passage for the stream unfrozen. Across the harbour of Phanagoria, however, sledges are driven with safety; and, on the other side of the Crimea, a Russian officer assured me that he had driven over the estuary of the rivers Bog and Dnieper, from Otchakof to Kinburn. But not only straits and estuaries, but the whole Sea of Asoph is annually frozen in November [!] and is seldom navigable earlier than April. This sea is fished during winter, through holes cut with mattocks in the ice, with large nets, which are thrust by poles from one to the other; a method which has given rise to Strabo's exaggerated picture, of "fish as large as dolphins (apparently meaning the beluga), dug out of ice with spades." This remarkable severity of climate on the northern shores of the Euxine, may induce us to give a proportionate faith to what the ancients assure us of its southern and eastern shores; and though Ovid may be supposed to have exaggerated the miseries of his banishment; and though religious as well as African prejudice may have swayed Tertullian, in his dismal account of Pontus, it is certain that Strabo can be influenced by neither of these motives, where he accounts for Homer's ignorance of Paphlagonia, "because this region was inaccessible, through its severity of climate." To account for this phenomenon is far more difficult than to establish its existence; and the difficulty is greater because some of those theories by which the problems of climate have been usually solved, will, in the present instance, apply. In elevation above the sea, which, when considerable, is an obvious and undoubted cause of cold, the downs of European Tartary do not exceed those of England. Forests, the removal of which has in many countries been supposed to diminish frost, have here never existed; and though the custom of burning withered grass in spring, which has been for so many centuries the only secret of Scythian husbandry, may have produced in many parts of this vast pasture a considerable deposite of saltpetre, it is not easy to suppose with Gibbon, that a cause like this can produce *such bitterness of wind or such unvarying rigour of winter.* It may be observed, however, (and the observation, though it will not solve the difficulty, may, perhaps, direct our attention into the right train of inquiry), that it is only in comparison with the more western parts of Europe, that the climate of Scythia is a subject of surprise; and that in each of the two great continents, we discover in our progress eastward, along the parallel of latitude, a sensible and uniform increase of cold. Vienna is colder than Paris; Astrachan than Vienna; the eastern districts of Asia are incomparably colder than Astrachan; and Choka, an island of the Pacific, in the same latitude with Astrachan or Paris, was found by the Russian circumnavigators in 1805, exposed to a winter even longer and more severe than is commonly felt at Archangel. In America, the same marked difference is observed between the climate of Nootka and Hudson's Bay; and even in so small a scale of nature as that afforded by our island, the frosts are generally less severe in Lancashire than in the East Riding of Yorkshire. If, then, the southern districts of European Russia are exposed to a winter more severe than those of France or Germany, they may boast in their turn of more genial climate than the banks of the Ural and the Amur; while all are subject to a dispensation of nature which extends too far, and too uniformly to be ascribed to any local or temporary causes.—*Life of Bishop Heber*, vol. i. p. 532.

2. *On the Influence of Lightning-Conductors on Vegetation.*—It having been stated that plants grow most luxuriantly near a lightning-conductor, and are there maintained in a healthier condition than elsewhere, and that the maintenance of the electric current between the earth and the heavens is connected with the growth of plants, we are induced to notice some experiments made by us two years ago, upon this supposed influence of electricity. We formed three conductors of tall poles, with pointed iron rods, projecting eight or nine feet above the poles, and with very thick iron-wire attached to the lower end of the rods leading down to the ground: the rods and wire as free of rust as possible.—*Experiment* 1. We placed

one of these conductors, from thirty to forty feet in height, in the middle of a large barley-field newly sown, the field level, and in a wide open flat country. We joined ten smaller wires to the lower end of the large wire near the surface of the ground, and fixed these down to the mould by wooden pegs, distributing them over several feet of surface, taking care not to trample nor disarrange the mould near the wires. We attended to the germinating, growth, and ripening of the barley, and distinguished no difference between that among the wires and the other parts of the field. The only thing remarkable in this experiment, was, that portions of the wire became oxidated (red rusted) externally, while other portions equally exposed to the dew, rain, sun, changed only from a bluish to a whiter more silvery colour, similar to the whiteness occasioned by a certain degree of heat. We failed in satisfying ourselves of the cause. —*Experiment* 2. We placed another conductor in a field of oats, just brairded, fixing down the lower end of the large wire about three yards along the surface of the ground. The growth of the oats along the side and at the end of the wire was in no respect different from the rest of the field.—*Experiment* 3. In spring we placed the other conductor by the side of an apple-tree, about three feet distant from the bole: the top of the pole and iron-rod extending high above the tree. We led the large iron-wire round the bulb at about three feet distant, placed four inches deep in the soil, immediately above the roots. This tree shewed no difference in size or colour of leaf, or length of annual shoot, from others of the same kind of apple, and same age and size of tree near it.—*Experiment* 4. In spring we procured a quantity of nails, about four inches in length, and by means of small thin slips of wood, with a hole in the middle to admit the nail, thus forming a T, and shreds of mat, we fixed these nails to the branches and shoots of an apple-tree, with the head of the nails touching the bark, and the point standing out like thorny spikes, rendering the tree almost like a hedgehog. We discovered no difference in the growth, leaves or flowers, or fruit of this tree, during the season, from others of its kind near it. There is one circumstance connected with conductors, which has not perhaps been attended to. There is generally a pit dug where the conductor is led into the earth, and new soil is turned up from the pit, and mixed with the superior soil; this, as well as the deep stirring of the ground, renders the vegetation more luxuriant.—*Communicated by P. Matthew, Esq. author of Treatise on Naval Timber.*

MINERALOGY.

3. *Chiastolite.*—According to Dr G. Landgrebe of Marburg, 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 for example, and again crystallized from them, exhibit in their crystals the same structure as observed in chiastolite.

4. *Magnetic Reaction of Platina.*—In a piece of Russian platina the size of a walnut, Göbel detected the two magnetic poles. Its magnetism was so powerful that a middle-sized needle was attracted by it, and a magnetic needle was, at a certain distance, set in motion by it. Many similar pieces of platina, from the size of a hazel nut to that of a hen's egg, in the collection of the Imperial Mining Academy of St Petersburg, exhibit similar properties.

5. *Olizoner Zircon of Breithaupt.*—*Colour* pitch or brownish black, seldom dark grey. *Occurs* in rolled pieces and in hyacinth crystals. *Lustre vitreous.* Opaque. *Fracture* conchoidal. *Cleavage* scarcely discernible. *Hardness* equal that of orthoclase felspar. *Specific gravity* from 3.987 to 4.032. From Island of Ceylon. The low degree of hardness, and the specific gravity, render it probable that it forms a distinct species.

