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EXHIBITING A VIEW OF THE

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IN THE

SCIENCES AND THE ARTS.

CONDUCTED BY

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THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

On the Physical Structure of the Site of Rome, and the adjoining Country *. Communicated by the Author †.

It has seldom happened that those who have undertaken to illustrate the classics, have endeavoured to throw light upon obscure passages in their authors by the aid of physical science. A great proportion of the most eminent commentators lived, it is true, at a period when science was little cultivated, or at least with that minute observation of facts which can alone give weight to its conclusions. But, of late, our classical scholars have often displayed considerable scientific attainments, and many of our men of science have given proofs of their accomplishments in classical learning. Of the latter, the interesting Treatise on Volcanoes by Dr Daubeny of Oxford, may be adduced as an example in this country; and the *Memoria dello Stato Fisico del Suolo di Roma*, of the accomplished and lamented Brocchi, may serve as a specimen of the classical attainments of the geologists of the continent. The science of geology bids fair to contribute largely towards this end, and the study of the physical structure of Italy, especially the neighbourhood of Rome and Naples, offers a wide and promising field to the researches of the scholar. Nor is it unimportant in the education of our youth, who are

* A coloured geological map of the vicinity of Rome, will be found in vol. viii. for 1830, of Edinburgh New Philosophical Journal.

† Transmitted from Bonn.

apt to associate Evander and Turnus and Romulus with ideas of the first state of things in Italy, to reveal to them the important truth, that, although the events of those days are of remote antiquity in the history of *man*, they are but the occurrences of yesterday, as compared with the age of the country in which they happened. That, although the Seven Hills were elevated at a period when the latest changes which the earth has undergone took place, they had probably existed for countless ages before they became the habitation of man, and had afforded shelter to races of animals which became extinct before man was created.

The writings of Brocchi, Von Buch, and Breislak, have supplied the chief facts contained in the following memoir, which, it is hoped, will not be uninteresting to those who have not made geology a particular object of attention, and who, in studying the history of Rome, have occupied themselves only with the productions of human genius, with the monuments which stand on the surface of the land, and have not suspected that the soil itself, on which these were built, contains faithful records of the highest interest, written in characters so intelligible that no doubt can exist as to the authenticity of the historical facts which they reveal.

To render a description of the form and structure of the spot upon which Rome was built, and of the country which lies contiguous to it, more intelligible, it is necessary to begin with a brief outline of the physical geography of Italy.

The Apennines are an uninterrupted range of mountains, which, branching off from the Maritime Alps, extends through the whole peninsula to the farthest extremity of Calabria. They do not present the sharp broken outlines, the pinnacles and needles, of the Alps; their summits have, in general, a rounded form, a more regular and uniform *contour*, and their sides a more gentle slope; and although there are many deep gullies in their flanks, there is no great valley which divides the chain completely across.

The most elevated part of the Apennines is in the territory of the Sabines. There are two points of great elevation; the one, called by the modern name of *Monte Corno*, and the loftiest part of it *Il Gran Sasso*, is situated about sixty-five miles north-east by east of Rome, and rises 9521 feet above the Mediterranean; the other *Il Velino*, about twenty miles south and by west of the former, and immediately north of the Lacus Fucinus, now Il Celano, which is 8182 feet high. The next greatest height is at a considerable distance, about forty miles north-west of Florence, *Il Cimone di Fanano*, which is 7000 feet above the sea.

Where they approach the Alps, the Apennines are composed of a mixture of primary rocks, viz. mica-slate, clay-slate, granular limestone, granite, and serpentine. The same rocks also occur at the southern extremity of the chain in Calabria, but they form only a small portion in the intermediate space. The country on the two sides of the range presents considerable difference in geological structure; that next the Adriatic being wholly composed of secondary rocks, with the exception of some insolated patches of serpentine here and there; while on the Mediterranean side there is an extensive tract, chiefly along the shore, of primary and transition rocks, with only occasional patches of secondary strata in it. On this side also, all the volcanic rocks are found.

The principal rock in the north-western part of the Apennines is a kind of sandstone and slate, well known to geologists by the names of Greywacke and Greywacke-slate, the latter containing subordinate beds of limestone with organic remains. There are also considerable hills entirely composed of transition limestone, many of which produce varieties of marble used for agricultural purposes, &c. The statuary marble is a different rock, and belongs to the primary class.

These rocks extend southwards as far as the neighbourhood of Cortona, but do not exclusively compose the Apennine ridge to that point. The rock which may properly be termed the rock of the Apennines is a limestone, but more modern, geologically speaking, than that already mentioned. It is not confined to the principal chain, but extends also into the lower country, forming here and there detached hills. In Tuscany it covers in many places the older rocks, and here there are a great many limestone hills quite detached from the main range. On the eastern side of it, there is no calcareous hills distinctly separated from the Apennines, except one forming a promontory on the sea-shore in the neighbourhood of Ancona, and a chain of low hills in Apulia. In the low country, on the Mediterranean side, the limestone seldom appears, being covered either by sand and marl, or by volcanic matter. The whole coast on this side from Mons Argentarius to Naples is a low sandy shore, shoaling gradually into the sea to a great distance, with the exception of some detached points, to be afterwards mentioned. In that part of Apulia now called *Puglia Pietrosa*, the rocky Apulia, bare limestone strata extend from the central range to the sea-shore, and are only occasionally concealed by a scanty covering of vegetable soil. In planting the olives and vines, they break the stony crust with iron-bars, in order to come at an intermediate layer of ochreous clay, where the roots may spread.

The wide and extensive valleys of Foligno and Terni, and the country around Otricoli, are covered with vast deposits of limestone gravel, which continues as far as Civita Castellana, where it is partially covered by volcanic matter.

At the foot of the Apennines there is a series of low hills, which cover the greater part of the space comprehended between the high mountains and the sea, on both sides of Italy. They are distinguished not so much by their lesser elevation as by the difference of their composition, and the epoch of their formation, which must have been posterior to that of the Apennines; in reference to which they may be termed *Tertiary Deposits.* They are of different degrees of elevation, sometimes rising to a considerable height; for the capital of the little republic of San Marino, built upon one of them, is nearly 2000 feet above the sea; and some near Sienna are still higher.

While the strata of the limestone mountains are always more or less inclined, the materials of the sub-apennine hills lie generally in a horizontal position. They consist of marl, sand, and gravel: they contain the trunks of trees almost in their natural state, leaves of vegetables, bones of quadrupeds, skeletons of fish, on which the dried flesh is still to be seen, and immense quantities of shells, in which the gluten and colouring matter is often preserved, and frequently the tendinous ligament which unites the two shells of the bivalves remains entire; all bespeaking an origin of much more recent date than the limestone of the central chain, but of ancient date in comparison with others hereafter to be described; for they are covered with volcanic ashes, and these last have a covering of more modern depositions from lakes of fresh water, under which vast tracts of Italy must have lain for ages.

These tertiary deposits compose the low hills which skirt the northern and eastern sides of the Apennines from Piedmont to Otranto. On the Mediterranean side, they have been found in patches at Nice and Savona, but not in Liguria, nor until you come to the territory of Lucca and Pisa, where they occur, and extend into the country around Arezzo, Volterra and Siena, and beyond the latter place as far as Santa Fiora, after which they are covered by the volcanic products which first appear there. Within the limits of the volcanic country they appear in several situations, as in the neighbourhood of Todi, Orvieto, Otricoli, at Monterose, about half-way between Rome and Civita Vecchia. In some places these tertiary deposits rise up amidst the volcanic materials, as will be afterwards shown in speaking of the hills of Rome, in different parts of the Campania, and in the Island of Ischia.

The volcanic district of Italy is confined to that part of the peninsula which lies between the promontory of Minerva, now Capo Campanella, on the south side of the Gulf of Naples, of which the Island of Capri is a prolongation, and the mouth of the river Umbro (the Ombrone), which lies a little to the south of the Island of Elba, a distance in a direct line of about 230 miles. The greatest breadth of this volcanic district is at Radicofani, south-west of Clusium, which is forty miles from the seashore; and it is bounded on the east by a line passing through Surrentum, Stabiæ, Nuceria, Nola, Capua, Teanum, up the valley of the Liris to Frusino, thence in the line of the Via Latina, passing between Tusculum and Præneste, Nomentum, Capena, and a line east of the Lacus Vulsiniensis, crossing the river Paglia and the ridge west of Clusium, of which the mountain now called Radicofani forms a part, and which rises to the height of 3060 feet; and thence westward to the mouth of the Umbro. There are also indications of volcanic action *within* the proper district of the Apennines near Telesia, between Capua and Beneventum; and even at a considerable distance from the great volcanic district, for Mount Vultur in Apulia, celebrated by Horace (Ode 4, lib. iii.), is a volcanic mountain rising in the midst of the chain of the Apennines, and the neighbouring town of Acherontia, "which Horace calls *Nidus Acherontiæ*, probably derived its name from being situated in an elevated and circular cavity on a mountain, such as the crater of an extinct volcano would exhibit, borrowing its name from the Lacus Acherontiæ, now Fusaro, near Naples."—Daubeny, 141. The Lacus Amsanctus appears also to be the crater of a volcano.—Id. 142.

Volcanic action has long ceased in every part of this district, except at its southern extremity, and there are no distinct human records of that action, except in Vesuvius and the country immediately contiguous to it. But the proofs of the agency of fire in distant ages, throughout the tract I have named, are written in characters which cannot be mistaken. The whole face of this tract is not, however, occupied by volcanic products: these are interrupted in various places by the Apennine limestone and the tertiary deposits rising up in the midst of them. An exact representation of the mineral structure of the district, could only be given by means of colours upon a map on a large scale.

The volcanic products are of various kinds. They consist of hard lava of a close, compact, semi-crystalline structure, resembling rocks of common occurrence in various parts of the United Kingdom, known by the names of greenstone, basalt, whinstone, &c.; also of a stone nearly as hard as the preceding, but less compact, and evidently composed of an agglutination of fragments. This is known by the name of volcanic *tuff* or *tufa*. Tufa differs from lava in this, that it has never run in a fluid state, but is an aggregate of scoriæ, lapilli, sand and ashes; substances, all of which have been subjected to fire, but thrown out by the volcano and deposited far from the craters from whence they were ejected. It is, besides, very common for volcanoes to throw out a vast quantity of water, which, mixing with the scoriæ and ashes, forms vast streams of liquid mud of greater or less density, as the ashes bear a greater or less proportion to the water. When the water evaporates, the mass becomes compact and hard, and thus tufa is formed. Such was the stream of volcanic matter which covered Herculaneum; ashes agglutinated by the mixture of water and converted into a hard stone by the evaporation of that water and by pressure. It does not appear that in the eruption of the year 79, by which Herculaneum and Pompeii were destroyed, any *lava* flowed from Vesuvius. At Herculaneum, the substance which fills the interior of the houses must have been introduced in a state of mud, but streams of lava have flowed over the site of the city in modern times, at different periods. Masses of hard lava and beds of ashes are accumulated to a depth of nowhere less than seventy, and in many places of 112 feet. Besides these stony bodies, there are others of a less aggregated texture, pumice, scoriæ, lapilli, and ashes. There are varieties of the tufa, which it is also necessary to distinguish, viz. *stony tufa* and *granular tufa*. The *stony tufa* is compact, of a reddish-brown colour, with specks of an orange tint, and is of sufficient hardness to be used as a building stone, and it was so employed to a great extent by the ancient Romans. The *granular tufa* is light, friable, and composed of largish grains weakly cohering, with fragments of volcanic minerals and rolled pebbles of compact lava. It is an aggregate of lapilli. There is, moreover, a variety of lava of such frequent occurrence, as to require to be described. It is known by the name of *Peperino*; the whole substance is fresh, undecomposed, and bright to the eye, whereas, in tufa, the greater part is dull, and appears withered. The peperino resembles a porphyry, the tufa a sandstone.

The general form of Latium is undulating and hilly. Rome stands in a spacious valley, flanked on both sides by hills, with the Tiber flowing through it. On the right bank are Monte Mario, the Vatican, and the long ridge of the Janiculum; on the left bank the Pincian, Quirinal, Viminal, and Esquiline, which can scarcely be called separate hills; then the Cœlian and Aventine; and in the plain surrounded by these, rise the insulated Palatine and Capitoline Hills. The breadth of the valley from the summit of the Esquiline to the summit of the Janiculum is about two miles, its length from the Pincian to the Aventine nearly the same. The breadth of the Tiber as it flows through Rome is from 180 to 190 feet, and its average depth twenty feet.

Of the hills of the right bank, Monte Mario is considerably the highest, being 468 feet above the level of the sea, or 446 feet above the surface of the Tiber; that river at its ordinary level, when neither swollen by floods nor reduced by droughts, being at Rome about twenty-two feet above the level of the sea at Ostia. The highest point of the Janiculum is 294 feet above the Tiber. The Vatican Hill is low, being only seventy-eight feet.

The heights of the hills on the left bank above the surface of the Tiber are as follows:—the Esquiline, 229 feet; the Pincian, 194; the Quirinal, 159; the Viminal, 148; the Palatine, 148; the Cœlian, 146; the Capitoline, 138; the Aventine, 133.

The high grounds were the first occupied, but a great part of the city was built upon land very little elevated above the level of the river, which, as we know from numerous passages in the classics, frequently overflowed its banks. It has been known in modern times to be swollen to the height of twenty-eight feet above its ordinary level. The pavement of the vestibule of the Pantheon is only twenty-four feet above the ordinary level of the Tiber, and it is situated nearly half a mile from its banks. The basis of the column erected in the Forum in honour of the Emperor Phocas, is only eighteen feet above the river. In that low part of the city situated between the Aventine, Palatine, and Capitoline hills, there was a district known by the name of Velabrum, which was very much occupied by markets and shops of various kinds. It was divided into two parts; the *Velabrum majus*, which ran up into the valley between the Palatine and Aventine hills; and the *Velabrum minus*, which occupied the lower extremity of the valley between the Palatine and Capitoline hills. There was a tradition that both had existed as shallow lakes, and that they continued as such until they were both drained by one common outlet, when the Cloaca Maxima was formed. The following passages may be quoted as proofs of this tradition.

1. Tibullus, in the fifth elegy of the second Book, says:

> "At, qua *Velabri* regio patet, ire solebat
> Exiguus pulsâ per vada linter aquâ."

2. Propertius, in the ninth elegy in the fourth book, "De Hercule et Morte Caci," says:

> "Qua *Velabra* suo stagnabant flumine, quaque
> Nauta per urbanas velificabat aquas."

3. Varro, in the fifth book, "De Lingua Latina," speaking of the etymology of the *Aventine* hill, says:—"Ego maxime puto ab *advectu;* nam olim paludibus mons erat ab reliquis disclusus; itaque eò ex urbe qui advehebantur ratibus, quadrantem solvebant. * * * Velabrum dicitur a vehendo." In another place, speaking of the Capitol, he says:—"Ab his palus fuit in Minore Velabro, a quo, quod ibi vehebantur lintribus, Velabrum."

That such shallow lakes existed before there was a proper outlet, is extremely probable, when we consider the lowness of the ground, that it is exactly at that point of the river where the water in floods would be most likely to overflow the banks, and that it forms the natural channel for the drainage of the surface water, from a very great part of the Quirinal, Viminal, Esquiline, and Cœlian hills. It is extremely probable, too, that so great a work as the Cloaca Maxima was not undertaken for the purposes of a sewer to a city, but in order to drain the land of great inundations.

A spot so covered with vegetation and with buildings as the site of Rome, is not very favourable for geological investigations; and another obstacle arises from the vast quantity of rubbish derived from buildings, which have been destroyed one after the other for so many ages. This has accumulated to so great a degree in many places, that a paved street is stated by Montfaucon (Diar. Ital. p. 195) to have been discovered at a depth of forty-two feet below the surface, in the valley between the Quirinal and Viminal hills. The ground of the Forum, at the base of the column of Phocas, is twenty-six feet below the level of the present Campo Vaccino, and that column is built upon ancient ruins, as are the Arches of Titus and Constantine.

I shall now proceed to describe the structure of each hill separately, beginning with the Capitoline.

The Capitoline Hill.—This hill is of an oblong form, insulated, running nearly north and south, about 500 yards long, and 230 yards broad. It has two summits, separated by a depression called the *Intermontium.* The southern summit, at the western angle of the Tarpeian rock, is 128 feet above the level of the Tiber: the northern summit, at the floor of the church of *Ara Cœli*, is ten feet higher. It is probable that, when the Capitoline hill was selected as a proper situation for a fortress, it was nearly inaccessible on all sides, except on that next the Forum. The crumbling of the rock of which it is composed, and the accumulations of rubbish, have, in the lapse of ages, rendered the sides less abrupt.

Of all the hills of Rome, this affords the best opportunities of discovering the internal structure, from the numerous excavations that have been made in it, anciently and by the modern Romans; and all the mineral substances found in the other hills are met with here.

In some excavations at the foot of the Tarpeian rock, the strata of marine formation are discovered, forming the subsoil upon which the volcanic and all the other superincumbent materials have been deposited. They consist (in ascending order) of,

1. A bed of a dry semi-indurated brownish clay, with scales of mica; slightly calcareous; thickness not discernible.

2. Thin beds of compact limestone, interstratified with the preceding clay.

3. A bed, four feet thick, of grey sand, slightly agglutinated, composed of grains of tufa, limestone, and a great deal of mica, with a thin band of the compact limestone.

4. A bed, two feet thick, of yellow clay.

5. A bed, five feet thick, of *granular tufa*, of a blackish colour, containing a distinct layer of limestone pebbles.

6. Another bed of five feet in thickness, of a grey colour, of granular tufa.

7. Stony tufa, which continues to the summit of the Tarpeian rock, and, therefore, about 100 feet in thickness.

The bed of yellow clay, No. 4., is the uppermost of what may strictly be termed the marine deposits.

The northern part of the hill is also composed almost wholly of the stony tufa.

In the intervening space, the *intermontium*, are found extensive fresh water deposits, consisting of a recomposed granular tufa and yellowish clay-marl, of two sorts; the one indurated, containing fragments of pumice, of the stony lava, vegetable remains, and numerous lacustrine shells; the other variety is of a softer texture, contains no fragments of volcanic products, and fewer shells. That the bed of recomposed granular tufa is also of fresh water origin, is clear, from its containing also land shells.

The part of the hill from which it is supposed criminals were thrown is still precipitous, but its present section was produced in the fifteenth century, by the fall of a large portion of the rock. Its present height is about sixty feet; its base having been raised by repeated accumulations of fallen portions of the rock, and the ruins of the buildings which these buried.

There are many ancient excavations in the stony tufa, the quarries from which building stones were obtained, before they began to use the *Peperino* (*i. e. Lapis Albanus*), and the *Travertino* (*i. e. Lapis Tiburtinus*), both of which will be described hereafter. Some of the most ancient structures of which remains still exist upon this hill, appear to have been built before these quarries were opened, being of a different kind of stone. The *Tabularium*, in which the public records were kept, and some others, are built of the peperino found in the neighbourhood of the Gabian Lake, the *Lapis Gabinus*.

These stone quarries (Latomiæ) were used as prisons. That called Tullianum, which is described by Sallust, was formed in one of them. Quarries of the stony tufa, similar to that of the Capitoline hill, must have been previously opened in other places, for the arch of the Cloaca Maxima is composed of it. The walls of the city raised by Servius Tullius are composed of square blocks of it. It was cut into the form of bricks, and used as such, as may be seen in the theatre of Marcellus; and in later times, in the walls of the fortress near the tomb of Cæcilia Metella. This stone, when spoken of by the Roman authors, has often the specific name of *Lapis quadratus*, or *Saxum quadratum*, applied to it; and when these phrases are used by Livy and Vitruvius, may they not be referring to a particular character in this stone, rather than to stones cut into a square form, or, as we say, *squared* by the mason? Is it not probable that this name was given to it, from the property it has of splitting in the direction of the cleavage into quadrangular masses, just as the Germans designate a sandstone possessing a similar property *quadersandstein*. Thus, when Livy speaks of the tomb of Horatia being constructed of *Saxum quadratum* *, and when Vitruvius†, speaking of certain monuments near Rome, says, that some were built of marble and others *lapidibus quadratis*, they are, it is conceived, to be understood to mean this stony tufa. Indeed the passage of Vitruvius makes it very probable; for had he alluded to the cutting of the stone by the mason, would he not have spoken of the marble being squared also? The younger Pliny ‡, speaking of the aqueducts of Nicomedia, perhaps refers to a stone of this description, for many parts of Asia Minor are volcanic §. This stone was also called by the ancients *tophus ruber*, a term made use of by Vitruvius‖ in speaking of that of Campania; and the *tophus niger* was probably the *peperino*, which is used in many of the buildings of Pompeii. They also speak of *saxum rubrum*, and *saxum rubrum quadratum.* Strabo uses the former phrase, and Vitruvius both, and also mentions the *rubræ lapidicinæ* ¶ of the environs of Rome. In the Flaminian Way, there was a place called *ad saxa rubra*, mentioned by Livy**, Cicero††, Tacitus‡‡, and Festus Pompeius, and which still preserves

* "Horatiæ sepulcrum, quo loco conruerat icta, constructum est saxo quadrato."—Lib. i. 26.

† "Id autem licet animadvertere etiam de nonnullis monumentis, quæ circa urbem facta sunt e marmore seu *lapidibus quadratis*;" and a little farther on, he speaks of building walls "ex *rubro saxo quadrato*, aut ex testa, aut silicibus ordinariis."—Lib. ii. c. 7.

‡ "Manent adhuc paucissimi arcus, possunt et erigi quidam lapide quadrato."—Lib. x. ep. 46.

§ Vitruvius mentions that pumice is found in Mysia, which is not very far distant from Nicomedia:—"Pumex—non in omnibus locis nascitur, nisi circum Ætnam, et collibus Mysiæ, qui a Græcis κατακεκαυμένοι nominantur." —Lib. ii. c. 6.

‖ "Sunt etiam alia genera plura, uti in Campania *ruber* et *niger tophus*."—Lib. ii. 7.

¶ Lib. ii. c. 7.

** Speaking of the battle of the Cremera, and the retreat of the Veientes: "Ita, fusi retro ad *saxa rubra*, (ibi castra habebant), pacem supplices petunt." —Lib. ii. cap. 49.

†† Phil. ii. 31.

‡‡ "Antonius per Flaminiam ad *Saxa rubra*, multo jam noctis, serum auxilium venit."—*Hist.* L. iii. c. 79.

its ancient name in that of *Pietre Rosse.* Livy states, that in the early ages of Rome, some of the streets of the city were paved with this kind of stone. Afterwards the more compact and durable lava found in the neighbourhood, near the spot where the tomb of Cæcilia Metella stands, appears to have been substituted for the softer tufa. They called it *silex* *.

The *granular tufa* is of a blackish or deep violet colour; light, friable, composed of grains of scoriæ and ashes slightly cohering, and mixed with many fragments of simple volcanic minerals; and it also often contains rolled pebbles of lava. It is of far more frequent occurrence in the hills of Rome than the stony tufa; it constitutes the chief part of the Pincian, Quirinal, Viminal, Esquiline, and Palatine hills; and it is found in great abundance in the neighbourhood. It is found on the summit of Monte Mario, and near Mons Sacer. In the former place, it forms extensive and distinct beds, traversed by those natural rents which so often occur in the stony tufa. In several places it contains impressions of leaves of land vegetables. In some situations it lies under the stony tufa, but in most cases it lies over it.

It is in this granular tufa that the numerous catacombs found in and around Rome are almost exclusively excavated. These subterraneous places were called Arenariæ †,—a name still preserved in the appellation given to those pits from which they dig pozzolano, for mixing with lime in making mortar, at Frosinone (Frusino), and Signi (Signia). Vitruvius, speaking of the sand used for making mortar, describes four kinds,—a black, a grey, a red, and one which he calls *carbunculus*, the latter found in Etruria. It appears by his description to be very similar to that found at Viterbo, and in the Tusculan and Alban hills.

* "Eodem anno (457, A. U. C.) ædiles curules aliquot fœnoratoribus diem dixerunt; quorum bonis multatis, ex eo, quod in publicum redactum est, æenea in Capitolio limina, et trium mensarum argentea vasa in cella Jovis, Jovemque in culmine cum quadrigis, et ad Ficum Ruminalem simulacra infantium conditorum Urbis sub uberibus lupæ posuerunt; *semitamque* SAXO QUADRATO *a Capena porta ad Martis straverunt.*"—*Liv.* x. 23.

"Censores (578, A. U. C.) vias sternendas *silice* in urbe, glarea extra urbem, substruendas marginandasque primi omnium locaverunt."—*Liv.* xli. 27.

† "Asinius autem brevi illo tempore, quasi in hortulos iret, in Arenarias quasdam extra portam Esquilinam perductus occiditur."—*Cic. pr. Cluent.* 13.

The red variety was the best, and was found at the Tre Fontane, a short way from Rome, on the road to Ostia, where it is dug at this day. It was employed in the mortar of the oldest Roman edifices. Sometimes it assumes the form of clay; and bricks and coarse pottery used to be, and are now, made of it.

At the foot of the Capitoline hill there was a street called *Argiletum*, which Varro says got its name, according to the opinion of some, from clay being found there: "Argiletum—alii ab argilla, quod ibi id genus terræ."—Lib. v. The clay pits were most probably in the *Intermontium*.

The Palatine Hill—is, like the Capitoline, insulated. It is ten feet higher than the Capitoline, and divided into two summits; the one of which was called Termalus, the other Velia. It is hardly possible to discover the external structure of this hill, it is so thickly covered by soil and the rubbish of ruins, and there being scarcely any excavations in it. The granular tufa has been found in it, and it is very probable that it is covered with fresh water deposits, like the other hills.

The Pincian Hill.—This hill, formerly called the Collis Hortulorum, is the first which flanks the left bank of the river, and rises nearly 200 feet above it. Several excavations have been made in different parts of it, so that its structure has been fully made out.

1. The lowest part is composed of granular tufa, and this has not been dug through. It contains calcareous concretions, with impressions of arundinaceous plants, and the tufa itself contains impressions of leaves of trees.

2. Next comes a bed of clay three feet thick, with impressions of leaves, the materials of the clay being evidently derived from a disintegrated tufa.

3. Above this is a granular tufa, mixed with pebbles of the Apennine limestone; a thin bed of fragments of pumice lies over the tufa.

4. These are all covered by a vast deposit of sand, forming, as it were, a mantle over the whole hill, the great external mass being the granular tufa. The sand is siliceo-calcareous, and contains a great quantity of calcareous concretions, similar to those deposited by calcareous petrifying springs, detached pebbles, beds of limestone gravel, and masses of travertino, with

here and there detached portions of tufa. All these materials have evidently been deposited by fresh water, and which must have stood at a considerable height above the summit of this hill.

The Quirinal Hill—Lies contiguous to the Pincian, and is nearly identical with it in composition, viz. a central mass of granular tufa, covered with the fresh water deposit of the siliceo-calcareous sand, and beds of marl. The tufa has been found within three feet of the summit, containing fragments of scoriaceous lava.

The Viminal Hill—Is identical in composition with the Pincian and Quirinal, and has its sides also covered by fresh water deposits.

The Esquiline Hill—Is of greater extent than the other hills; of an irregular shape, being divided into several subordinate parts. Indeed the Quirinal, Viminal, and Esquiline hills, may almost be said to form one hill, both in form and substance. There are two principal heights of the Esquiline; *Mons Cispius*, next the Viminal, and *Mons Appius*, next the Cœlian. It is the highest of the seven hills, being 229 feet above the Tiber.

Mons Cispius is chiefly composed of granular tufa, which in one place contains a thin stratum of pumice, and in other places portions of scoriæ, lava, pebbles, and fragments of white pumice. *Mons Appius* is also composed of beds of granular tufa of various structure, and of stony tufa, and of clay.

The Agger of Servius Tullius.—This artificial mound runs along the summit of the plain of the Quirinal, Viminal, and part of the Esquiline hill, in a direction nearly north and south, being somewhat less than a mile in length, and about fifty feet broad; and it is the general opinion that it was erected as a fortification against hostile incursions from that side. In some parts of it which have been opened, it was found to be composed of blocks of peperino lava.

The Cœlian Hill—Lies between the Esquiline and Aventine, and, like the Palatine and Capitoline, is insulated. Its height is not more than 146 feet above the river. It appears to be chiefly composed of stony tufa, like that found in Mons Appius in the Esquiline, but covered with deposits like the other hills, containing fresh water shells.

The Aventine Hill is the lowest of all, being only 133 feet above the river. Under this name, however, are comprehended two distinct eminences, separated by a valley or *intermontium.* It was that part next the river which alone received in former times the name of the Aventine Hill. It is chiefly composed of stony and granular tufa, the latter containing many indications of recomposition; but, on the side which overhangs the Tiber, there are extensive deposits of sand and marl, together with thick solid horizontal beds of travertino, extending above half a mile. This travertino contains numerous fresh water and land shells, among which are found the shells of snails now common in the gardens of Rome. It also contains fragments of pumice.

I shall now proceed to describe the hills on the right bank of the Tiber, which differ very materially from those on the left bank, as they are mainly composed of marine strata. There are three marked eminences, the Janiculum, the Vatican, which is a continuation of the Janiculum, and Monte Mario, which is a continuation of the Vatican Hill; the three forming one ridge, interrupted only by slight depressions and valleys.

Monte Mario.—This hill rises to the height of 446 feet above the Tiber. It is composed of sand, in some places wholly siliceous, in others siliceo-calcareous, containing in several situations thin beds of gravel and masses of solid sandstone, and full of marine shells. Large oyster shells have been found in abundance on the very summit, as well as marine shells of other species and genera. Univalve and bivalve shells are also seen adhering to the pebbles or the beds of gravel, evidently shewing that these pebbles once lay at the bottom of the sea. This siliceo-calcareous sand is of the same nature as that which forms the chief part of the low sub-appenine hills throughout the whole of Italy. It is in general loose, and without aggregation; but, in some places, it is agglutinated with a pretty solid stone. Under this bed of sand lies a bluish clay, regularly stratified, full of marine shells.

The Vatican is a low hill, being not more than seventy-eight feet above the river. In composition it is similar to that of the Monte Mario. The clay found in this hill is used now to make bricks and pottery, as it was for the latter purpose in ancient times, as appears from a passage in Juvenal *.

The Janiculum is a long ridge of about a mile and a quarter in extent, and nearly parallel with the river, its highest point being 294 feet above the Tiber. In composition it is similar to the Vatican and Monte Mario. Granular tufa has been found in several places, and deposits with fresh water shells have also been found on its sides next the Tiber †.

Although these three hills are chiefly composed of marine deposits, volcanic products have been found upon all of them at the base and on the summit. A granular tufa is found at the base of the Vatican, and in that part of the Janiculum which is next the Vatican. It contains fragments of pumice. Granular tufa is found on the very summit of the Janiculum, containing large pieces of pumice, and lying distinctly upon the marine deposits. The same thing occurs on the summit of Monte Mario.

The marine deposits of which these hills are composed, are found to constitute a line of hills, extending northwards as far as a brook called *Acqua traversa*, and westwards to Ostia and Civita Vecchia; and as they are similar to those composing the great range of the Subapennine hills, it is extremely probable that they form the subsoil of the whole country around Rome, upon which the volcanic products have been deposited,—a probability rendered still greater by their being actually found at the base of the Capitoline Hill. In sinking wells at Rome, it is always necessary to pass through the tufa; and, as that is done at various depths, it is probable that the marine strata formed a hilly uneven surface, before the volcanic matter was deposited upon them.