6. *Specific gravity of Datolite.*—Some late writers have stated the specific gravity of datolite as high as 3.3. Breithaupt, however, finds the generally given specific gravity to be the correct one. In two varieties of datolite he found the specific gravity to be 2.9298, and 2.9911.

7. *Professor Jameson's Manual of Mineralogy and Geology.*—This work, which will form one or two compendious volumes, is now in the press.

8. *Tremolite found in Teesdale.*—In a granular limestone, a member of the lead measures, near Caldron Snout, Teesdale, Durham, I found, in 1829, *tremolite,* in small radiated crystals of a greyish colour.—*W. C. Trevelyan.*

GEOLOGY.

9. *Salt Spring of Birtley in Durham.*—I have lately examined some water from the salt spring at Birtley in the county of Durham, and have ascertained that it contains both iodine and bromine.—The specimen was procured for me in February: I found its specific gravity at temperature 60° to be 1.072, and calculating according to Kirwan's formula given in Thomson's Chemistry, $1072 - 1000 \times 14 = 100.8 =$ saline contents in 1000 parts of this water. I evaporated to dryness, but without expelling the water of crystallization, 1000 grains of it, and found the residuum to weigh 103 grains. Mr Winch, in the Transactions of the Geological Transactions, vol. 4th, mentions that this spring produces 26400 gallons in 24 hours; and that when analyzed by Mr Woods, it was found to contain in 1000 grains, muriate of soda 87; muriate of lime 43; muriate of magnesia, carbonate of lime, carbonate of iron, and silica, 4; = 131 grains, which is considerably more than I found in it; but perhaps it may vary at different seasons in the quantity of saline matter.—A remarkable circumstance with regard to this spring, and some others in the same district, is, that it occurs in the coal-formation far below the well-known saliferous or new red sandstone.—*W. C. Trevelyan.*

10. *Deshayes' New Classification of the Tertiary Formations.*—Mr T. J. Torrie informs us, that Deshayes classes the whole of the tertiary deposits at present known, from the simple consideration of their fossils (of which he possesses 3000 species) into three groups. The most ancient embraces the London and Paris basins, and the tertiary strata of Belgium, and contains more than 1200 fossil species, of which only 38 are analogous to the shells actually living. The second embraces the whole tertiary deposits of Bordeaux, Dax, Touraine, Anjou, of the south-west of France in general; the inferior part of those of Montpellier, and probably the Calcaire mœlon of Marcel de Serres; those

around Turin, of Vicenza and Verona in Italy. The number of fossils in this group may approach to 1000, but Deshayes did not state the exact number, of which 180 are living species. The third group comprises the greater part of the deposits of Montpellier, especially of the blue marl,—the subapennine formation of Italy and Sicily, &c.—those of Vienna, and the basin of the Danube, the crag of England, and certain modern conchiferous deposits along the west coast of South America. The zoological character of this group is, that it contains 50 species analogous to the living, the greater part of which inhabit the neighbouring seas. Deshayes has examined 600 Italian species; of 190 from Sicily, 188 are living species. A similar classification was some time ago proposed by Elie de Beaumont, founded on geological considerations,—the first group he traces to an up-raising nearly north and south, the second to an up-raising N. 25° E., and the third from W. S. W. to E. N. E., which raised the subapennine beds of Italy.

11. *Universality of Formations.*—If the primary and igneous rocks are found all over the globe, we cannot as yet say so much for those of the secondary class. Thus the great coal formation appears to abound most under the polar circle, and in the two temperate zones, but is rarer near to the equator; a geographical distribution, probably connected with its mode of formation. The deposits between this formation and the Jura limestone, have scarcely been met with beyond the limits of Europe, excepting in India, when the new red sandstone and the lias limestones are said to abound. The deposites observed by Pander and Eversman, between the lake of Aral and Bucharia, are probably referable to these two secondary formations. If the Jura limestone is infinitely more frequent, or better known in the four quarters of the world, the greensand and chalk have only been found well marked in America, as in Patagonia, at the entrance of the Straits of Magellan, and in the Atlantic portion of the United States. The tertiary and alluvial deposits, on the contrary, play a more important part on the surface of the earth. It appears that at least throughout Europe, and in Russian and Central Asia, the upper tertiary formation prevails in an eminent degree. In the grand basin of the North of Germany, Von Buch observed, by means of the fossils, a greater resemblance with the

subapennine deposits than with those of Paris, which confirms our idea of uniting as to age, these subapennine basins of Gallicia and Poland, with those just mentioned. It is even possible that the inferior tertiary deposits may be rare beyond the limits of Europe, the greater part of the tertiary lignites not appearing to belong to them. The ancient and modern alluvium occurs every where in the valleys, and in the plains, on the hills, and upon some plateau that have been raised up after their formation; but they are wanting on the elevated acclivities, and on the high mountain chains raised before the alluvial period. These alluvia contain marine fossils only when they occur on the sea shore; elsewhere, we observe only debris of land and river shells, and bones of terrestrial animals. We defy the partisans of the deluge to shew us any thing else, in all their pretended diluvium throughout Europe, and which nevertheless according to their ideas ought to be characterized by marine fossils. We believe in local cataclysms, of great lakes of fresh water, and even probably of salt water; but there is nothing, absolutely nothing in Europe, that can justify a general cataclasm during the alluvial period. As to the debris on the sides of mountains, their angular form and their repository indicate their origin and mode of accumulation by decomposition, sliding down, carrying away by the passing rains, by avalanches and the motions of glaciers. The calculations which it has been attempted to found on the talus of debris, with the view of inferring the age of the world, has never probably been done in earnest by any practical geologist. Indeed, we do not see that the historic times have any connection with the geological periods, even the most recent of these. It is a well known fact, that deposits of shells during the alluvial period occur on the coasts of the Atlantic, and of the North Sea, at a considerable height above the level of the sea. It is also known that the same phenomenon is repeated not only in Norway, and upon the shores of Britain and France, but also according to Keilhau in the islands of Spitsbergen; on some coasts in the United States of Brazil (Bahia). It appears also to occur in the Pacific Ocean, at least on the American coast.—*A. Boué, Journal de Geologie*, t. ii. p. 205.

12 *Submarine Forest, near Cullen.*—Mr Christie of Banff informs us that a submarine forest exists at the mouth of the

burn of Cullen, and along the bay about that point; but as it can only be reached at the lowest tides, it has not yet been fully examined. It is said to contain oak trees in an erect posture, rising from a bed of blue clay. We hope to hear more regarding this interesting statement.