Fresh-Water Deposits.

Having repeatedly alluded to the deposits which lie upon the sides of the hills over the volcanic matter, in so many places, and form so important a feature in the physical structure of this region, I shall give a brief description of their nature.

* "Et Vaticano fragiles de Monte patellas." Sat. v.

† Some of the sand of the Janiculum is of a shining sparkling nature, and hence that hill got the name of *Mons aureus*, and by corruption *Montorius*.—*Adam's Antiq.* 562.

They are composed of sand, clay, and marl, and of a solid rock called *Travertino.* The sand is of a yellowish colour, and is in many places very calcareous. The clay is generally also calcareous, and may properly be called an argillaceous marl: it is of a yellowish-grey colour, contains scales of mica, and small fragments of pyroxene, a common mineral among volcanic products. These deposits all contain lacustrine shells, particularly those found in stagnant waters.

The *travertino*, from its importance, deserves a more particular description.

If water be highly charged with carbonic acid gas, it acquires the property of dissolving carbonate of lime, *i. e.* limestone, so as to hold a considerable quantity in solution. If water thus charged be exposed to the open air, and especially if the surface be increased, as is the case when streams are broken by a cataract, the carbonic acid gas escapes, and the calcareous matter which it enabled the water to hold in solution is deposited. Most petrifying springs are of this nature, and whatever objects are presented to the water, are more or less speedily encrusted. The calcareous matter, in certain cases, forms a solid crystalline mass, which sometimes cannot be distinguished from statuary marble either in grain, colour, or composition, as is the case with that found in the neighbourhood of Civita Vecchia, which is as close and crystalline in its texture as Carrara marble.

A vast number of these calcareous springs occur in Tuscany, in many parts of which the whole ground is coated over with the deposit. In other places, in the same country, compact rocks are seen descending the slanting sides of hills, very much in the manner of lava currents, except that they are of a white colour. At St Vignone, near Radicofani, there is a spring which has deposited a vast series of strata, to the depth of 200 feet, and so compact as to form an excellent building stone, of which enormous blocks have been raised. Near the same place, are the celebrated thermal springs and baths of San Filippo, where the water is so highly charged with calcareous matter, that a hard stratum of stone, of a foot in thickness, is obtained in four months; and there is a mass of stone a mile and quarter in length, one-third of a mile in breadth, and 250 feet thick in some places. But one of the most remarkable places in which it is found, inasmuch as it has given the name to the stone, is Tivoli, the ancient Tibur; and hence it is called *Lapis Tiburtinus,* modernized into *Travertino* *.

A great number of the most splendid edifices of ancient and modern Rome are built of travertino, derived from the quarries of Ponte Leucano, on the right bank of the Anio, a little below Tivoli.

These fresh-water deposits appear in so many places, that there is every reason to believe that they extend over the whole area on which Rome stands. They are found on the sides of the greater number of the hills along the left side of the great valley of the Tiber, and several miles from the city, as far as Monterotondo, which is near the ancient Nomentum. The quantity of travertino and calcareous tufa found on the hills on the left bank from the Porta del Popolo to the Milvian Bridge is astonishing. They form a series of successive horizontal strata, from the bottom to the summit of these heights, and frequently contain impressions of leaves of trees, and encrusted branches. The extensive beds of travertino on the side of the Aventine Hill next the Tiber, and the fresh-water deposits in the *intermontium* of the Capitoline, have been already noticed. They are found at the height of 150 feet above the Tiber on the Esquiline.

On the right bank, the tower called Torre di Quinto, nearly opposite the confluence of the Anio with the Tiber, which is three miles from Rome, is built upon a mass of travertino, resting on calcareous sand, which sand rests on volcanic matter. Beyond this tower, at Prima Porta, a considerable height above the river, there is a great mass of travertino, full of fresh water univalves. Beds of travertino are also found in that part of the valley which lies between Rome and the sea, particularly on the Via Ostiensis, near Torre di Valle.

But there is a circumstance connected with these fresh water deposits which is yet to be noticed, of the greatest interest as connected with the physical history of this region, viz. that they are found to contain bones of elephants and other land animals,

* For a description of the mode of formation of this stone at Tivoli, see Lyell's Principles of Geology, vol. i. p. 208. 1st edition.

buried at a great depth, and not in a few spots only, but over a great extent of country.

Elephants' bones have been found in the following places near Rome:

1. On the Pincian Hill.

2. On the summit of Monte Verde *, covered with calcareo-siliceous sand.

3. In the Mons Sacer; at the depth of thirty feet. They were found, in cutting down a portion of the hill for the purpose of collecting pebbles to mend the roads: they were imbedded in a mixture of sand and pebbles of limestone and flint, and fragments of lava. The bones were encrusted with calcareous spar.

4. Near Monte Mario, in the side of a valley in the Valley Farnesina; and near that place they were found in a spot where they were covered by a concretionary deposit, similar to travertino, and containing fresh-water shells.

5. At the foot of the Vatican.

6. Near the Villa Borghese, a short way from the Porta del Popolo.

7. At Aqua Acetosa, about three miles from Rome, near the confluence of the Anio, and near the Torre di Quinto, on the opposite side of the river.

8. Near the Porta Ostiensis.

9. Near Tivoli, at San Vellerino.

10. At Castel Guido, twelve miles from Rome.

11. Elephants' bones have been found near Viterbo, in a stratum of pumice, and lying under a current of lava.

12. In the neighbourhood of Puteoli.

But the occurrence of these bones is by no means confined to the country round Rome: they are found on both sides of the peninsula, from the Alps to the extremity of Calabria. In some places they are found in most extraordinary abundance, particularly in that part of Tuscany called the Valdarno Superiore, which looks like a vast cemetery of these animals. Before the peasants found out that they were objects of curiosity, and could sell them as such, they were in the habit of fencing their gar-

* Monte Verde is on the right bank of the river, opposite to the Aventine, and a short way from the Pons Sublicius. It is remarkable that in this hill strata of marine origin are seen lying between and covering beds of tufa.

dens with the tibiæ and thigh-bones of elephants dug from the adjoining sand-pits.

Such, then, is the remarkable structure of the ground upon which Rome was built, presenting phenomena of no ordinary interest, and which afford a field of speculation far wider than the limits to which this paper must be confined. But some of those general views which the phenomena described suggest, as to the successive changes which this region has undergone, and the probable causes of those changes, may be hinted at. Before entering upon these, it will be necessary to give a general idea of the physical structure of the adjoining country.

The Apennine mountains come close to the left bank of the Tiber, until that river takes a sudden turn to the south-west, in the immediate neighbourhood of Soracte. From that bend of the river, a line drawn through Cures, Cameria, along the base of Mons Lucretilis, Tibur, Præneste, Anagnia, Ferentinum, Frusino, to Fregellæ on the Liris, will bound the Apennine range properly so called; and these mountains, with some slight exceptions, which will be presently mentioned, are wholly composed of secondary limestone.

A fertile vale, which is distinguished by the name of the Campagna, in the bottom of which runs the Trerus, now the Tolero, separates the mountainous district that was inhabited by the Æqui and Hernici * from the detached range of mountains occupied by the Volsci. This latter tract of high country runs nearly north and south, from Artena, now Monte Fortino, to the sea at Anxur. Its northern part was called the Montes Lepini †. Here the rivers take their rise, the waters of which

* Cramer says, "it was maintained by some, that the Hernici derived their name from the rocky nature of their country; *Herna*, in the Sabine dialect, signifying a rock."—Vol. i. 78.

† This mountainous range rises to a very great elevation: the greatest height, now called Monte Schiera d'Asino, is stated by Prony to be 4878 English feet above the sea. Another point, Monte Capreo, is 4816 feet. The former of these heights is 500 feet greater than that of Ben Nevis, in Scotland, and nearly 1000 feet higher than Vesuvius. Comparing the heights with English mountains, for the sake of those who have not seen Ben Nevis, Monte Schiera d'Asino is 1310 feet higher than Snowdon, 1550 higher than Helvellyn, and three times and a half as high as Penmaen-Mawr. Strange to say, there are very few maps of Italy in which these mountains are laid down.

stagnate in the Pontine marshes. The whole of this range is composed of secondary limestone, and is properly a branch of the Apennines. The Circeian Promontory is a lofty insulated mass, rising 1729 feet above the sea, also composed of limestone, but of a totally different kind from that of the neighbouring mountains of the Volsci, being, geologically speaking, of a much older formation, and belonging to the transition class. There is a remarkable circumstance connected with this rock, for, in the face of the precipice next the sea, it is perforated, at the height of forty feet above the present level of the water, with holes formed by the Mytilus lithophagus, portions of the shell of the animal being sometimes found in the holes,—a clear proof, among many others on this coast, of a change in the relative level of the sea and land, since the formation of our present continents. That the Circeian Promontory was at one time an island, is evident from the proofs that exist of the sea having at one time covered the whole of the Pontine marshes to the base of the Volscian mountains. Excavations made near the sources of the Uffente, which is nearly ten miles from the shore, gave, at the depth of seventy-two feet, sea-sand mixed with shells, and the remains of marine plants in tolerable preservation. Lower down in the marshes, a section across the Appian Way gave, at the bottom, a clay mixed with sea-shells, above which came a bed, between five and six feet thick, of peat, and over that a bed of clayey soil, mixed with fragments of limestone.

North of the Montes Lepini, connected by a ridge, at the base of which the small town of Ulubræ is supposed to have stood, rises a group of hills, the site of many places of great renown, Tusculum, Aricia, Alba Longa, Velitræ; Mons Algidus, Mons Albanus, and the Alban Lake. The highest of these hills, Mons Albanus, now Monte Cavo, rises to the height of 3160 feet. Mons Artemisius, the point which rises immediately above Velitræ, is 3018 feet above the sea, and the town of Velitræ itself is situated at an elevation of 1187 feet. These differ in form and structure from any yet named, being wholly volcanic; not, however, composed of recomposed stones from ashes and cinders, but of hard compact lava, streams of which appear on every side; the waters of the Lacus Albanus and the

Lacus Nemorensis, now filling the craters from which these lava currents flowed*.

A line of connexion may be traced between the volcanic mountains of Teanum and Rocca Morfina, in the Campi Phlegræi, and those of Latium, streams of compact lava having burst forth in many places in the Campagna, as at the modern town of Pofi, near the junction of the Tolero with the Garigliano, where it lies upon the Subapennine clay of marine origin,—in the midst of the apennine limestone, in the country of the Hernici, near Veroli, between Frusino and Ferentinum; at the modern Tichiena, where there is an ancient crater,—and close by the Lacus Regillus. A current of lava has been traced by the side of the Appian Way, from the volcano of the Alban Mount to within two miles of the gates of Rome, about three quarters of a mile from the spot where the tomb of Cæcilia Metella stands, a distance of six miles. It is of different dimensions in different places, but in the quarries nearest Rome, it has been found above 60 feet in thickness. It has long supplied, in ancient as well as in modern times, the paving-stones of Rome; and there are numerous quarries in it, along the whole of its course. It is important, also, to remark, that this stream of lava lies upon a mass of volcanic lapilli †. Basaltic lava has also been met with about seven miles from Rome, on the Via Ardeatina.

Passing over the country north of the Tiber, we find other sites of extinct volcanoes. The Lacus Sabatinus was once the crater of a volcano, and is now surrounded by hills of solid lava, sending forth numerous currents into the surrounding country. Between this lake and Centum Cellæ, the modern Civita Vecchia, there is a chain of hills, at the eastern end of which, at Tolfa, there is a lava current, in great vertical masses, breaking through limestone. The main part of the ridge is a transi-

* The mysterious rising of the waters in the Alban Lake, may be very rationally accounted for, by some partial volcanic action in this region.

† "There are some passages in ancient writers, which might lead us to suppose a volcano to have existed among these mountains, even at a period within the limits of authentic history; for Livy notices a shower of stones, which continued for two entire days, from Mons Albanus, during the second Punic war, '*Albano Monte biduum continenter lapidibus pluit.*' Julius Obsequens, in his work *de Prodigiis,* remarks, that in the year 640 ab U. C. the hill appeared to be on fire during the night."—*Daubeny on Volcanoes,* p. 130.

tion limestone, similar to that of the Circean Promontory, of which, in all probability, it is a prolongation.

Farther north is Mons Ciminus, the highest point of which, now called Monte Soriano, east of Viterbo, is 4183 feet above the sea, which is 620 feet higher than Snowdon, and only 200 feet lower than Ben-Nevis. This is another range of volcanic hills, composed of compact lava, and sending out currents of it on every side; with the Lacus Ciminus, once the crater of a volcano*. Lava streams are met with in Sutrium, Nepe, Baccanæ, and the modern village of Borghetto, near Fescennium.

Soracte is an insulated mountain, an offset, or out-lier, as geologists term it, of the Apennines, on the right bank of the Tiber, and composed of the same species of secondary limestone. It rises to the height of 2270 feet above the sea, which is only 100 feet lower than Ingleborough, in Yorkshire.

These are the great features of the country which surrounds Rome; but the intervening spaces are by no means level plains. On the contrary, they present a very undulating surface, and rising sometimes into elevations, which obtained distinctive appellations as hills; such as the Mons Sacer, the Crustumini Colles, which are a part of the same range as Mons Sacer†, the Corniculani Montes, and those with the modern names of Monticelli and St Angelo, near Nomentum.

The whole of the country surrounding these heights is covered with volcanic matter, either in the form of stony tufa, granular tufa, or in a less coherent state, which last often goes by the name of Pozzolano, being that variety which, when mixed with lime, forms a mortar that has the property of setting under water; whence our imitative *Roman Cement* has got its name.

These volcanic products rise to a considerable height upon the hills; and they are found high up among the sinuosities of

* "According to some of the ancient writers, this lake was caused by a sudden sinking of the earth (Am. Marcellinus, l. 17, c. 7); in further proof of which they say, that the ruins of a town that formerly existed on this site, might be seen at the bottom of the lake when the water was clear. Servius, in his note on the line in the 7th book of the Æneid, in which this lake is mentioned (Et Cimini cum monte lacum, lucosque Capenos), alludes to a fable grounded on this tradition."—*Daubeny,* 125.

† Varro, speaking of the secession to Mons Sacer, says, "Tribuni—qui plebem defenderent in secessione *Crustumerina*."—De Ling. Lat. v. 14.

the Apennine valleys. Thus, ascending the bed of the Anio, stony tufa forms lofty rocks, near Varia, now Vicovaro, above Tivoli, and is met with about 2½ miles from Sublaqueum, now Subiaco. Ascending the valley of the Tiber, it is found surrounding the limestone of Soracte on all sides, at Falerii and at Otriculum. In the Campagna, it is found in many places high up on the sides of the hills; likewise on the western side of the Volscian Hills; and vast deposits of it have been found at Ardea, and about five miles from Rome, on the Via Ostiensis.

It is an important circumstance to remark, that, on examining minutely the mineral substances of which the tufa found in the Campagna, and between the Volscian mountains and the sea, is composed, there is indubitable proof that they have been derived from the same source as those which form the tufa of the Seven Hills, and not from the adjoining volcanoes of the Alban Hills. The tufa in the valley above Tibur is identical with that of the Tarpeian Rock*.

The volcanic products are, in their turn, covered with freshwater deposits, for these have been found in a great variety of places throughout this district: indeed, all the way from Vulsinii to Pæstum.

The facts here narrated evidently point out that this country has undergone great changes,—that these changes must have occurred at distant epochs,—and that, during the intervals of the later changes, there probably existed the same repose in the greater operations of nature, as we know to have prevailed since the earliest records of history; for although the neighbouring Campi Phlegræi have been repeatedly disturbed by volcanic action, Latium, and the whole region north of the Liris, is the same now as it ever has been since it was possessed by the human race (as far, at least, as we have any means of knowing or

* Hot springs, emanations of gas, sulphurous vapours, and sublimations of sulphur, are of common occurrence. Between Rome and Tibur, in the *Lacus Albula*, now called Solfatara and Lago de Zelfo, the water is tepid, is saturated with carbonic acid gas, and holds a vast quantity of lime in solution. "The stream which flows out of this lake fills a canal about nine feet broad and four deep, and is conspicuous in the landscape, by a line of vapour which rises from it."—*Lyell*, 207.

of conjecture), save those changes which the slow but constant action of existing forces has produced, such, for example, as are seen in the delta formed at the mouth of the Tiber, and the partial depositions of travertino.

Without carrying our views beyond a comparatively recent geological period, we see three distinct conditions of this region: viz. the period when the surface was formed of the clay, with marine shells; next, that period when the clay received a covering of volcanic ashes; and, lastly, the deposition of the beds, whose included fossils show that they were formed under tranquil lakes of fresh water. There is yet another state of things, of which records are left, when the whole country was acted upon and eroded by running streams and floods, which scattered blocks of stone upon the surface of the fresh-water deposits, in situations where the existing rivers could not have carried them, even if their waters could have transported such masses.

Marine shells are found imbedded in the tufa or volcanic ashes on the summit of Mons Albanus, an elevation of 3000 feet above the level of the present sea. It is demonstrable, therefore, that a change, to that extent at least, has taken place between the relative level of the sea and land now and formerly *.

Volcanic ashes cover the country more or less on the western side of the Apennines, from the Umbro to Calabria. They are invariably deposited in horizontal beds, or nearly so, whether in their loose incoherent state, or agglutinated in the form of the stony tufa. That they were deposited by water, is not only indicated hy this horizontality, but by their having been carried into the sinuosities of the valleys in the Apennines, as is seen in the valley of the Anio, to within a short distance from Subiaco. It is found in the same manner in the valleys of the Volscian mountains. Another remarkable circumstance is, that between beds of stony lava are frequently found layers of rolled pebbles, not only of pumice-stone and other volcanic substances, but of Apennine limestone. Elephants' bones have also been met with imbedded in the tufa.

This vast mass of volcanic matter, must therefore have been

* More than one argillaceous stratum, containing marine shells, occurs within 800 feet of the summit of Epomeo, in Ischia, a mountain 2605 feet above the sea.—*Lyell.*

ejected from volcanoes under the surface of the sea, at a time when the whole region that is lower than the summit of Mons Albanus was submerged. That these loose materials were deposited in the sea, and not in fresh water, is evident from the tufa containing marine shells in many places, and from its being found in the islands of Ischia, Procida, and in Lipari, where fresh-water lakes of any extent could not have existed.

If we look for the probable sources of the materials of the tufa which covers the country around Rome, we find, on the one side, the volcanoes of the Alban Hills; on the other, those of Mons Ciminus, and those which surround the Lacus Sabatinus. When the mineralogical characters of the tufa are examined, it is found that they do not resemble the lava of the Alban Hills, even that tufa which covers the country immediately surrounding those hills; that the fragments of pumice cannot have come from thence, as that substance is not found in any part of the volcanic district of Mons Albanus. But the mineralogical characters of the tufa coincide with the lava of the volcanoes which surround the lake Sabatinus, and with those of the range of Mons Ciminus; and it is probable, therefore, that from these craters all the vast mass of matter was poured forth. That loose materials may be thrown out by submarine volcanoes, we have had evidence at a very late period, in the formation of the island of Sabrina, off St Michael, in the Azores, in 1811 *.

After the deposition of these volcanic materials, the ground upon which they rested must have become dry land, and that land in process of time was covered with vegetation, and was inhabited by graminivorous animals. How many ages elapsed in this transition, and during how many the region continued to be so inhabited, before the next great catastrophe, our imagination alone can number; and if we take the experience of *human* records of changes on the earth's surface as our measure, we shall

* In 1814, a volcanic island rose in the sea off the coast of Kamtchatka, which is said to be 3000 feet high, and four miles round.—*Lyell*, 307. New islands have often been thrown up off the coast of Iceland, and on one occasion the quantity of pumice ejected was so great, that the light spongy stone covered the sea to the distance of 150 miles, and to such an extent, that ships were impeded in their course. The island thrown up in 1831, off the coast of Sicily, will be in the recollection of every one.

find that we can do no more than rest upon some general expression of great undefined magnitude.

The surface of the country was next destined to be covered by a different class of materials, not universally, perhaps, as in the former case, but partially through its whole extent; for the fresh-water deposits are met with at intervals in every part of the region we are now considering. Vast lakes of still water must have spread over the country, and must have covered at least all the land that is lower than the summit of the Esquiline Hill, that is, 150 feet above the bed of the Tiber, for at that elevation fresh-water deposits are found; and it is, moreover, probable that they occur at a much greater elevation in the neighbourhood of Tibur, independently of those formed by the Anio. That such inland seas of fresh water did exist, there can be no doubt; but it is impossible to form a conjecture by what barrier they were contained on the side of the Mediterranean, unless we suppose a ridge of limestone hills parallel to the Apennines, afterwards swept away, and of which the Circean Promontory and the hills behind Civita Vecchia are the remains. That the water of these lakes rested upon the surface of the country for many ages, is proved by the great thickness of the beds of travertino, which, in stagnant water, would be deposited much more slowly than in those cases where rapid evaporation takes place, as in the motion of water charged with extraneous matter.

The draining off of these lakes, if it took place suddenly, would cause much abrasion of the land, and probably by this operation the present surface of the country was fashioned.

Changes in the relative level of the sea and land have been alluded to. By what probable causes were these changes effected? The answer that most naturally occurs to such a question is, that it was the sea which changed its level; but farther inquiry makes it much more probable, nay almost certain, that it was the "fixed earth" which moved, and that the "unsettled sea" remained unaltered. No permanent *partial* change in the level of the sea can take place*. If it rose at any time to the

* "No river can put forward its delta, without raising the level of the whole ocean, although in an infinitesimal degree; and no lowering can take place in the bed of any part of the ocean, without a general sinking of the water, even to the antipodes."—*Lyell*, 474.

height of the Alban Mount, it must have stood 3000 feet higher than it does at present over the whole globe; and if it fell from the height of the Alban Mount to its present level, a mass of water equal to a stratum 3000 feet in thickness over the whole globe, must have disappeared. Nor can we suppose that it could be received in hollow places in the interior of the earth, the mean density of which is in direct opposition to any such hypothesis.

But the phenomena in question may be accounted for by partial elevations of the land, and proofs of such movements are to be found in many parts of the earth; no where in a more palpable manner than in this district of Italy. The remarkable circumstance of the perforation of the limestone of the Circean Promontory by lithophagi, at the height of 40 feet above the present level of the sea, has already been mentioned: and perhaps the most conclusive evidence which has yet been observed, is that of the changes of position which the temple of Jupiter Serapis has undergone. For an account of this, see Lyell's Principles of Geology, vol. i. p. 449 *.

Before concluding, it may be worth while to notice the view which some authors, not acquainted with geological observations, have taken as to the origin of the elephants' bones discovered in the neighbourhood of Rome, viz. that they are the remains of those animals brought into Italy by Pyrrhus and Hannibal, and at subsequent periods. The discovery of an elephant's tusk imbedded in gravel, and encrusted with calcareous spar, at a depth of 30 feet below the surface in the Mons Sacer, renders it quite unnecessary to adduce any other proof in refutation of such an idea.

* *Vid.* Ricerche Sul Tempio di Serapide in Puzzoli. Del Canonico D Andrea de Jorio. Inspettor-Generale della Istruzione Publica, e Socio Onorario dell' Accademia di Belle Arti, &c. Napoli 1820. This curious work contains an interesting view of the geology of the Temple of Jupiter Serapis, —EDIT.

Observations on the Deviation of the Compass; with Examples of its fatal influence in some melancholy and dreadful shipwrecks *. By the Rev. William Scoresby, F.R.S., &c. (Communicated by the Author.)

The *deviation of the compass* on shipboard, is that error or anomaly in the needle, from the correct magnetic meridian, produced by the magnetic condition of the vessel. It is but a modern discovery, and, until within a very few years, did not obtain much consideration; and even now, is very far from having obtained that general attention to which its great importance in practical navigation so abundantly entitles it. A few personal observations, and well ascertained facts, will be sufficient to prove that a correct knowledge of the deviation must greatly contribute to the safety of persons traversing the ocean; and that ignorance of it must expose all persons engaged in commercial transactions by sea to a fearful risk (a risk by no means generally appreciated or accredited) of life and property.

The amount of deviation necessarily varies, because of the unequal character of the disturbing force, not only in different vessels, but in the same vessel in every change of magnetic dip, and on every change of course. In very high magnetic latitudes, the deviation may be such as to influence the compass more than the directive action of the earth; but in equatorial regions it will be generally so inconsiderable as to be of little importance in practical navigation. On two or more points of the compass, the deviating force being coincident in direction with the earth's magnetism, is not observable (these are denominated "the points of change"); whilst its influence rises to a maximum in the ratio of the sines of the course (nearly) on both sides of the points of change. Most commonly the points of change will be found to occur when the direction of the ship's head is north or south, or nearly so; and the maximum on or near an east or west course. But to this rule there are many exceptions.

* From a "Lecture on the Deviation of the Compass," delivered at the Royal Institution at Liverpool, by Captain (now the Reverend) William Scoresby, F. R. S.; January 23. 1822.

In an ordinary way, a vessel sailing *up* the English Channel, steering E., or E. by S., will probably have only 25° or 26° of westerly variation, instead of 27° or 28°; the difference of 2° or 3°, or about a quarter of a point, being the effect of the local attraction, which, in thick weather, or during the night, must produce a serious error in the reckoning. In going *down* the Channel, on the contrary, the actual variation of the compass on board the vessel will probably be 29° or 30°, instead of 27° or 28°, the variation on shore, which difference, if unknown to the captain or pilot, must throw the vessel considerably to the southward of her position. Even more than this quantity of error was fully proved by Mr Bain, whose "Essay on the Deviation" contains a number of useful practical observations on the important subject on which it treats *; and a still larger quantity of error, amounting, when at a maximum, to 6° or 7° of deviation, or even more, has subsequently been discovered in very many of our ships of war under the magnetic dip and condition of our own coasts.

Bain also found, in navigating the river St Lawrence, that it was necessary to steer a different course coming down from the opposite one he steered on going up. Owing to this circumstance (the local attraction), one of our ships of war, the Zealous, had a very narrow escape in going up that river. During a fog, this vessel ran so near the shore, not far from Cape Chat, that she was in nineteen fathoms water; and had not the fog fortunately cleared at the moment, she would probably have been wrecked. Many of the losses that have occurred in the St Lawrence are, he reasonably concludes, attributable to the local attraction.

In crossing the Atlantic to the W. or S.W., vessels will almost always be found to the southward and eastward of their reckoning; and in an equal degree if passing to the north-eastward or eastward, the error being still towards the S.E.

In the voyage to Greenland, I have invariably found the deviation acting with the most marked effects; so much so, indeed, for some years before I knew any thing about the cause, that I found it necessary to allow only two points westerly variation

* Mr Barlow's admirable investigations on the Laws of the Magnetic Deviation were not in my hands when this Lecture was delivered.

outward, instead of two and a half, and three homeward, in order that some sort of agreement might be found between the reckoning and the actual place of the ship. The total effect of the deviation on a passage from Spitzbergen to England commonly amounts to 4° or 6° of Longitude; and almost all strangers to that navigation, unprovided with chronometers, instead of making Shetland, the place at which the whalers aim, fall upon or near the coast of Norway, 160 or 180 miles distant. Even Captain Phipps, on his return from his Polar discovery, committed this error; but its cause was then unknown.

This error was usually attributed to the operation of an easterly current,—but it undoubtedly belongs in a great degree, if not entirely, to the deviation.

The ship Baffin, which I recently commanded in the Greenland fishery, possessed a very large and uncommon measure of local attraction. The first intimation which we had of this dangerous influence, was on passing on a north-easterly course to the eastward of the Faroe Islands. In one day's run, during a gale of wind, the difference of latitude, as found by observation, was less by *almost a degree* than that determined by calculation,—an error which, if ascribed entirely to the local attraction on the course steered, would have indicated a quantity of deviation amounting to nearly two points! Though this amount, however, was subsequently found to be considerably in excess, yet the absolute quantity in a high latitude, where the dip of the needle was about 80°, proved to be 17° on a S. S W. course! The dangerous influence of such a deviation will be readily appreciated by a simple example.

Suppose the Baffin to have sailed with a fair wind 100 leagues on a S. S W. course, per compass [the variation being, say, 42° W.], and then back again 100 leagues on a N. N E. course, per compass, it is evident that, if there were no deviation, or other cause of error, she would return exactly to the point from whence she started. But, in consequence of the deviation only, her actual position would prove to be 123 miles to the eastward, and 55 miles to the northward of the place from whence she set out—the deviation, as above, being 17° southerly when steering S. S W., and $8\frac{1}{4}$° easterly, as also determined by observation, when steering N. N E.

Or, supposing the same ship to sail 200 leagues on a S. S W. course (a course often pursued on the homeward passage from the Greenland Sea), the error in the reckoning, neglecting the deviation, would be 86.4 miles too far southerly, and 160·8 miles too far westerly! That is, the ship would prove to be 189 miles to the eastward and northward (or in the direction E. 27° N. true) of her position, as calculated without the application of a correction for the deviation. Such an error, existing without its being known or compensated, it is evident, might be productive of the most fatal consequences *.

Hence, besides the many hair-breadth escapes to which navigators have been exposed from ignorance of the deviation, there can be no doubt but that some of the most dreadful shipwrecks which are to be found in our naval annals are to be ascribed to the same cause. I shall mention an instance or two where very fatal consequences have resulted from ignorance of, or inattention to, the deviation of the compass.

A fleet of sixty-nine sail of merchant ships, bound to the West Indies, sailed from Cork, under the convoy of His Majesty's ships Carysfort and Apollo, on the 26th of March 1804. On the 27th they were out of sight of land, with a fair wind, blowing strong, under which they steered W. S W. until the 31st. At noon of Sunday, 1st April, they observed in Latitude 40°.51′ N., Longitude, by account, 12°.29′ W. At 8 P. M. of the same day, the wind shifted to S. W., and began to blow very hard: course about S. S E. During the night the Apollo lost some of her canvas, and had to reduce sails to a fore-sail with main and mizen storm-stay-sails. At 3½ A. M. of the next morning, when by their reckoning they were above 100 miles from any land, the Apollo, to the astonishment of every one on board, struck the ground. After beating over a shoal, she was again afloat for about five minutes; she then met the ground, and beat with such tremendous violence, that it was apprehended she would instantly go to pieces. Getting, however, at length firmly wedged on shore, she became more quiet; but the sea broke continually over her. At day-light many other ves-

* See the Author's Voyage to the "Northern Whale Fishery" in 1822, p. 94, where this subject is enlarged upon, and from which these illustrative examples have been superadded.

sels were found to be on shore; and the sailors discovered that they were on the coast of Portugal, near Cape Mondego. It is unnecessary for me to detail the sad events which succeeded, excepting the general results of this dreadful accident. The Apollo being at a distance from the beach, and the gale continuing for three or four days, lost sixty of her crew, who perished from cold, drowning, hunger, and other circumstances, connected with their perilous situation. Many adhered to the wreck for about sixty hours, sustaining during this period the most intense anxiety and severity of suffering from cold, wet, and exhaustion, without either meat or drink. Along with the Apollo, twenty-nine sail of merchantmen were likewise wrecked; some of these foundered with all hands, and most of the others lost from ten to twelve men each. The total loss of lives has been estimated at 250 or 300 men.