13. *Vast Extent of the Earthquake of* 1827.—On 16th November 1827, a violent earthquake was felt at Santa Fé de Bogota, in Columbia, and on the same day at Ochotsk in Siberia. It is stated 17th November in Siberia, which, however, considering the relative geographical situation, is the same day as at Santa Fé de Bogota. It is worthy of remark, that the direction of the earthquake in Columbia was from SE. to NW., and that this direction points towards Siberia. Not less interesting is the circumstance that the line from Columbia towards Siberia strikes the most remarkable volcanic region in Mexico, and is parallel to the principal range of American mountains. This may be viewed as a proof that the operation of earthquakes is propagated in a linear direction, it may be in great rents, or according to the arrangement of chains of mountains, strata, or rocks. It affords also a striking proof of the great depth at which the process which gives rise to earthquakes is carried on.

14. *Huge scattered Blocks of Granite.*—Not far from the town of Lovisa (which lies on the Finnish or northern shore of the Gulf of Finland, about 200 miles east of St Petersburg), we entered upon a level and extensive plain. For three or four miles from west to east, we traversed this plain or steppe, which is covered with huge blocks of granite, many of which must weigh 200, 300, and even 400 tons. These masses of granite are rapidly crumbling to the ground, and large heaps of the disintegrated matter lie piled at the base of each block. So extensively has this decay of these rocks prevailed, that the roads of the neighbouring district for several miles are *metalled* with their *debris* alone. But what chiefly deserves notice is, that the decay takes place on that side only which I found by compass faces to the SW. From this quarter the wind is said chiefly to blow,—a circumstance that, in connection with the luxuriance of the wild vegetation of the neighbourhood, may favour the idea that this decay of the rock is to be attributed to the action of the wind impregnated with carbonic acid. Indeed, the

brushwood is extremely thick and tangled over the whole plain; bramble and juniper bushes grow in irregular patches over its whole extent; and the crowberry, whortleberry, cranberry, dog-moss, and wood-sorrel, are very abundant. Ferns, of great size and strength, also grow under the shelter of these rocky masses, and by insinuating their roots, perhaps sometimes hasten the dissolution of their protector. The rock is itself generally coated with large lichens, of green, purplish, and yellow colours. In the neighbourhood of this plain the rocks are granitic, containing a large proportion of mica, and exhibit a slaty structure; but the blocks which were strewed over this extensive plain were not, so far as I remember, characterized by stratified appearance. They are extremely coarsely grained, of a brownish colour, and contain a large proportion of mica.—*Mr Alan Stevenson.*

BOTANY.

15. *Localities of rare British Plants.—Chrysocoma Linosyris,* I gathered in 1824, near the road-side between Brighton and Shoreham. *Orobus tuberosus* β *tenuifolius,* near Blanchland, Northumberland, 1820. *Chenopodium botryoides,* near Newhaven, Sussex. *Equisetum variegatum,* in wet sandy spots on the banks of the Tees, near Middleton in Teesdale, Durham, 1829. *Eriophorum pubescens* and *angustifolium* are both abundant in the same neighbourhood. *Jungermannia cochleariformis,* near the head of Waskerly Burn, near Wolsingham, Durham, 1829.—*W. C. T.*

16. *Dimensions of a Larch Tree, cut down at Wallington, Northumberland, May* 1831—

	CIRCUMFERENCE.	
	Feet.	Inches.
At the base	8	4
... 5 feet	7	11
... 10 ...	7	5
... 20 ...	6	11
... 30 ...	6	9
... 40 ...	5	10
... 50 ...	5	3
... 60 ...	3	
... 70 ...	2	4
88 ... extreme length.		

The age of the tree was about 80 years. There are several larger still standing at the same place, which are supposed to be some of the largest and oldest in England.—*W. C. T.*

17. *On a New Vegetable Razor-Strap.*—Having observed, when at Buenos Ayres and Monte Video, previous to my return to Europe in 1828, that the barbers were in the practice of giving a fine edge to their razors, by using instead of a razor-strap a portion of the stem of a monocotyledonous plant, divided in the direction of its fibres, I made inquiry from whence they obtained it, and was informed that it was procured from Rio de Janeiro. Accordingly, on my subsequently visiting that place, I took care to obtain a supply of it, and have not only ever since used it myself as a razor-strap, but have induced many of my friends to do so likewise, with the most satisfactory results. From a belief at one time entertained, that the presence of minute particles of silica interspersed among the fibres of this substance, might give rise to its peculiar property of giving a fine edge and polish to cutting instruments, I was induced to request of my friend Mr James F. Johnston to subject it to analysis, to ascertain whether it contained any silica; but, after a most careful investigation, he could not find it to contain the least trace of any siliceous earth. It is evident, therefore, that its useful properties as a razor-strap depend on the mechanical management of the numerous longitudinal fibres of which it principally consists, and which, being surrounded on all sides by a quantity of light cellular substance, is rendered somewhat elastic. This substance is of a dirty white colour, with a specific gravity, according to Mr Johnston, of ·09 in its porous state, and about ·3 after its being boiled in water to expel the air. To prepare it for use as a razor-strap, it is only requisite to divide the portion of the stem to be used in a direction parallel to that of the fibres, and forming a flat surface, which is rendered smooth. I have also understood that it is likewise used as a substitute for cork to line boxes in which insects are preserved, and some give to it a decided preference for this purpose. I am likewise informed that it is sold for this object at Guayaquil, on the Pacific coast, under the name of Balsa Wood, which name it has probably obtained from its great buoyancy. At Rio de Janeiro, I was informed that it

was the stem of the Pita, by which name the *Agave Americana* or American Aloe is known at Buenos Ayres, but am very doubtful whether it is the stem of this particular species, as it grows with great luxuriance at Buenos Ayres, where it is in common use in forming inclosures; yet the razor-straps used there, I was informed, are brought from Rio de Janeiro. It may therefore be presumed to consist of the stem of some other of its congeners, which flourishes only in tropical America; or is it only under the influence of a tropical sun that the Agave Americana has its peculiar properties fully developed?—*Dr Gillies.*

ZOOLOGY.