This fatal accident has very generally been ascribed to the carelessness and inattention of the Commodore; but, from what has been observed, it will, I think, appear most probable, that the deviation of the compass was the occasion of the calamity. An officer, from whose narrative the preceding facts were derived, acknowledges, that no one on board the Apollo expected the ship to be near land, and that when the ship struck, they imagined they were upon some unknown shoal. It is indeed possible that part of the error might have been owing to currents; but as we know that the deviation in men-of-war, on a course S. 29° W., and a distance of 700 miles (the course and distance between Cork and Cape Mondego), would, in many cases, be upwards of a degree of longitude, we may reasonably consider the deviation as a material cause in this disaster. The Commodore was no doubt chargeable with a want of that prudent and watchful jealousy of mere dead reckoning, which, under Providence, is one of the best safeguards in practical navigation.

Of a nature somewhat similar, but vastly more calamitous, was the loss of His Majesty's ships St George of 98 guns, Defiance of 74 guns, and Hero of 74 guns, in the winter of 1811–12.

The Hero, Captain Newman, with the Grasshopper sloop, Captain Fanshawe, sailed, December 18. 1811, from Wingo Sound in the Cattegat, with the Egeria and the Prince William, armed ship, and a convoy of 120 sail. This vessel, the Hero, instead of standing well to the westward, to compensate for the deviation and the action of a north-westerly wind, steered the direct compass-course for the Downs; and having, in the night of the 23d, separated from most of the convoy, she struck the ground in a heavy squall of wind and sleet, upon the Haak Sand, near the Texel Island. Some of the convoy which kept by her shared the same fate; but the greater part, aware, apparently, of the danger into which they were running, hauled off to the westward and escaped. The Hero, after enduring the violence of the concussions against the ground during the night, was seen in the morning totally dismasted, and lying on her beam ends. She soon went to pieces, and the state of the weather preventing assistance reaching her, all the people, with the exception of eight who were washed ashore, perished with her.—*Naval Chron.* 1812, p. 43.

Though thus stranded on the coast of Holland, the captain, it appears, was so confident of his being sufficiently removed from that shore, that when the ship was found to be in danger, he ordered her to be steered to the S. or S. SE. (a course leading directly upon the sand), from the supposition that he was upon some shoal on the British coast! Surely a person entrusted with the command of a line-of-battle ship, could not be so ignorant of the common rules of navigation as to fall into such a disaster by a mere blunder, especially when different persons in the ship must have kept a reckoning, and mutually secured themselves against such a chance of error. There was doubtless a great want of prudence shewn by the Commodore, yet I imagine that the deviation which he had, doubtless, neglected to take into the account, had a great share in producing the catastrophe *.

The St George and Defiance were circumstanced a little differ-

* A Mr White of Whitby, who was employed as a pilot on board of one of the transports, being told on the fatal day of the accident, that the Commodore had made the signal to steer S. S W., ordered his ship to be hauled up W. S W., observing in the quaint language of a sailor, "If they stand that way they will all sleep in their shoes before morning." This prediction was awfully fulfilled, whilst Mr White, by his prudence, escaped. He knew nothing of the local attraction of the compass, but he knew from experience, that something carried the ship towards the Holland coast. This prudent sailor was afterwards, I understand, called up to the Admiralty to be examined in respect to the cause of the disaster that had occurred.

ently. The former, under Admiral Reynolds, had been dismasted in the Baltic, but being refitted, and considered capable of performing the passage, she made the attempt, accompanied by the Defiance. Unfortunately, they steered a direct compass course, and being overtaken with the same gale under which the Hero suffered, both ships went on shore on the western coast of North Jutland. Of the crew of the Defiance, which went to pieces half an hour after striking, only six men were saved, who got to shore on pieces of the wreck. Eleven of the crew of the St George most providentially escaped in a similar way; "and when the last of them left the ship, on the afternoon of the 25th, the Admiral and Captain were lying dead beside each other on the quarter-deck, together with the greater part of the crew. Only about fifty remained alive, whose cries were heard till it was dark. The ensuing night terminated their sufferings."

The number of persons that suffered in these three ships, including the whole of the officers on board, amounted to nearly 2000, being a greater loss of life in British seamen, than has occurred in some of the most splendid battles in which our fleets have been engaged.

Under circumstances, I believe, somewhat similar to those of the Hero, was lost the Minotaur of 74 guns, Captain Barrett, on the Haak Sands, at the mouth of the Texel, on the night of the 22d of December 1810. She left Gottenburg on the 15th, in company with the Plantagenet and the Loire, with sixty sail of ships under convoy, in tempestuous weather. During the gale she separated from the ships in company, most of which, if not all, made their escape. One hundred and ten of the crew of the Minotaur succeeded in saving themselves in the boats, the remainder, about 360 in number, perished.

Towards the production of all these dreadful calamities, the *deviation of the compass*, I am persuaded, greatly contributed. This, by a very little calculation, we shall be able to render extremely probable, if not to prove. The distance from Bovenbergen, on the north-west coast of Jutland, to Yarmouth Roads, is 330 miles on a true course S. 42° W., or course per compass, (the variation being 25°) S. 67° W. Let the *mean deviation* of a vessel on an east or west course be 5°, a quantity frequently met with and sometimes exceeded, and let the points of change be north and south, such a vessel, on coming from the Baltic, and steering S. 67° W., or W. S W. nearly, will have $4\frac{1}{2}$° westerly deviation,—that is, by the attraction of the vessel, the north point of the compass will be drawn towards the west $4\frac{1}{2}$°. By this deviation, therefore, if no allowance be made for it, she will be carried, within the limits of the proposed distance, twenty-six miles to the south-eastward of her reckoning. Now it is very evident, from a simple inspection of the chart of the German Ocean and English Channel, that had there been an allowance of twenty-six miles made on the courses of the vessels already mentioned as having been lost on the Haak Sand, *an allowance which the wind at the time would have amply admitted*, they would have all gone considerably to the westward of every danger, and the two men-of-war, the Hero and Minotaur, and four transports, together with above 1000 men, would have been saved.

As to the other case (the St George and Defiance), I am not sufficiently acquainted with all the circumstances to speak decidedly of the influence of the local attraction. But I think it exceedingly probable, that had their commanders been fully aware of the deceptive influence of this, then little understood phenomenon, they would at all events have steered a course so much more westerly as might, by possibility, have preserved them from the catastrophe which ensued.

Various methods have been devised for the discovery and correction of this insidious influence, some of which it may be proper, in conclusion of this article, briefly to describe.

The first regular process employed for the determination of the "deviation" was to take the bearing of a distant object by a compass in the binnacle, whilst the ship was laid at anchor or at moorings, and successively to observe the relative bearings when the ship's head was put on each point of the compass in succession, as she was gradually "swung" round. In this case, the bearings which were found to accord with the correct magnetic meridian determined the points of change, or those positions of the ship's head in which the compass gave correct indications; and the differences of the bearings in all other positions of the ship's head, indicated the quantity of local attraction on the several courses.

Another method which I adopted in my own practice was still more simple. A compass was secured at the main top-gallant-mast-head, where, being remote from all iron, and directly above the attraction of the ship, it was found to give *the correct magnetic position* on every course alike. This was made the standard compass. Comparing, therefore, the course steered by the binnacle-compass with that indicated by the standard, which could be done as frequently as requisite in calm weather and smooth sea, the deviation in that particular position of the ship's head was at once determined. Occasionally a whole series of differences was observed, so that the deviation on every course might be known.

A beautiful and philosophical detector of the deviation has for some time been in use in the navy, the invention of Mr Barlow, in which a plate of iron is temporaneously affixed in proximity to the steering compass, so as exactly to double the influence of the ordinary attraction of the ship; this increase upon the usual deviation affords, if the position of the plate be correct, a measure of the local attraction produced by the iron in the vessel. The discovery of the position of the plate, however, is a matter of more experimental nicety than can be usually expected from the men of any profession as a body; and no provision, that I am aware of, short of a new determination of the position of the plate, can be obtained for such accidental changes of the local attraction, as ships in general are liable to on any change of position in their guns or other masses of iron on board. Where, however, the iron in the vessel remains unaltered, both in quantity and position, Mr Barlow's plate will, unquestionably, be found capable of exhibiting the influence of the local attraction, generally, throughout the globe, not only with useful, but even philosophical, accuracy.

Another invention for the same purpose remains only to be noticed, which is, the beautiful apparatus of Lieutenant-Colonel Graydon of the Engineers, denominated by him the "Celestial Compass."

This ingenious instrument, by a beautiful arrangement of graduated arcs and circles, is so adjusted for the latitude of the place and declination of the sun, that a moveable arm, bearing a lens for the concentration of the sun's rays to a point at the axis of the instrument, can be made to traverse in an oblique plane exactly coincident, from the eastern to the western horizon, with the plane of the sun's motion. The speck from the rays of the sun, concentrated by passing through the lens, is received upon a small disk of ivory, and made to coincide, by a vertiginous motion of the instrument, with a dot at the centre of the disk. As, however, the speck from the lens, when the instrument is adjusted for latitude and declination, will always fall either above or below the centre of the disk, except when the azimuth of the arm, in reference to the instrument, is the same as that of the sun in reference to the earth, the simple act of placing the instrument so, that the speck may fall upon the dot, will of necessity put it *in the exact meridional position.* By comparing, then, the course steered by the binnacle compass with the true meridian pointed out by the celestial compass, the variation and deviation conjointly will, under existing circumstances, be correctly exhibited, as it were by direct observation; or, which may be of equal importance, the *true* direction of the ship's head will be at once determined. The *apparent time* is likewise given by the horary circle, without calculation or additional trouble. And besides these properties, so useful and important in practical navigation, the celestial compass has other capabilities, such as the determination of the *latitude of the place*, within remarkably small limits, by a single observation; yet, in this case, as in all others in which the instrument is used, every result is independent of the visible horizon.

This instrument, so scientific in principle, and so strikingly satisfactory in its results, especially as regards the determination of the local attraction of ships, will, it is to be hoped, when better known, find general acceptance with nautical men.

Memoir on a Cave at Cefn in Denbighshire visited by the Rev. Edward Stanley, F. G. S., F. L. S., &c. With a Plate. Read before the Geological Society of London, 30th May 1832. And communicated by the Author, with the permission of the Council.

On inspecting a map of North Wales, it will be seen that several minor streams, rising, some of them, a little to the eastward of Llanvcost, and others still farther eastward in the heart of Denbighshire, particularly from the small lake of Llyn Aled, and the mountains adjacent, effect a junction, and form the river Elwy; which, after proceeding in its course through a beautiful valley, between two ranges of limestone hills, more or less precipitous on the left, though inclining to undulation on the right, takes a sharp turn at Cefn, where the cliff terminates abruptly, and then shapes its course towards the sea, uniting itself with the Clwyd, a little to the southward of Rhyddlan, near St Asaph. At this point of curvature at Cefn, it must either have forced a passage by breaking down a barrier, connecting the present headlands of Cefn and Galltfaenan, or, as long as it was checked by this interruption, have formed a vast lake, not inferior in size to that of Bala, or some of the still more extensive lakes of Cumberland, receiving at this point another tributary stream, the brook Meirchion, which rushes through a lengthened gorge from the S. W., and occasionally discharges a powerful body of water.

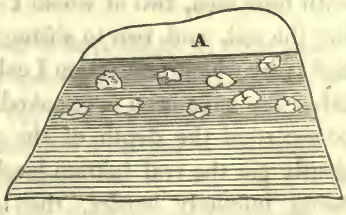
Having thus briefly described the localities and prominent features of the country, I shall proceed to the more particular objects of this paper.

In the month of February last, being in the neighbourhood, I was induced by some friends who had spoken highly of the natural beauties of the vale of Cyffredan *, to visit a perforated rock named Cefn cave, through which the road passes at a little distance above the bed of the river Elwy. This perforated rock is clearly a natural production, though, possibly, art may

* This name is I believe only strictly applicable to that portion occupied by the brook Meirchion, but I have been informed that it also applies to the whole valley.

have assisted to render the passage more commodious. Beyond its picturesque beauty and fantastic forms, it has, however, no particular claims to attention, except, indeed, that at various times in exploring some lateral ramifications opening into the interior parts of the perforation, human as well as animal bones, together with *stags' horns*, and I believe some remains of ancient weapons, have been found. That they were of considerable antiquity is not improbable, but there is nothing surprising in their position. That the stag's horns at least had belonged to deer coeval with man, was evident by the frequent marks of filing, cutting, or sawing, apparent on the greater portion; and it will be obvious to any person visiting the place, that a more eligible retreat, whether for shelter or ambuscade, in times of feuds or warfare, could not have been selected, where travellers or foes might have been way-laid, and their remains deposited in the recesses and cliffs of so inviting a sepulchre. Indeed, if it is not the accidental mark of a pick axe, a small hole through a skull I saw there would sufficiently explain the cause why its unfortunate owner should have laid his head for ever in so strange a place. It was on returning from this lower cave, I accidentally heard that the owner of the property, Edward Lloyd, Esq. of Cefn, in the recent formation of some walks, by cutting away projecting points of the cliff, and smoothing the irregular surface of the ledges, had removed a quantity of soil from a spacious opening in front of which his improvements were carrying on; and that in this soil, used with the best effect for manuring the meadows below, some bones had also been found. From a glance at the position of this opening, and the general resemblance of the cliff to those in which the bone caves of Rabenstein in Franconia are situated, it occurred to me, that, by a closer examination of this opening, I might be fortunate enough to find a counter-part of the Kirkdale cave. I accordingly returned on the morrow, and decided the question in a few minutes, by collecting, with no other instrument than a walking stick, a considerable number of bones embedded in alluvial soil, many of them probably of comparatively recent origin, but others, particularly a portion of an os humerus, unquestionably of a *rhinoceros*, as decidedly antediluvian. How many valuable relics of remote ages had already been scattered and lost, it is impossible to say; but one remarkably fine upper molar tooth of a rhinoceros, had attracted notice, and been preserved, and is still in the possession of Mr Lloyd.

This upper cave is situated in the face of a cliff running nearly N. and S., the general line of bearing of the range of rock being nearly horizontal, though in some places there are slight interruptions and curvatures. On the west, the face partakes more or less of a perpendicular character, but it gradually shades off on the eastern side, at a dip of about 10 or 12 degrees, forming a portion of the western boundary to the vale of Clwyd. These upper caves (for there are two of them, to the latter of which as yet entirely unexplored, I shall more particularly allude at the end of this paper) are at an elevation of about 40 or 50 feet from the summit, and about 100 feet (I speak entirely by guess) above the road passing through the perforated rock already mentioned. Previous to the facilities afforded by the present approaches, it could not have been very easily accessible; an active person might, indeed, without any very great effort, have found his way thither, but I much doubt whether a cow or horse would willingly have ventured on the ledge leading towards it; at all events, it was utterly beyond the reach of such large and unwieldy animals as elephants, rhinoceroses, &c.; and the contracted dimensions of the cave are equally at variance with the supposition, that had the surface of the valley ever been at so high a level, they could have resorted to it as a retreat. The bones of such animals must therefore have been deposited by floods, or more probably by *hyænas*, whose existence I have since satisfactorily ascertained, by the discovery of several molar teeth decidedly belonging to this genus. The fragments of the larger bones are, generally speaking, in a state of great comminution, as if gnawed and smashed by the powerful jaws of beasts of prey. The entrance is in the form of a capacious vault or porch, about 10 feet high; on the south side of which, at the distance of a few feet from each other, are two perforations, through one of which certainly, (but I believe both) a passage may be effected through the heart of the cliff to its south-eastern side; and may, as the worn appearance of one of these passages at least seems to indicate, have been occupied as a temporary retreat. It is indeed on record, that about seventy or eighty years ago, a mysterious being took up his abode somewhere in these cliffs, suddenly appearing, and as suddenly, at the end of seven years, disappearing. Nothing was known of him, but the prevailing opinion seemed to be, that he was a catholic priest or pilgrim, performing penance for some deadly sin: assuredly with such an intention, no situation could have been found more eligible, with its fine porch by day, and its inner-chambers, as a dwelling-place, for the night. The extent of this porch, if it may be so called, is about 20 feet, in a direction nearly due east, the front of the main opening being nearly due west. But beyond this extent, till about two years ago, none had penetrated. Indeed, from all I could learn, the existence of any cavern beyond it was not even suspected, further progress being cut off by a solid mass of indurated soil, on the north-eastern angle of this main entrance. At the above mentioned time, however, the labourers employed in forming the walks on the face of the rock, were directed to remove some of this soil; and it was soon apparent, that it occupied the entire space of a continuous cave, which, after running due north about 12 or 14 feet, turned to the east at nearly a right angle, following this direction for the space already opened, of about 15 yards, making in all from the immediate front entrance a continued cavern of about 80 feet, varying in height from about 6 to 10 feet. Here and there, calcareous exudations present themselves, though in no part assuming the slightest approach to pendent stalactite, their general appearance being that of a hard chalky white froth, of close texture; with one exception, namely, a curious fungus-like spongy-formed excrescence, projecting from the roof, compounded of a calcareous deposit of a crystalline character, its sharp points and angles being amalgamated with a portion of clay, and in one instance, which I collected, with an imbedded greywacke pebble. At the extremity of the present excavation, the cavern presents the annexed appearance, the whole space being choked up, with the exception of the space A, with a more or less indurated mass of fine loam or clay, of an ochrey colour, and calcareous nature, readily



effervescing with acids; generally speaking, the mass is deposited in horizontal laminæ, portions of which may be easily detached, but broken in upon without order or regularity by pieces of limestone, which, from their position and angular form, have evidently fallen in from the roof, and buried themselves in the sediment, when in a plastic state; or been caught up and intermingled with it at the time of its introduction. I saw no other portions of extraneous rocks or stones in this general mass, with the exception of the small pebble above mentioned, cemented into the fungus-like excrescence, and another of a larger size, weighing about 15 oz. also greywacke, rounded by continued friction, and deposited near the top of the clay. There were, however, a considerable number, of which I shall speak hereafter, at a lower depth. Throughout this whole mass, scattered in the most irregular manner, bones of all sorts and sizes were confusedly intermixed. Many apparently recent, but others, as I have observed, antediluvian, admitting further proof of their being so, when submitted to the usual tests. The larger specimens were in no one instance entire: some few remnants were left, indeed, sufficiently large and perfect to identify their anatomical position and name, but by far the greater portion were broken into a profusion of smaller pieces by jaws, of necessity more capacious and powerful than those of foxes or other minor animals.

I should observe, that hitherto, though I had visited it twice, I had met with nothing approaching to a flooring or covering of stalagmite, similar to that in the Kirkdale cave, Forster's Höhle near Weischenfield, (Dil. Rel. 127), and many other caves of this description. Anxious, therefore, to satisfy myself on this point, as well as to make further observations, I again repaired to the cave on the 4th April; and, with the kind permission of Mr Lloyd, spent the greater part of the day there, with four men, two of whom I employed in digging and removing the soil, and two in sifting it, when wheeled into day open light; by which precaution I collected several teeth, which would otherwise have been overlooked. One of my great objects was, to ascertain the depth of the present flooring, which was evidently not the real bottom-level of the cave, though, from its being infinitely harder, the labourers employed before had doubtless concluded it to be the lower and real surface of the rock. So hard indeed was it, that, in addition to the difficulty of working in a confined space, I was unable to excavate in the whole more than about two square yards of soil, which brought me to a depth of about 3 or 4 feet, but I cannot say positively, that even then the workmen had attained the actual floor. Stalagmitic fragments indeed occurred, but broken as they were by pick-axes, I could not distinctly ascertain, by the doubtful glimmering of candle-light, whether they formed parts of larger masses uniformly deposited, or were mere insulated patches, formed by partial drippings from the roof, confined to particular spots immediately below some crevice above. My great object, as I have observed, being a more minute examination of this lower stratum, I paid at this latter visit less attention to the upper depositions, and therefore, confined as I was in space, in proportion to the depth, collected comparatively but few bones from that quarter, though, had this been my sole pursuit, judging from the produce of my two former visits, I might have filled a basket in the same space of time. But those I did collect, were sufficient to realize the conclusions I had before formed. They were all antediluvian, and most of them belonging to large animals. Here, also, I met with pebbles, though in no great quantities, perhaps at the rate of a dozen in a cubic foot of soil, most of them not exceeding ¼ or ½ an inch in thickness, and generally of an oblong form, and a few of them broken. With very few exceptions they were homogeneous, viz. of the greywacke formation, which constitutes the prevailing class of rocks (I have reason to believe) in the distant districts from whence the tributary streams of the Elwy have their source. In addition to these pebbles and bones, I also detected some very minute portions of wood, to all appearance broken pieces of twigs of hazel or birch, none exceeding a half, or at most an inch, in length.

Of the farther extent of this cave it is impossible to form the slightest guess ; it may continue for several hundred yards, and communicate with fissures or large openings, containing abundant stores of similar remains, connected with the indigenous animals of our island in those remote times.

It only remains for me to make a few observations suggested by the situation and character of this cave, in the hope that more experienced and professed geologists than myself, may turn their attention to its peculiar features, the consideration of which may possibly throw additional light on these singular and interesting museums which have been handed down to us, unheeded or undiscovered by our forefathers, and the old times before them.

In the first place, then, I should suggest the probability, that a barrier, to a certain extent, must have existed, connecting the approximating headlands of Cefn and Galltfaenan, from the appearance of the valley, indicating a wider spread of water permanently flowing through it than could ever under any circumstances occur at present. The bed of this valley, when seen from the heights of Galltfaenan, shews an ample expanse of nearly flat meadow land for a considerable distance up the vale, as if smoothed down by the operations of a body of deeper water, the lower current of which would act with less erosive power than the turbulent bed of a wide and shallow mountain torrent. From a closer inspection, however, it appears far from improbable, that a much more formidable barrier might have existed, by a natural union between the cliffs of Cefn and Galltfaenan, similar in character, form, and structure. No large fragments, to justify such a supposition, are, I am aware, to be found close at hand, or even on the lower levels between these cliffs and the sea. But to those who are conversant with the incalculable power of agitated water as a moving force, even in projecting huge blocks up steep acclivities, it is unnecessary to dwell upon the probability that the wreck of this barrier once broken, however gigantic might have been its ruins, was hurried downwards with a rapid comminution of its materials, till they reached the deeper beds of the ocean. In support of this view, I shall merely mention as an instance of the irresistible force of currents, a fact mentioned by Dr Hibbert in his account of the Shetland Islands, p. 527, and quoted by the learned Secretary to this Society, in his valuable work on the Principles of Geology, vol. i. p. 259. In the winter of 1802, a tabular-shaped mass, weighing between 15 and 20 tons, was not only torn up from its original bed, but removed to a distance from 80 to 90 feet. Another in 1818, of still larger dimensions, was upheaved from its bed, and borne to a distance of 30 feet, where it was shivered into fragments, which were carried still farther, while another, not much smaller, was hurried up an acclivity to a distance of 150 feet. A further proof that these limestone ranges, as well as ranges of still harder rocks in the vicinity, have at some former period suffered by convulsions, is fully ascertained by the inexhaustible quantities of boulder paving-stones with which many parts of this coast abound, forming a constant source of traffic between Liverpool and Wales, either for the purpose of burning into lime, or breaking up for the macadamised roads in the interior of Lancashire and Cheshire. One other supposition may be given, respecting the former state of the waters and valleys of this district, dependent upon the existence of the barrier in question, namely, that, instead of a deep lake abutting at once against a rocky mound, like the waters of a canal or reservoir against a lock-gate, or similar artificial check to their escape; the valley itself existed, not, indeed, in its present deeply excavated form, but elevated above its present bed to the height of about 100 feet, that is, to the level of the higher cave. On which supposition, it is easy to conceive that it formed the bed of a wide torrent, covered with shingly pebbles, brought down from their parent rocks on the higher lands, from whence the waters had their source, and rounded in their progress by constant attrition. Allowing, then, this latter supposition, there can be no great difficulty in accounting for the partial and sparing deposit of pebbles, in the lower flooring of the cavern. A body of water rushing down from the distant higher lands, saturated with loamy mud, would either bring with it a supply of them, or, more particularly if caught up in its vortex, a shingly accumulation of small sized pebbles *, similar to those so commonly found deposited on the shores of streams and lakes, would have been forced inwards. The quantity admitted would of necessity be limited, for the cavern having in all probability no exit at its further extremity, would, on being filled after the first rush of the torrent, become a reservoir of quiescent water, strewing the bottom with those pebbles alone, collected near its mouth as it rushed in, and leaving them imbedded in its muddy sediment. And to the same cause we

* They were so small and similar in size, that an average collection of 20 weighed little more than 10 oz., or about half an ounce each.

may look for the introduction of the small portion of twigs, &c.; for had the river descended in a slow and gliding stream, there is no reason why branches of a larger size or other light substances might not have floated gently in. But admitting the powerful irruption of a sudden flood, we can at once account for things as we find them ; mountain torrents of this description, in their progress tear up trees, shrubs, and every minor vestige of vegetation, root and branch ; they are the first victims of such catastrophes, and are borne on the first headings of the waters towards their final destination, leaving not a relic of their existence near the scenes of their growth. Added to this, knowing that the velocity of a descending stream is greatest at the surface, and that the aqueous particles in the middle move with greater rapidity than those at its sides, we see at once that if the stream which deposited the lower stratum rushed by with a velocity sufficient to force small pebbles on its influx into the interior of the cave, the lighter floating extraneous masses, if not carried away by the first rush before the flood had risen to a level with the cavern, would have been confined to the centre of the current, and nothing but here and there a trifling particle of brushwood, probably torn from the very mouth of the cavern, according to the rules which regulate the motion of fluids, would have floated near the sides, or gained an entrance within. To this cause we may again refer for the non-existence of fish bones, for in such a tumult of waters, fish, like the uprooted branches, must, if dead and floating, have been carried off in the centre of the stream. From the peculiar pebbly character of this lower stratum, we may then reasonably conclude, that this first deposit was the result of a flood, so violent in operation and so rapid in its motion, as to convey off the descending waters, without giving time for accumulations of earthy matter to any considerable depth, and that after this, for an unknown period, there was no recurrence of any similar disaster ; during which time, the cave might again have become the resort of wild animals, gradually strewing this new floor with similar fragments of half consumed bones ; but that at the close of this period another flood occurred, far more powerful in its agency and tremendous in its operations. Without going back to former ages, or trusting to traditionary reports, we have within the memory of man convulsions on record capable of producing effects infinitely more stupendous than those required for the comparatively insignificant purpose of the case before us.

Let us suppose, then, that at a certain time some great convulsion occurred (as the bursting of a lake, violent rains or waterspouts) causing an irruption of waters far exceeding the last, so copious as to raise the level of the descending stream some feet higher than the caves, and at the same time impregnate it with those fine particles of loamy mud which we find deposited in the cave. In fact, a catastrophe, similar to that of modern date, which occurred near St Lucido in Calabria, when the ground is described as having been dissolved, so that large torrents of mud inundated all the low grounds like lava, the swampy soil in two ravines being filled with calcareous matter. We may conceive this moving mass acting with inconceivable pressure on the rocky limestone barrier between it and the plains below, till at length forcing a passage through some weaker part, its concentrating volume burst forth with inconceivable violence, and finally tore up every opposing obstacle. Such was the effect of the pressure of water on a barrier something similar in the valley de Bagne in Switzerland, which I had an opportunity of inspecting a few days after the catastrophe, productive of such disastrous effects for upwards of twenty miles below ; and when we bear in mind that limestone ranges are frequently honey-combed, if I may so speak, with fissures and chasms connected with cavernous chambers within, instances of which occur in the very rocks adjacent to the caves before as *; we are not making suppositions unsupported by facts. The consequence of this irruption would naturally be, not only the probable removal of the rocky barrier, but, by powerful erosion, the excavation of the bed of the valley itself, till it had scooped out its course to the level at which it now runs. Whether such an inundation of mud and diluvial detritus in its progress towards the sea may have caused the wide extent of low alluvial land, forming what is now called Rhyddlan Marsh, may be matter for future inquiry;

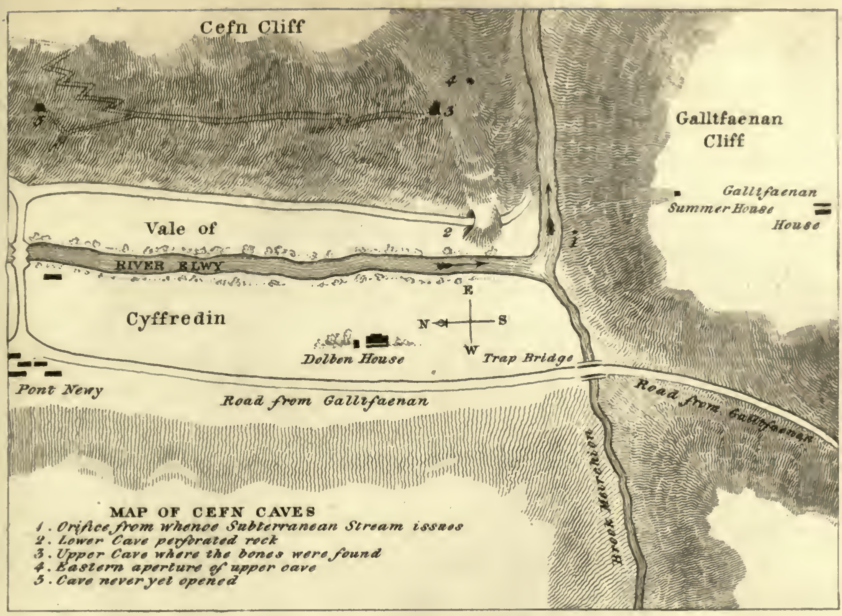
* At the base of the cliff of Galltfaenan, a stream gushes out from a subterraneous channel, through which it is supposed to be conveyed from a considerable distance.

at all events, local appearances render such a conjecture by no means improbable. On the final erosion of the former bed of the river now running at the bottom of a still deeper valley, the present upper caves would thus be left high on the façade of the cliffs as we now behold them. It may be argued, that, on the retreat of the waters, the mud injected into the recesses of the cave would have been removed. But two reasons may be urged why this should not have happened: 1*st*, That in consequence of the very peculiar character of the earthy particles, the laminous sediment would have been deposited in a few hours in so compact and adhesive a state, as to defy any ordinary means for its removal. The particles are indeed so extremely fine, and impalpable and unctuous, that it is almost impossible to separate them sufficiently for the purpose of microscopic observation. Consequently when, in addition to this, the adhesive character of such loamy argillaceous atoms is taken into consideration, it may be well conceived that a very compact deposit is easily formed. So minute indeed are the particles, that 20 grains in two ounces of water, gave the liquid as deep an ochrey colour as a mixture of the liquid and the powder in equal parts, with all the appearance at the same time of being in a state of chemical solution. In two or three hours, however, they subsided, leaving the water nearly colourless, and this, when poured off, left the deposit in the form of a strong adhesive paste. Very few hours, therefore, and still more, if we allow a duration of days, would have effectually choked up the interior of the cave with the compact mass now existing, more particularly, when we further take into consideration that the water admitted within the recesses would have been in a state of comparative quiescence and stagnation, little if at all affected by the agitation of the external stream. 2*dly*, On reference to the ground-plan, Fig. 1, Pl. II., it will be perceived that whereas the course of the river is at the cave from about N. to S., the portion of the cave entirely blocked up commenced at the north-east corner of the great opening, about 20 feet within, and that its course is to the northward; so that the descending waters would naturally be drained gradually from the injected mud, by no means acting upon it as a disturbing force, probably, moreover, forcing its way and clearing out an upward channel by pressure through the orifices before mentioned, existing on the southern side of the main opening vault, till it spouted forth at the aperture on the south-eastern side of the cliff, which may account for the trifling appearance of loamy deposition in these passages. I am aware, however, that, on high authority, to which I feel inclined to pay the greatest deference, it has been urged that this loamy stratum is to be attributed not to inundation, but to filtration of earthy calcareous matter through the rocky roof. In answer to this, I would merely remark, that the solid mass of superincumbent rock from 40 to 50 feet in thickness strongly militates against this view, and further, that it receives little support on inspection. For on examination it will be seen, that the upper surface of the deposit has every appearance of having originally formed a compact mass, completely filling up every cranny and fissure to the very roof, though at present there is a void space, varying from 8 inches to a foot between the surface of the diluvium and the roof. Now, if the sediment had entered by filtration, this surface must have followed the laws of gravity, and formed a line parallel to the present horizontal strata observable in the mass of the deposit; but instead of so doing, it follows the irregular sloping of the roof, which dips to the north at a small angle, as if the upper portion of the mud had gradually and uniformly collapsed into its present inclined position, just as the muddy deposit near Laureana, quoted by Mr Lyell, vol. i. p. 427, is said to have collapsed to the extent of 10 palms. It would be presumptuous to express any positive opinion as to the probable origin of these caverns, so frequent in the limestone ranges, in the face of the many ingenious conjectures of more experienced geologists. It is, however, worthy of remark, and will be easily seen on reference to the sketches, that although the general character of the whole upper line of stratification in the cliffs from its southern extremity at Cefn to its northward termination, are horizontal, yet, at the level of this cave, and near its aperture, the beds of limestone have a visible curve upwards, as if some sort of pressure had dislocated or bent the weaker joints of the cliff, and thereby enlarged, if not actually caused, the cave under consideration.