18. *The Extinct Dodo.*—Naturalists have known for a long time, but only through means of figures and descriptions, executed in the sixteenth and the commencement of the seventeenth century, a great bird, incapable of flying, found in the Isle of France after its discovery, but which appears to have been since entirely extirpated. It was named *Dronte*, *Dodo:* it is the genus Raphus of Mæring, or the Didus of Linnæus. All that is preserved of this bird is a head and a foot deposited in the Ashmolean Museum at Oxford, and another foot, with a figure painted in oil, after the living animal, which are in the British Museum. Cauche, who also saw it in the Isle of France, has given an imperfect description of it, in which he says it had but three toes, which has caused some naturalists to form a second species, under the name *Didus nazarenus,* the first being called *Didus ineptus.* Leguat mentions another bird, resembling the dodo, found in the Island of Rodrigue, and which has been named *Didus solitarius.* Cuvier had sent him, by an excellent naturalist in the Isle of France, M. Desjardins, the large bones of a bird found in the Island of Rodrigue, in part encrusted with calc-tuffa, which Cuvier conjectured might be those of the dodo. Judging from the cranium, sternum, and very small humerus, the thigh-bone, and tarsus, he supposed they belonged to a gallinacious bird. M. Blainville, in a learned memoir, endeavours to shew that the dodo was a kind of vulture, which, he says, it resembles in beak, head, claws, and other circumstances of its organization. Du-

ring his visit to England, Cuvier compared the remains of the dodo preserved in the British Museum and in that of Oxford with the bones sent to him by Desjardins, when he found that the heads were identical, but the tarsus is more elongated than that of the British Museum, which, again, is thicker, but shorter, than that of Oxford. There is, therefore, some doubt as to the tarsus, but none as to the head, which he therefore refers to the dodo; and as this head, as also the sternum found along with it, and also the humerus and femur, undoubtedly belong to the Gallinæ, this bird falls to be placed in that tribe.

19. *Bengal Tiger found in Siberia.*—Ehrenberg, during his journey through Siberia, made a discovery of great interest for the geography of animals, and in some respects for the history of fossil bones, viz. the existence of the great tiger of Bengal in Northern Asia, between the latitudes of Paris and Berlin. He also describes a great panther, with long hair (Felis irbis), he met with in the Altain chain of mountains.

20. *Footmarks of Man and Lower Animals.*—Voltaire, in Zadig, has attributed to his hero a sagacity in tracing footsteps, which no doubt has often been considered an idle invention. Such a power, however, appears to be possessed by the Arabs to a degree which deprives even Zadig of the marvellous. The Arab, says Burckhardt, " who has applied himself diligently to the study of footsteps, can generally ascertain, from inspecting the impression, to what individual of his own, or of some neighbouring tribe, the footstep belongs, and therefore is able to judge whether it was a stranger who passed or a friend. He likewise knows, from the slightness or depth of the impression, whether the man who made it carried a load or not. From a certain regularity of intervals between the steps, a Bedouin can judge whether that man, whose feet left the impression, was fatigued or not, as, after fatigue, the pace becomes more irregular and the intervals unequal; hence he can calculate the chance of overtaking the man. Besides all this, every Arab knows the printed footsteps of his own camels and of those belonging to his immediate neighbours. He knows by the depth or slightness of the impression whether a camel was pasturing, and therefore not carrying any load, or mounted by one person only, or heavily loaded. If the marks of the two fore feet appear to be deeper

in the sand, he concludes that the camel had a weak breast, and this serves him as a clue to ascertain the owner. In fact, a Bedouin, from the impressions of a camel's, or of his driver's footsteps, draws so many conclusions, that he always learns something concerning the beast or its owner; and in some cases this mode of acquiring knowledge appears almost supernatural. The Bedouin sagacity in this respect is wonderful, and becomes particularly useful in the pursuit of fugitives, or in searching after cattle. I have seen a man discover and trace the footsteps of his camel in a sandy valley, where a thousand of other footsteps crossed the road in every direction; and this person could tell the name of every one who had passed there in the course of that morning. I myself found it often useful to know the impressions made by the feet of my own companions and camels; as from circumstances which inevitably occur in the desert, travellers sometimes are separated from their friends. In passing through dangerous districts, the Bedouin guides will seldom permit a townsman or stranger to walk by the side of his camel. If he wears shoes, every Bedouin who passes will know by the impression, that some townsman has travelled that way; and if he walk barefooted, the mark of his step, less full than that of a Bedouin, immediately betrays the foot of a townsman, little accustomed to walk. It is therefore to be apprehended that the Bedouins, who regard every townsman as a rich man, might suppose him loaded with valuable property, and accordingly set out in pursuit of him. A keen Bedouin guide is constantly and exclusively occupied during his march in examining footsteps, and frequently alights from his camel to acquire certainty respecting their nature. I have known instances of camels being traced by their masters during a distance of six days' journeys, to the dwelling of the man who had stolen them. Many secret transactions are brought to light by this knowledge of the *athr* or footsteps; and a Bedouin can scarcely hope to escape detection in any clandestine proceeding, as his passage is recorded upon the road in characters that every one of his Arabian neighbours can read."—*Notes on the Bedouins and Wahabys by Burckhardt.*

21. *Destruction of Live Stock by Wolves in Russia.*—In the

government of Livonia alone, the following animals were destroyed by wolves in 1823. The account is an official one:—

Horses,	1841	Swine,	4190
Sheep,	15,182	Sucking Pigs,	312
Horned Cattle,	1807	Kids,	183
Calves,	733	Dogs,	703
Lambs,	726	Fowls,	1243
Goats,	2545	Geese,	673

NEW PUBLICATIONS.

1. *Arrian on Coursing. The Cynegeticus of the Younger Zenophon, translated from the Greek, with Classical and Practical Annotations, and a brief sketch of the Life and Writings of the Author; with an Appendix, containing some account of the Canes Venatici of classical antiquity.* By a Graduate of Medicine, with embellishments from the Antique. London. 8vo. p. 314.

The amateurs of the leash, the naturalist, and the scholar, will be delighted and gratified with this elegant translation and richly illustrated edition of one of the most curious remains of antiquity. It is addressed, says the translator, to the coursing public alone, for whom the original was written thirteen centuries ago, by their representative of old, a courser of Nicomedia in Asia Minor; and for whose amusement and instruction the same now assumes an English garb. The sportsman, fond of the musical confusion of hounds and echo in conjunction, will read it with indifference, as treating of a branch of rural sport not congenial to his taste, and wonder that an attempt should be made to bring under public notice so ancient a treatise on a subject of such partial interest. But the Courser, it is humbly conceived, the active patron of the κυνες κελτικαὶ, proud of his greyhounds, that

> "are as swift
> "As breathed stags, aye fleeter than the roe,"

will peruse it *con amore*, and find in its pages much that is entertaining and practically useful, and that utility enhanced in the department of annotation. It is foreign to my purpose, says the unknown but accomplished translator, " to enter into a prolix defence of the courser's pursuit, against the objections of its adversaries in the field or closet." " I would not goe about," in the words of Gervase Markham, " to elect and prescribe what recreation the husbandman should use, binding all men to one pleasure,—God forbid! my purpose is merely contrary: for I know in men's recreations, that nature taketh to herselfe an especiall prerogative, and what to one is most pleasant, to another is most offensive; some seeking to satisfie the mind, some the body, and some both in joynt motion." We of the coursing fraternity prefer the " canis Gallicus," and " arvum vacuum" of Ovid, as instrumental to our choisest diversion:

" camposque patentes
" Scrutamur, totisque citi discurrimus arvis;
" Et ——— cupimus facili cane sumere prædas:
" Nos timidos lepores———"

but we do not forbid others,

" imbelles figere damas,
" Audacesve lupos, vulpem aut captam dolosam."