For the information of those who may be induced to visit this spot, as attractive to the artist from its picturesque beauty, as it is interesting to the lover of science, from the circumstances I have endeavoured to detail, I shall add a few directions which may be found useful. I have mentioned the bluff of Galltfaenan as forming a striking feature in the pleasure grounds of Col. Salusbury, on the crest of which has been erected a summer house, commanding in front a bird's eye view of the whole valley through which the river Elwy runs, affording at the same time on the left, a partial view of the narrow gorge confining the brook Meirchion, and on the right, the progress of their streams through the aperture supposed to have been formed by the removal of a continued line of rock, connecting this with the opposite cliff of Cefn. From this point, the main opening of the upper cave is not seen, being concealed by the projecting portion of the cliff, by the base of which, the road passes the perforated rock forming the lower cave; but the aperture alluded to as communicating by subterraneous channels with the main vault of the upper cave, appears immediately in front. These features are represented in Fig. 2. of Plate I.

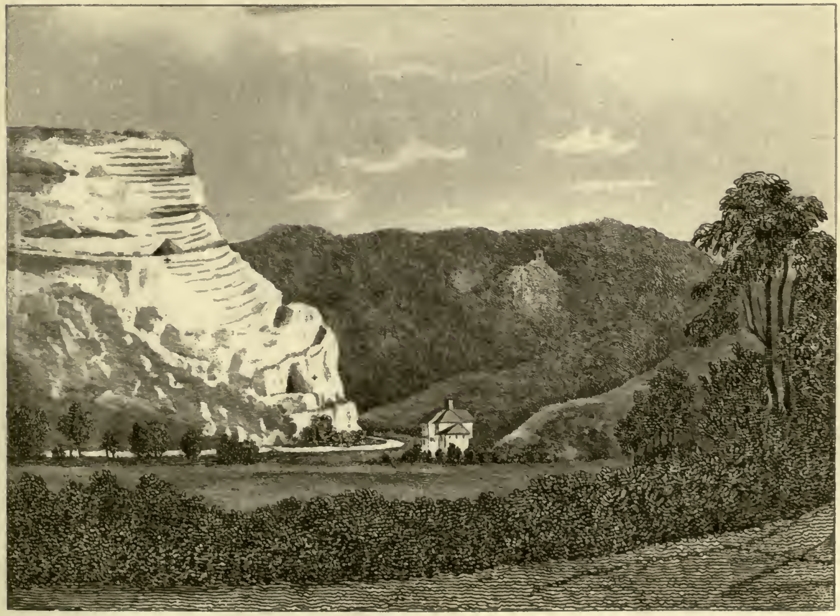
From Galltfaenan, the real distance, as the crow flies, cannot much exceed a quarter of a mile; but on account of the river intervening, which is not at all times fordable, it is necessary to take a circuitous route, either by returning to the main road from St Asaph, down a very steep carriage-road, or by descending a winding path cut by Col. Salusbury, leading to the foot of his cliff near to the mouth of the subterraneous stream, alluded to in note p. 49, which bursts up with a plentiful supply of water, not certainly equal in degree, but similar in other respects, to the reappearance of the river Mole near Dovedale in Derbyshire. This path leads to a small bridge called Trap-bridge, over the brook Meirchion, on the high road above mentioned, which runs parallel to the Elwy, and immediately opposite to the west front of the Cefn cliffs, commanding an admirable view of the whole line of stratification, as well as the apertures of the upper and lower caves. The river is crossed at the small village of Pont Newydd, so named from its bridge built by Inigo Jones, whose family it is said came originally from this neighbourhood. This road, after crossing the bridge, diverges to the right and left, the latter leading towards the great turnpike-road from St Asaph to Abergele, while the other branch turns towards the lower

Fig. 1.



CLIFFS OF CEFN AND GALLTFAENAN, AND DOLBEN HOUSE SEAT OF COL.L SALUSBURY.

Fig. 2.



+ Cefn Caves Upper & Lower.

F. Mitchell Sculp.t

or perforated cave-rock. A winding path, however, meets this part of the road, by which there is an easy ascent to the upper cave. A new road is also now forming by Mr Lloyd, with great taste and judgment, along the side of the cliff, near to which, and at no great distance above it, and about half a mile from the upper cave, another excavation in the rock presents itself, which, on examination, I found to be entirely blocked up with soil, and has clearly never been open to human observation. But I have no doubt, from its appearance and character, that it will prove closely analogous to this which has been the subject of the present communication, and will therefore, there is every reason to believe, exhibit as rich a prospect, whenever its recesses may be explored, in search of those organic remains of animals now unknown in the temperate zones. These roads and the situation of the caves shewn in Fig. 1. of Plate I.

On the Silicification of Organic Bodies *. With a Plate. By Baron Leopold Von Buch.

From the lively intercourse of naturalists with one another, it has happened that a number of minute observations have become far spread and well known, before any public mention has been made of them. Every communication of such observations, when made by persons of ability, will assume another form. Either one has to add other facts to those originally discovered, or knows how to place these same under other points of view; and thus give a new, more comprehensive, and detailed account of them, from the observations which they suggested. Then it is often difficult, perhaps impossible, to trace back to their origin the individual facts and observations, which at length afford rich and fruitful results. The priority as to the original discovery becomes lost, the more easily, that in general it cannot be at all foreseen what may arise out of an apparently trifling discovery in other hands, or whither it may lead. But true naturalists have never cared much about priority of discovery: such a feeling would disturb every sort of fellowship. It would be easy to imagine that the germ of important discoveries

* Read in the Academy of Sciences (of Berlin) upon the 28th of February 1828, and translated from the German original by George F. Hay, Esq.

and views lay in some indefinite superficial view, or in loose facts, which were only thrown together as mere conjectures.

This personal communication, if we may say so, has, however, the disadvantage, that remarkable facts and reflections worthy of remark, have become for long a kind of common good; and notwithstanding this, the observations or discoveries have not reached those who might have made them the means of effecting the greatest benefit to science. And many facts, many views, are entirely lost, because their authors did not deem them worthy of being made public; or those who may bring them forward, are unable to apply them to more extended views.

The object with which I wish to engage the attention of the Academy for a short time, viz. *The Silicification of organic bodies*, is of the above class. The remarkable appearance is known to many, but with very different degrees of accuracy. Many excellent naturalists indeed are ignorant of its existence, notwithstanding that it is daily before their eyes, because no publication has directed their attention to it. The greatest share in the discovery of remarkable facts on this topic, appears in the mean time to belong to M. Brogniart of Paris, who some time since prepared a work on this subject. Some illustrations from the above work have been published in pl. 6 and 7 of the engravings in the Dictionnaire d'Histoire Naturelle*. He who occupies himself with the study of fossils, knows very well how many shells are completely converted into flint and calcedony; and that, since the soft parts of the animals do not remain, only the harder calcareous shell, the whole silicifying process must have developed itself upon this hard shell. Many univalve shells are found in their spiral form, composed of the most beautiful calcedony. Many corals appear as jasper or quartz. It is known that it has been long wished to prove from this appearance, that chalk changes into a siliceous substance, and carbonate of lime into

* The author states, that in J. Sowerby's Min. Conch. vol. iv, plate 330), (year 1823), there occurs the following remarkable passage: "Productus latissimus from Anglesea. In chertz (mountain) limestone, the shell is in many parts gone, and its place supplied by silex in numerous small drops, each surrounded by several irregular rings of the same material, a form of silex not rare among fossil remains of shells, composed of laminæ strongly impregnated with gluten, as Ostrea, Pectens, &c. in the green sand and other formations." Page 44.

 Edinr. new Phil. Jour. Vol. XIV. p. 55

GROUND PLAN OF CEFN UPPER CAVE

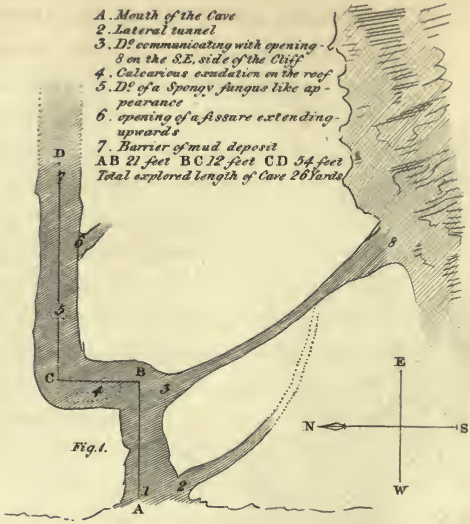


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

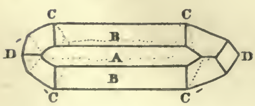


Fig. 6.

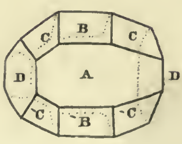
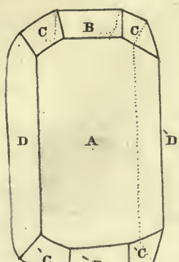


Fig. 7.



E. Mitchell sculpt.

flint. New works upon fossils (of Sowerby, Conybeare, and Brogniart) mention, that shells would be changed into a siliceous substance, when they occurred in siliceous strata, but do not explain themselves in general, upon the disappearance of the calcareous shell. The case is not as here stated. The entire silicifying process, as it can be easily traced in nature, leads to the remarkable result,—*That the silicifying process never immediately attacks the calcareous shell; that it developes itself only upon the organic substance of the animal, and that where such an organic substance is not present, there no silicifying takes place.*

When such a result is well established and proved, there naturally follows the important, and, in its application, the highly fruitful position, that where the silicifying process is remarked, there an organic substance must have previously existed.

When a shell begins to be silicified, there appears over its surface a small, dark coloured, semitransparent wart, probably in a semifluid state like jelly.

The white shell is raised up all around this small wart, whence it follows that the wart has risen from within, and has not been deposited from without. It spreads around, a new small wart rises in the middle of the first, which now surrounds the new central point like a small ring, and is separated from it by a deepened space. Other small warts arise in succession, and push the ring still farther back. And as this always takes place under the raised-up calcareous shell, so this shell will be completely broken and shivered by means of the siliceous rings, and the shell falls off in small scales, and is lost. The rings become always wider, but likewise constantly less elevated, until a new system of rings comes in opposition, and each, as it becomes extended, is the limit of the other. Thus one system of rings is added to another, larger or smaller, according as they encounter each other earlier or later, until the whole shell becomes silicicated. This appearance is represented in Plate II. Fig. 2, as it is observed in *Gryphaea columba*, from Castellane in Provence. The half is still covered with a thin calcareous shell; but we see upon the edges plates which are separated by the rings. Some plates remain in the hollows between the rings; and occasionally we observe an entire piece of the shell, because no rings are found under it. That these rings have spread out, when in the gelatinous state, from the siliceous wart in their centre, can be proved from their boundaries. They do not leave off where they meet one another, or they do not go through each other as waves would do; but they are set off evenly at the side of one another, each having a concentric series of rings, where there is no obstacle to oppose their course. When the silicicating process is completed, the substance resists the storms of time, while the surrounding chalk will be carried away, and the natural form of the shell shows itself with all its peculiarities, more clearly than if it had possessed its natural covering.

Now, this is completely and universally the manner in which bivalve shells become silicified. One will never fail to see in them the siliceous warts with their surrounding rings. But at the same time, we never see any system of rings spread itself over the shell, or extend itself within the substance of the shell. In every case this last is raised up, while the siliceous rings are found underneath. When these rings trace out in their course the finest parts of the shell, so that we can follow out the concentric lines and rays through all the inequalities of the calcedony, we must suppose that the calcedony found another guide than the shell itself, when it received the impressions of the shell during its onward course, for the shell would have been a hinderance to the calcedony's receiving these impressions. This guide is the organic slime which is deposited by the cloak upon the inside of the shell.

I hope to be able to illustrate this most exactly, from the silicifying process, as it is seen in Oysters.

The oyster possesses, as we know, not only a very thick shell, but the individual lamellæ of this shell, which the animal forms from within, gradually extend wider; and are but very loosely connected with one another. The inner surface of the oyster shell is covered over with the slime of the cloak of the animal, and by that means becomes shining. This slime remains behind, and will be covered with a new coating of shell, which will be seen when we dissolve the shell in acid. The organic substance is not dissolved. Likewise, it is easily seen by the unassisted eye between the lamellæ. Hence the oyster-shell consists of two parts, one of which still belongs to zoology, the other to mineralogy; for the calcareous part is not carbonate of lime, in a zoological form, but it is actually calcareous spar, and hence is no more an organic substance. The secretion of the calcareous spar, and its being kept as a surrounding substance, may be indispensably necessary for the life of the animal; just as the secretion of apatite (phosphate of lime), and its being amassed in the form of bones, may be necessary to the existence of animals having an osseous skeleton. Thus, it is as little entitled to be considered an organic substance, or such as appertains to the operations of life, as the serpentine, marble, or fragments of shells would be, with which the *Trochus agglutinans* builds or strengthens his dwelling; or as the shell in which the Pagurus Bernardus conceals itself, and without which it could not live. The substance of shells, as well as of bones, obey entirely mineralogical laws. And when the apatite (phosphate of lime) cannot be recognised in the form of a bone, it will still have lost as little of its nature, as the calcareous spar, when the hand of the sculptor has converted it into a marble statue. Life, pursuing its work enclosed in an independent circle, seeks, in the steadiness and rigidity of mineral substances, for protection from the principle of gravity, which destroys all animated beings.

The skeleton of animals would have become very different, had nature had another substance to work with than phosphate of lime, the axes of which are unequal. I have been told that, in the fœtus, the formation of the skull begins from a central point, from which it extends around in the form of rays.

Such minerals only as have unequal axes, *i. e.* in which there is one axis of greatest contraction, can become fibrous, or extend themselves in rays. They are those minerals in which the axis of the ray is always at the same time, the axis of the greatest contraction. This axis ever decides the predominant direction of the shooting out of the rays. It is only in such minerals that these rays can so arrange themselves together, as to form a thin covering.

Were the secreted substance one having equal axes, like fluor-spar, for instance, the organic life would have had thus great difficulty in arranging the particles of fluor-spar when formed. Instead of rays and plates, masses would have been produced; and the skeleton, and with it the entire animal and its capabilities, would have been completely different from what they actually are.

But I will return to the consideration of the oyster, for the conclusion as to other shells will be easy, when we can shew, in the case of the oyster, that the shell actually consists of calcareous spar.

When a person examines fossil oysters, the shells of which are generally particularly thick, he finds without trouble lamellæ of such strength that the fracture of the profile can easily be investigated. On every side we see it to be fibrous, with thick parallel fibres, which are placed at right angles upon the planes of the lamellæ.