For the refined diversion of coursing may be as disagreeable to the foxhunter, whose only joy is when

" The hounds shall make the welkin answer them,
" And fetch shrill echoes from the hollow earth,"

Taming of the Shrew, Sc. II.

as it is delightful to the general amateur, on account of its chaste and temperate, and contemplative quiet. King James, in his Βασιλικὸν Δῶρον, (himself, according to Sir Theodore Mayerne, " violentissimis olim venationis exercitiis deditus,)" praises " the hunting with running houndes, as the most honourable and noblest sort thereof," and is supported by the high authority of Edmond de Langley, master of game; adding, " it is a thievish forme of hunting to shoot with gunnes and bowes, and greyhound hunting is not so martiall a game." But, on the other hand, Sir Thomas Elyot, in " The Governour," speaking of " those exercises apte to the furniture of a gentleman's personage," and " not utterly reproved of noble autours, if they be used with oportunitie and in measure," calls " hunting the hare with grehoundes a right good solace for men that be studiouse, or theim to whom nature hathe not geven personage or courage apte for the warres; and also for gentilwomen, which feare nether sonne nor wynde for appayryng their beautie. And, peradventure, they shall be thereat lesse idell, than they shold be at home in their chammers." And the author of "The Booke of Hunting," annexed to Tubervile's Falconrie, concludes his treatise with the following singular panegyric, "concerning coursing with greyhounds,"—"the which is doubtlesse a noble pastime, and as meet for nobility and gentlemen, as any of the other kinds of Venerie before declared, especially the course of the hare, which is a sport continually in sight, and made without any great travaile; so that recreation is therein to be found without unmeasurable toyle and payne: whereas, in hunting with hounds, although the pastime be great, yet many times the toyle and paine is also exceeding great; and then it may well be called eyther a painfull pastime or a pleasant payne."

Coursing, more than the other laborious diversions of rural life, while it ministers to our moderate sensual enjoyment, admits also, during the intervals of the active pursuit of hound and hare, much rational reflection, opportunities of conversation with our brethren of the leash, and mental improvement. It tends, as Markham quaintly expresses himself, "to satisfie the mind and body in a joynt motion;" for, in the beautiful poetry of a living patron of the Celtic dog, there is no interval of idleness with the well-read courser:

> "Nor dull between each merry chase,
> "Passes the intermitted space:
> "For we have fair resource in store,
> "In Classic and in Gothic lore." MARMION.

But there are those who anathematise hunting and coursing, and other rural recreations, either as sinful *, or indicative of

* The reader will be amused with Simon Latham's epilogue to the third edition of his "Faulconry," wherein he combats (for he wrote in ticklish times, 1658), with his usual quaintness of style and illustration, the notion of the sinfulness of rural sports, inferring that they may be "lawfully and conscientiously used with moderation by a magistrate or minister, or lawyer or student, or any other seriously employed, which in any function heat their brain, waste their bodies, weaken their strength, weary their spirits; that as a means (and blessing from God), by it their decayed strength may be restored, their vital and animal spirits quickened and refreshed, and revived;

barbarism and mental degradation, in the ratio of the pursuit. Like Cornelius Agrippa, they view venation *in genere* as the worst occupation of the worst of mankind; and say with Philip Stubes, that "Esau was a great hunter, but yet a reprobate; Ismael, a great hunter, but a miscreant; Nemrode, a great hunter, but yet a reprobate, and a vessel of wrath;" and bid us, in the poetic badinage of the poet of Cyrene, leave of coursing:

" ἔα προκυσ ἠδὰ λαγωοὺς
" οὔρεα βοσκεσθαι το δε κεν πρόκες ἠδὲ λαγῶοὶ
" ρηξειαν;

Swearing with the melancholy Jaques,

" That we
Are mere usurpers, tyrants, and what's worse,
To fright the animals, and kill them up,
In their assign'd and native dwelling-place."

As You Like It.

But if "some habites and customes of delight" are allowable and indispensable to the "contentment" of the human mind, and "men of exceeding strickt lives and severity of profession," have indulged in rural diversions, why need we regard the severe reflections of the sensitive Monsieur Paschal, or his modern plagiarists? Why think that wisdom loves not the courser's sport? Or that man is degraded before the tribunal of sound reason, by estimating aright the instinct of any of the creatures around him? Or made sinful in the eyes of his Creator, by availing himself of the adapted powers of the lowliest of the brute race, for the subjugation of such wild animals as were originally designed by a bountiful Creator for the sustenance and recreation of man? "Canum vero tam incredibilis at investigandum sagacitas narium, tanta alacritas in venando, quid significat aliud nisi se ad hominum commoditates esse generatos."—*Cicero, de Nat. Deor.* l. ii. c. 63.

The inference in regard to the chases, and field sports generally, is surely just, "that man, by co-operating with such animals, employs both his and their faculties on the purposes for which they were partially designed, tending thereby to complete the bounteous scheme of Providence, the happiness and well-being of all his creatures.

their health preserved, and they better enabled (as a bow intended for shooting) to the discharging of their weighty charges imposed upon them."

"The brute creation are man's property,
Subservient to his will, and for him made.
As hurtful these he kills, as useful those
Preserves; their sole and arbitrary king.
Should he not kill, as erst the Samian sage
Taught unadvised, and Indian Brachmans now
As vainly preach; the teeming rav'nous brutes
Might fill the scanty space of this terrene,
Incumb'ring all the globe." *Somerville; Chase*, b. iv.

Mr Warton, the talented historian of English Poetry, a bookful Academic, and not a μαθητὴς κυνηγεσίων, acquits the hunter of the chase of barbarism, and acknowledges that "the pleasures of the chase seem to have been implanted by nature; and, under due regulation, if pursued as a matter of mere relaxation, and not of employment, are by no means incompatible with the modes of polished life." But our space is exhausted, and we must now leave our readers to the delightful work itself, of which by-the-by we observe only 250 copies are printed.

2. *Ornithological Dictionary of British Birds.* By Colonel G. Montagu, F. L. S. Second Edition. By James Rennie, A. M. Professor of Natural History, King's College, London, &c. 1 vol. 8vo. pp. 650. 1831.

The late Colonel Montagu's Ornithological Dictionary, we always considered a good book of its kind, and regretted it had been so long out of print. The zoological public will feel much indebted to Professor Rennie for the present elegant edition, which he has enlarged by many additions, most of them of a popular and amusing description. We are decidedly adverse to some of the scientific views and nomenclatural changes of the Professor, and cannot refrain from noticing, that Mr Rennie, we truly believe inadvertently, says, "*that the descriptions of Linnæus are dry, lifeless, marrowless, and unphilosophical.*" Much might be said on this head, all indeed very much to the disadvantage of those who think so loosely and so unphilosophically.

3. *Synopsis Reptilium, or Short Descriptions of the Species of Reptiles.* By J. Ed. Gray, F. L. S. &c. 1 vol. 8vo. p. 90. With Plates. London, 1831.

We have much pleasure in recommending to the attention of naturalists this interesting monograph, descriptive of the different known tribes of Tortoise, Crocodile, and Enalsosauri. The practical zoologist, and those also who cultivate the geological history of fossil organic remains, will find it a most useful guide. Mr Gray gives the following amusing account of his volume:—"The collection of reptiles of the British Museum, the College of Surgeons, and Mr Bell, have furnished the basis of this work. The two first of these collections contain many of the species which have been described by Dr Shaw; the College of Surgeons contains the tortoises which were in the Leverian Museum; but, in the part now published, I am most indebted to the kindness of Mr Bell, whose collection of tortoises far exceeds that of any museum in Europe, and whose liberality, in allowing me the use of it, I cannot too highly appreciate. It is to be hoped that his monograph, for which he has collected them, and for which he has kept and had drawn alive more than two-thirds of the known species, will shortly appear.

"To render the collection of species as complete, and the synonyma as correct as possible, every opportunity has been taken, during my visits to the continental museums, to examine and take notes of the individual specimens which have been described by the various foreign authors who have written on this subject. Amongst the continental cabinets, that of the Garden of Plants of Paris must be first mentioned, if not from its intrinsic value, from the fact that most of the modern original writers on this branch of natural history have used it as their type collection; witness the works of La Cépède, Latreille, and Daudin, among the French; and Oppel, Oken, and Schweigger, among the Germans. It is much to be regretted that many of the specimens described by these authors should not have been more particularly ticketed, and that the most of the species collected by the later expeditions, are not yet added to the public parts of the collections. I have to thank Baron Cuvier, M. F. Cuvier, and M. Dumeril, for their kindness in permitting me to examine these subjects, and more especially the former, whose attention to me on each of my visits to Paris, has been highly flattering to my feelings. Besides the National Museum at Paris, by the kindness of M. Blainville, I have been enabled to examine the Museum of the Ecole de Médécine, containing several curious reptiles, especially some from California.

"The Royal Collection at Berlin having been recently re-arranged, and the Royal Museum of Leyden, and the Museum of the Senckenberg Society of Frankfort having been formed within these few years, the greater part of the specimens are quite fresh, and in the most perfect condition, and their history is generally known, and accurately marked upon them. These museums are the more valuable, as each of them is peculiar for having the most complete collections from certain parts of the world. That of Berlin excels in those of Buchara, of Mexico, and of the Braziis; while the Leyden Museum is richest in the productions of the Dutch colonies, as the Islands of the Indian Archipelago, the Cape, and Surinam. That of Frankfort contains the most complete collections of the animals of Egypt, and the rest of Northern Africa, that was ever brought together, having been entirely formed by the exertions of Dr Rüppell, during his travels in those countries, and extended by specimens received from other museums in exchange for his duplicates; yet this monument of the industry of an individual, must rank very high amongst the museums of Europe. After having laid before the scientific public the novelties which he has discovered, Dr Rüppell has again left Europe (at his own cost) to extend still farther the empire of science.

"I hardly know how sufficiently to express my thanks to Herr Temminck and Herr Schlegell of Leyden; to Professor Lichtenstein, and Herr Deppe of Berlin; to Drs Cretzrchmarr and Rüppell, and Senator Von Heyden of Frankfort for the courtesy and attention which they shewed me during my visits to the various museums under their direction; indeed with such liberality, that it would be impossible, however desirable, to imitate them in our more populous towns. In each of these museums all the specimens were intrusted to me to describe, draw, or examine them, as might best suit my purpose, without any restraint, except that, at Leyden, Herr Temminck requested that I would indicate in what museum I had seen it, and the name under which it was described,—a rule which I hope I have most faithfully kept. In Frankfort, some specimens were even sent to my hotel, that they might be examined more at leisure. I cannot here omit to mention the names of Sir James MacGrigor, and Dr Burnet, for their kindness in allowing me to examine the museum of Fort Pitt, Chatham, and of Haslar Hospital, and to Dr Horsefield, for the facilities which he gave me of seeing the reptiles in the Museum of the Indian House, and more especially of comparing and copying the drawings made under the superintendance of Dr Hamilton in India.

"Besides those who assisted me with specimens, I cannot forget the kindnesses shewn me by Prince Massena, Baron Ferussac, and M. Deshayes, at Paris; Professor Reinwardt, at Leyden; Professors Kunth and Ehrenberg, at Berlin; and Herren, Oken, Fischer, Otto, Boie, and numerous other German, Swedish, and Danish naturalists, at Hamburgh, in whose society I spent one of the happiest weeks of my life. The opportunity of examining the museums of the north of Europe not occurring till the body of the monograph was printed, I have been reduced to the necessity of adding the remarks and additional species as an Appendix. To this Appendix have also been added descriptions of some drawings of Chinese species, sent by Mr Reeves to General Hardwicke, which will be shortly figured in a work on the zoology of that country, now in the press; and also the synonyma of Dr Wagler's System der Amphibien, which has but lately arrived in London.

"I have to regret that, after every inquiry and considerable delay on its account, I have not been able to procure the last parts of the Annals of the Lyceum of New York, in which I understand M. Le Conet has given descriptions of the American species of tortoises."

4. *Transactions of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne.* Vol. i. Part 2. 4to. Pp. 80.

This Part of the Transactions of the active Newcastle Society, contains five memoirs; 1. Remarks on the Geology of the Banks of the Tweed, from Carham in Northumberland to the sea coast at Berwick; by N. J. Winch, Esq.—2. On the Red Sandstone of Berwickshire; by Henry Witham, Esq. These two memoirs embrace several points in common, and go, in the opinion of the authors, to shew that the secondary rocks belong to the coal formation.—3. Notice of the Edge Seams of Mid-

Lothian, with a description of Gilmerton Colliery; by Mr M. Dunn. This also we consider a useful local piece of description, and the same is the case with 4., which contains a description of a group of Dikes called Rivers, discovered in the Whitehaven colliery; by Mr W. Peile. And, 5. Mr Aitkinson's Biography of the late reviver of Wood Engraving in this country will be read with interest. We are delighted to learn, that, through the influence of this Society, there is a certainty of the principal sections and plans of the mines in the north of England being laid before the public.

5. *First Steps in Botany.* By Dr DRUMMOND, Belfast. With numerous illustrative wood-cuts. 1 vol. 8vo.

MANY elementary guides for the study of popular botany have of late years made their appearance in this country; of these, the most agreeably written, the most intelligibly illustrated, at the same time the most useful, is Dr Drummond's interesting volume.

6. *A Synoptical Table of British Organic Remains.* By SAMUEL WOODWARD, H.M.Y.P.S. 1830. Pp. 50. 8vo.

WE have looked through this work, and although there are some mistakes and omissions, it is creditable to the author. Now that the subject of the fossil organic remains of this island engages much of the attention of geologists, and also of botanists and zoologists, the work of Mr Woodward cannot but prove acceptable, and the author meet with the encouragement he so well deserves.

7. *Transactions of the Plymouth Institution.* Vol. i. 8vo. Pp. 360. 1830.

THE Plymouth Institution was founded in 1812, for the promotion of literature, science, and the fine arts, in the town and neighbourhood. Among other means adopted in furtherance of the objects of the institution, it was deemed expedient, in the 18th year of its existence, to publish a volume of Essays, selected from the lectures read during the meetings of the society. These Essays we consider highly creditable to the society, and we doubt not the same opinion will be formed by others on perusing this interesting volume.

The following papers are published:—1. A Discourse delivered at the opening of the Institution, by Robert Lamper, Esq. A judicious and sensible address.—2. Geological Survey of the Country around Plymouth, with a coloured geological map; by J. Prideaux, Esq. As the country around Plymouth is very interesting, this sketch and map cannot but prove acceptable to the geologist, who will find in it many of the most remarkable geological features of the country described.—3. Experimental Inquiries concerning the laws of Electrical accumulations; by Mr W. S. Harris. This valuable memoir is already well known to philosophers through the Philosophical Journals.—4. Mr Rendel's account of the Cast-iron Bridge near to Plymouth will interest the engineer.—5. On the Rise and Decline of particular Mortal Diseases during the last twenty-five years, with an attempt to ascertain the law of Mortality, in respect of its distribution on various ages and in both sexes; by Dr Ed. Blackmore. We purpose, if possible, in a future Number of our Journal, to take particular notice of this curious memoir.—6. Papers of Dr Leach, valuable to the practical zoologist.—7. Antiquarian Investigations in the Forest of Dartmoor, Devon; by Samuel Rowe, Esq. On this moor are to be found examples of the sacred circle, avenues, the cromlech, the kistvaen, the rock idol, rock-basin, monumental pillar, the cairn or barrow, dwellings, and tract-ways. Of these several relics of former times, our author gives, in this paper, a variety of curious notices, collected from personal observation.—8. On Persian Poetry; by Nath. Howard, Esq. This very amusing paper contains a sketch of the state of Arabian poetry before, and about the time, of the Mahomedan conquest, with many interesting details in regard to the soft and beautiful language of Iran.—9. An account of the collection of Drawings of Major Hamilton Smith, F. R. S. This account of the rise and progress of a vast collection of drawings, ten thousand in number, made by the intelligent author Colonel Smith, will be read with pleasure. It consists of three divisions: the first, of costumes of all times and all nations; the second, of shipping and scenery; the third, of objects of natural history.—10. On the Ornithology of the South of Devon; by Edward More, M.D., F.L.S., &c. This is a good paper. We wish ornithologists in other parts of the island would publish similar local lists, and illustrate them in the same judicious manner as is done by Dr More. Our space does not permit us to enter into details. We may, however, notice, that a specimen of that rarest of all British, even of all European, birds, the *Alca impennis* or great awk, was picked up dead near Lundy island. Was this the specimen Mr Stevenson got in St Kilda, and which made its escape from the lighthouse-keeper of Pladda, when on its way to Edinburgh?

8. *A Geological Manual.* By HENRY T. DE LA BEECHE, F.R.S., F.G.S, &c. 1831. Pp. 550. 104 Wood-cuts. 8vo.

PROFESSOR JAMESON'S Works, and those of other British geologists, being out of print, MacCulloch's System of Geology, being very abstruse, and therefore not fitted for the student, and Mr Lyell's Principles but in progress, the student and practical geologist were in want of a guide for their studies and investigations. The appearance, therefore, of a Manual of Geology, from an observer so experienced as Mr de la Beeche, was most opportune. We have given the "Manual of Geology" full consideration, and hesitate not, although it contains views and statements to which we cannot subscribe, to recommend it to the attention of geologists, as containing a very interesting and useful view of the present state of geology, particularly of that department at present most studied, viz. the natural history of alluvia, tertiary and secondary deposits, with their accompanying plutonian and volcanic rocks. Its convenient size, independent of its other merits, will secure it a place in the knapsack of every travelling geologist; and even those who cultivate this most fascinating branch of science only in their cabinet and library, will find they cannot be without it.

9. *American Ornithology, or the Natural History of the Birds of the United States, by Wilson and Bonaparte.* 4 vols. Edin. 1831. Edited by Professor JAMESON.

THIS delightful popular work is now before the British public, and in a form which renders it in every way much more accessible than the very expensive and unarranged American work. Professor Jameson has been careful to see that this edition contained the whole letter-press of the original, but arranged according to a system, which is nearly that of the celebrated Illiger. The fourth volume contains the whole of Bonaparte's Birds of America, with many additional histories of the feathered creation, from Audubon, and the still unpublished Arctic Ornithology of Richardson and Swainson. To the scientific ornithologist the views and arrangements of Brehm, almost unknown to the ornithologists of Britain, and here given for the first time, will be read with interest. A general Index might have been appended, although not particularly wanted in a popular work, where every volume has its table of contents; but we understand the proprietors being unwilling to increase the expense of the work to the public, the editor yielded to their wishes, and closed the volume without the index. As a proof of the interest this work is exciting, we may add, that the plates of the original works are re-engraving and publishing. *Three editions* are now in progress, one in folio, another in royal octavo, a third the size of the Edinburgh edition of Wilson and Bonaparte, and, as stated in the advertisement, intended to bind up with that work.

List of Patents granted in England, from 15*th December* 1830, *to* 2*d February* 1831.

1830.

Dec. 17. To B. Redfern, Birmingham, gunmaker, "for a lock, break-off, and trigger, upon a new and improved principle, for fowling-pieces, muskets, rifles, pistols, and small fire-arms of all descriptions."

To A. Graham, a citizen of the United States of North America, but now residing in West Street, Finsbury, London, gentleman, "for certain improvements in the application of springs to carriages." Communicated by a foreigner.

23. To D. Papps, Stanley End, in the parish of King Stanley, Glocestershire, machine-maker, "for certain improvements in machinery for dressing or roughing woollen cloths."

To W. Wood, Summer Hill, Northumberland, near Newcastle-upon-Tyne, "for the application of a battering-ram to the purpose of working coal in mines."

To M. E. A. Pertins, No. 56, Rue du Bac, Paris, spinster, "for the fabrication or preparation of a coal fitted for refining and purifying sugar and other matters." Communicated by a foreigner.

Dec. 23. To J. Ferrabec, Shrupp Mill and Foundry, Strand, Gloucestershire, engineer, "for improvements in the machinery for preparing the pile or face of woollen or other cloths requiring such a process."

1831.

Jan. 13. To J. Blackwell and T. Alcock, both of Claines, Worcestershire, machine-makers, and lace or bobbin-net manufacturers, "for certain improvements in machines or machinery for making lace, commonly called bobbin-net."

15. To S. Seaward, Canal Iron-works, in the parish of All Saints Poplar, engineer, "for an improvement or improvements in apparatus for economising steam, and for other purposes, and the application thereof to the boilers of steam-engines employed on board packet-boats and other vessels."

To W. Parker, Albany Street, Regent's Park, gentleman, "for certain improvements in preparing animal charcoal."

18. To J. and G. Rogers, Sheffield, cutlers, and J. Fellows, jun. New Cross, Deptford, gentleman, "for an improved skate."

22. To A. Smith, Prince's Street, Leicester Square, St Martin's-in-the-Fields, engineer, "for certain improvements in machinery for propelling boats and other vessels on water, and in the manner of constructing boats or vessels for carrying such machinery."

To J. G. Ulrich, Nicholas Lane, London, chronometer-maker, "for certain improvements in chronometers."

To C. M. Hannington, Nelson Square, Surrey, gentleman, "for an improved apparatus for impressing, stamping, or printing, for certain purposes."

To L. Schwabe, Manchester, manufacturer, "for certain processes and apparatus for preparing, beaming, printing, and weaving yarns of cotton, linen, silk, woollen, and other fibrous substances, so that any design, device, or figure, printed on such yarn, may be preserved when such yarn is woven into cloth or other fabric."

29. To R. Winch, Gunpowder Alley, Shoe Lane, London, printers-joiner, "for certain improvements in printing-machines."

31. To J. Bates, Bishopgate Street Within, London, Esq. "for certain improvements in refining and clarifying sugar." Communicated by a foreigner.

Feb. 2. To. J. C. Schwiero, Regent Street, London, musical instrument-maker, "for certain improvements on piano-fortes, and other stringed instruments."

List of Patents granted in Scotland, from 23d June to 23d August 1831.

1831.

June 23. To James Slater of Salford, in the county of Lancaster, bleacher, for an invention of " certain improvements in the method of generating steam or vapour, applicable as a moving power, and to arts and manufacturers; and also for improvements in vessels or machinery employed for that purpose."

To Mathew Uzielli of Clifton Street, Finsbury Square, in the county of Middlesex, gentleman, for an invention in consequence of a communication made to him by a certain foreigner residing abroad, " for improvements in the preparation of certain metallic substances, and the application thereof to the sheathing of ships, and other purposes."

27. To James Cochrane of Greenside Lane, in the City of Edinburgh, brass-founder, for an invention of " a certain improved method of manufacturing tubes or pipes of lead, block-tin, copper, or other metals."

To George William Turner, of the parish of Saint Mary, Bermondsey, in the county of Surrey, paper-manufacturer, for an invention of " certain improvements in machinery for making paper."

To William Westley Richards of Birmingham, in the county of Warwick, gun-manufacturer, for an invention of " certain improvements in the construction of touch-holes and primers suitable to percussion guns, pistols, and all sorts of fire-arms fired upon that principle."

July 6. To Richard Wood of New York, in the United States of America, but now of Bishopsgate Street Without, in the city of London, being one of the people called Quakers, for an invention of " an inking apparatus to be used with certain descriptions of printing-presses."

To George Goodlet, residing in Leith, in that part of the United Kingdom of Great Britain and Ireland called Scotland, and proprietor of the London, Leith, and Edinburgh Steam-Mills, for an invention of " a new and improved steam-kiln for drying all kinds of grain, beans, peas, malt, and seeds of every description."

To William Gutteridge, of the parish of St John, Clerkenwell, engineer, for an invention of " certain improvements in apparatus for distilling, and other purposes."

22. To Henry Lister Maw of South Molton Street, in the county of Middlesex, Lieutenant in the Navy, for an invention of " an improved method of using fuel, so as to burn smoke."

27. To Thomas Spiney, of Cheltenham, in the county of Gloucester, gas-engineer, for an invention of certain improvements in apparatus for manufacturing gas for illumination."

Aug. 18. To George Givinett Bompas of Fishponds, near Bristol, Esq. M. D., for an invention of "an improved method of preserving copper and other metals from corrosion or ozydation."

To Isaac Higgins of London Street, in the city of London, merchant, for an invention in consequence of a communication made to him by a certain foreigner residing abroad, "of certain improvements in extracting sugar or syrup from cane-juice and other substances containing sugar, and in refining sugar and syrups."

23. To Benjamin Ainsworth of the parish of Birmingham, in the county of Warwick, button-maker, for an invention of "an improvement in the making and constructing of buttons."

Omitted last Number.

June 2. To Andrew Ure of Finsbury Circus, in the county of Middlesex, M. D., for an invention of "an improved apparatus for distilling."

INDEX.

Supra, p. 378. after Nierembergia, *read* N. gracilis, *Hooker*, in Bot. Mag. t. 3108.

NEILL & Co. PRINTERS,
Old Fishmarket.