Oysters from the chalk at the lake of Berre, near Martigue, not far from Marseilles, show this structure very clearly. When we look down upon them with the light of the sun, we thus discover, by turning them in some directions, the very small shining plates which the fibres surround, and towards which they are considerably inclined. And these plates can belong only to the rhomboedral calcareous spar, the principal axis of which agrees with the axis of the fibre. And this is what the law requires which regulates fibrous calcareous spar, as well as every crystalline structure having the axes unequal. Since the formation of the lamellæ does not begin from a point, and since the calcareous spar will be secreted in a similar form upon the whole surface of the cloak of the animal; so the calcareous spar cannot construct fibrous tissues, stellularly disposed. But the thin lamellæ produced will resemble a calcareous pellicle, such as is separated from calcareous water, and is deposited at the bottom. But such a calcareous pellicle is exactly like the terminal planes of the perfect six-sided prism of calcareous spar, and has the same appearance. This is an observation as fine as it is just, and has been made public by a person unknown to me.

We know that when six-sided prisms of calcareous spar are quite transparent, this transparency never exists at the even surface of the terminal planes. These are always muddy, pearly and glimmery, like slate-spar, (schieferspar).

There are many small axes projecting from the surface, and the small inequalities which arise therefrom reflect the light in many different directions.

We cannot believe that this structure probably belongs only to fossil oyster-shells, and that it is not a property of those which are at present forming in the ocean.

If not in every one, still we find in some oyster-shells lamellæ, which are thick enough to permit us to observe clearly the right angular fibres upon their surface; and I do not doubt likewise, by means of a greater magnifying power, and very clear light, the inclined plates of rhomboidal calcareous spar would be discovered.

Hence, every plate of an oyster shell would correspond to the flat terminal plane of a six sided prism; and the fibres, when observed, are the lateral planes of this prism, by means of which, perhaps, the sphere of the operation of each secreting organ of the cloak of the animal will be denoted.

Now, that which the oyster has taught us, will likewise be easily believed to happen in the case of other testaceous animals, which secrete carbonate of lime, in order that they, by means of it, may construct for themselves a covering or dwelling. There are also many shells which give rise to considerations similar to those which occur on examining the oyster shell, and which, perhaps, admit of being more clearly explained. The fibrous structure of the shell of the *Inoceramus* had drawn attention towards it, long before the true form and shape of the shell was ascertained. An equally fibrous structure appears in *Pinna*, *Pachymia Gigas*, (Sowerby, plate 505), the shell of *Nautilus Aturi*, and many others.

After these reflections upon the true structure of shells, it will be allowed me again to take up, and to follow out, the proof, that it is only the animal slime, between the lamellæ of the shell, that will be silicified.

There are found strewed in the plains of Mecklenburg and Pomerania a great quantity of oysters, which are in very different degrees of silicification. They probably belong to the Tertiary formation. Plate II. Fig. 3 and 4 represent some of these oysters. Their silicification seems to have been effected with violence; the central wart of the small calcedonic system appears in general very thick, and the waves which extend from it are very high and very broad. We see clearly how much greater the space is which this siliceous jelly requires, than the space of the organic substance, which the siliceous jelly destroyed. This last presses forwards between the lamellæ of the shell; and where the calcareous shell cannot be burst through, by means of the greater expansion of the siliceous jelly, the shell becomes enveloped in that substance.

The siliceous mass presses through between the fibres. The whole becomes siliceous, and now possesses much more the appearance of wood-opal than of calcedony. Likewise, in this far advanced stage of the silicification, we can always distinguish the different lamellæ of the shell. Those which belong to the organic substance, are of a much darker colour; and by means of the greater extension of the siliceous hydrate, they are much thicker than they were originally. The brighter calcareous lamellæ, on the contrary, still retained somewhat of their former fibrous structure; and frequently we can act so far upon them with acids, as to cause them to effervesce. This is a clear proof that here likewise the calcareous part is not that which is changed, but is only enveloped where it cannot be forced off.

The inside of the shell, when it is possessed of any thickness, continues very much in its natural condition. The silicicating process goes on only from the outside inwards; hence the process is a decided change of the organic substance, which by no means takes place without the operation of external causes. Does this organic substance decompose in some way or other a siliceous combination, by which means the siliceous earth becomes free, absorbs water, and then appears in the condition of calcedony, opal, or hyalite?

We might also believe the animal of the oyster to undergo silicification, although such an assumption is opposed to the views adopted by naturalists, who maintain that so soft an organic mass is incapable of petrifaction. There is represented in Fig. 3, Plate II, a mass of flint, which fills up the inside of an oyster shell, and which appears to be the animal of the shell. The animal would have lain in the oyster-shell in this position had it been alive. The greater mass lies towards the right side, where the muscle fixes it to the shell; insomuch, that one could believe we could distinguish the muscle as it passed upwards from the under to the upper shell. The smaller mass of the petrifaction extends itself out as far as the point where the mouth of the animal would have been situated. We might believe it possible here to distinguish even the spreading out of the cloak of the animal around this muscular mass. It is very worthy of remark, that the shell is converted into a siliceous hydrate, while the animal, on the contrary, is converted into flint. But this latter still contains within it the organic substance itself, which distils out of it as an animal oil.

It is even this animal oil which makes the above substance flint, as, without this admixture, it would be only a purer quartz. And although it may appear strange, still the fact is certain, that the most regular strata of flint between the chalk, even when we can trace them for many miles, are still nothing else than silicicated organic remains, consisting principally of corals. With some attention we easily discover this to be the fact; and in this case, likewise, we remark that it is not the calcareous covering, but the animal corals themselves, which have been converted into flint; and that this has been the case abundantly, and with such precision and exactness, that the inner structure of the animal of the coral can be investigated and observed, not unfrequently, far better in the silicicated than in the living state.

I have never remarked that flint formed warts and concentric waves, like the siliceous hydrate; perhaps it is even on this account that flint is not a hydrate, and never assumes a gelatinous consistence.

Testaceous animals which, when they increase in size, leave the chamber which they had hitherto inhabited, and pass to a new one, very seldom become silicicated; because the deserted chamber cannot strengthen itself, by depositing new lamellæ. Neither does there remain on the shell, nor in the inside of it, an organic substance, which can become silicified. Therefore, the examples of silicified Ammonites or Nautiluses are not common. And when Belemnites are found in the state of calcedony, it is not the alveolæ which are silicified, but only the fibrous apex in which a new layer had been deposited by means of every growth of a new chamber in the cell. On this account, the silicified apex is almost always brown; and by carefully dissolving it in diluted acids, the organic matter between the fibres and layers will frequently appear.

A Series of Experiments on the Quantity of Food, taken by a Person in Health, compared with the Quantity of the different Secretions during the same period; with Chemical Remarks on the several articles. By John Dalton, F.R.S.

During my residence at Kendal, nearly forty years ago, I had at one time an inclination to the study of medicine, with a view to future practice in the medical profession. It was on this account chiefly, but partly for my own personal interest in knowing the causes of disease and of health, that I was prompted to make such investigations into the animal economy, as my circumstances and situation at the time would allow. I had met with some account of Sanctorius's weighing chair, and of his finding the quantity of insensible perspiration compared with the quantity of aliment; and it occurred to me, that the differences of constitution and of climate might occasion very considerable modifications, which it would be desirable to ascertain. The following train of experiments was accordingly instituted for the purpose.

It may be proper to observe, that my habits, daily occupations, and manner of living, were exceedingly regular; my health during the time was uniform and good; and that the weight of my person has never been subject to much change since grown to maturity.

The first series of experiments was made in the month of March, for fourteen days successively. I had three meals each day, breakfast between seven and eight in the morning, dinner between twelve and one, and supper about seven in the evening; except on two days in which I had tea to breakfast, and again in the afternoon. The usual breakfasts consisted of boiled milk, with bread, and a little oat-meal, and suppers were of the same, with the addition of bread, cheese, and beer. The dinners consisted of butcher-meat, potatoes, pies, puddings, and cheese. About one-third part of the bread used consisted of a thin oat-cake, common in Westmoreland and Cumberland. I drank no water, seldom wine, and no fermented liquor, except common table-beer.

The weight of the individual articles were taken at each meal separately, and entered in a journal, distinguishing fluids from solids.

It will be quite unnecessary to give a detail of the individual articles and their weights just as they were entered in the journal, because it would be found little more than a repetition of names and quantities. A very short time showed that the daily demand for food, both solid and fluid, was nearly uniform as to quantity, and that the supply might have been made absolutely so, without any inconvenience. But the diurnal evacuations were by no means so near uniformity.

An aggregate of the articles of food consumed in the fourteen days is given below; and the mean proportions for one day are also given, neglecting small fractions.

	Consumption in fourteen days.	Consumption in one day.
Bread, - -	163 ounces avoirdupois.	12 ounces avoirdupois.
Oat-cake, -	79	6 ... .
Oat-meal, -	12	1 ... .
Butcher-meat,	54½	4 ... .
Potatoes, -	130	9 ... .
Pastry, - -	55	4 ... .
Cheese, - -	32	2 ... .
Total,	525½ Solids.	38 Solids.

	Consumption in fourteen days.	Consumption in one day.
Milk, -	435½ ounces avoirdupois.	31 ounces avoirdupois.
Beer, -	230	16½ ... .
Tea, -	76	5½ ... .
Total,	741½ Fluids.	53 Fluids.

Thus it appears that the average daily consumption of solid and fluid articles was 91 ounces, or a little short of 6 lb. avoirdupois. The distribution of the aliments into solids and fluids as above, is evidently to be understood in a popular sense; as it is well known that all the solids contain a greater or less quantity of water, and all the fluids a greater or less portion of solid matter. In fact, water must be considered as the basis of all the fluids. During all this period, a daily register was kept of the urinary secretion, and of the evacuation of the bowels. The total quantity of urine for the fourteen days was 680 ounces; and the total quantity of fæces 68 ounces.

The daily average was, urine 48½ oz., fæces 5 oz., a greater disproportion than was anticipated, being nearly in the ratio of ten to one; they amount together to 53½ oz. or 3½ lb. nearly; but the quantity of food taken daily was 91 ounces; there remains a balance of 37½ ounces to be accounted for, which must have been spent by the insensible perspiration from the skin, and that from the lungs conjointly, on the supposition that the weight of the body remained stationary.

I have already observed that the daily evacuations were not so nearly uniform as was the quantity of food. The urinary secretion was greatest when tea was substituted for milk, and on one day was 15 ounces above par. On another occasion, finding a greater defalcation than I had before observed, I could discover no cause for it, unless a tea-spoonful or two of vinegar taken at dinner could account for it. To be satisfied of it, I took, some days after, an ounce of vinegar in four equal portions during one day; and the effect was a greater diminution of urine on that day than on any other during the two weeks, the quantity being 15 ounces below the average, and 4 ounces less than the former day, when vinegar had been taken. There did not appear to be any increased effect in any other secretions, as a compensation for this diminution.

In order to try the effects of different seasons, I resumed these investigations in the month of June the same year, and continued them for one week successively. The results were what might have been anticipated nearly. A less consumption of solids, and a greater consumption of fluids, were observed. The evacuations were somewhat diminished, and the insensible perspiration was increased.

The following were the results:—

	Solids consumed in seven days.	Fluids consumed in seven days.
	236 ounces.	391 ounces.
Per day,	34 ...	56 = 90 Total.

being 4 ounces per day less in solids, and 3 ounces in fluids, than in the former trial.

The daily averages in the evacuations were—urine 42 ounces; fæces $4\frac{1}{3}$ ounces, leaving a balance of nearly 44 ounces for the daily loss by perspiration, being an excess of about 6 ounces above that in the former season, or one-sixth more, owing no doubt to the higher temperature of the weather.

Another trial of one week's continuance was made in September the same year. The results were so nearly alike to those in June, as to render an enunciation of them unnecessary. The daily consumption of food was $93\frac{1}{2}$ ounces, and the perspiration one-half of that quantity.

I may now be allowed, perhaps, to subjoin one day's experience of the effect, that taking a large dose of carbonate of potash (salt of tartar) has upon the secretions. This was suggested by a similar experiment made by Dr Alexander, and published by him in a small volume of medical essays. His results I do not at present recollect; but my notes at the time imply, that I expected the alkali to act as a diuretic. My experiment was made on a fine day at the end of March after the two week series; the thermometer ranged from 40° to 60°. In the morning I had a basin of tea prepared for breakfast, with the usual quantity of sugar and cream; into this I infused 4 drams avoirdupois (100 grains) of dry carbonate of potash; after it was dissolved, I proceeded to my repast as usual, apprehending the diluted alkali would be so far qualified in its taste by the sugar, as to be rendered tolerably palatable, but in this I was mistaken; the nausea was unbearable, and I was obliged to drink it off as fast as I could, and then eat my toast to an additional cup in the ordinary way. This done, I felt nothing amiss, took a moderate walk, and returned. On sitting down, I perceived small drops of fluid on the backs of my hands, without any sensation of heat above common. My appetite was rather keener than usual during the day, and I felt uncommon agility in the evening. The secretion by the kidneys was not at all disturbed; but, on retiring to bed, I burst into profuse perspiration, which continued through the night, and was felt in degree during the succeeding night. By taking care, the effects went off without any detriment.

Being satisfied by the preceding trains of experiments, that no information was to be expected in this way, than was already acquired, I varied the process, with a view to obtain the quantity of perspiration, and the circumstances attending it more directly. I procured a weighing beam, by which I could weigh my own body, so that the beam would turn with one ounce. Dividing the day into periods of four hours in the forenoon, four or five hours in the afternoon, and nine in the night; or from ten o'clock at night to seven in the morning. I endeavoured to find the perspiration corresponding to those periods respectively.

My method of proceeding was, to weigh myself directly after breakfast, and again before dinner, observing neither to take or part with any thing during the interim, besides what was lost by insensible perspiration; the difference in the weights, in this case, was the loss by perspiration. The same procedure was adopted in the afternoon and in the night.

I continued this train of experiments for three weeks in November, the same year. I then took the aggregate of the morning observations, next that of the afternoon observations, and lastly, that of the night observations, and divided each of those three aggregates by the number of hours in the several periods, in order to find the hourly perspiration in each period, apprehending that there might be some differences owing to the time of the day, or being awake or in sleep.

The mean hourly losses by perspiration, were as under:

Morning, ...	1.8 ounce avoirdupois.
Afternoon, ...	1.67
Night, ...	1.5

During twelve days of this period, I kept an account of urine, corresponding in time with that of perspiration. The ratio was urine: perspiration 46 : 33, or 7 to 5 nearly; which is somewhat greater disproportion than that observed in March; owing probably to the temperature of the weather being lower in the latter season.

So far I have given the facts and observations made forty years since; I made no deductions from them at the time; indeed, the knowledge of animal and vegetable chemistry was at that time in its infancy. Since then, the progress of this branch of philosophy has been very considerable, and we are now enabled to approximate, in a good degree, to the quantities of the several chemical elements to be found in the great variety of products of the two kingdoms.

By combining this knowledge with that obtained from the preceding facts, we may possibly discover or establish some physiological principles, important to be understood in the animal economy, more especially in regard to the acquisition and preservation of health.

From the table we have given, it will appear that bread and farinaceous vegetables constitute the greatest part of ordinary food. About the time of the above experiments, I found that 5 lbs. of flour would make 7 lbs. of bread. Now, from the analyses of flour that are given in our systems of Chemistry, I think we cannot estimate the carbon in flour at less than 42 per cent.; hence we have 30 per cent. of carbon in bread; 12 ounces of bread (the daily average in the first set of experiments) must then contain 3·6 ounces of carbon. Seven ounces of oat-cake and oat-meal may be estimated, I think, = 1.8 ounces of carbon, or half the quantity that 12 ounces of bread have. Four ounces of pastry can scarcely contain less than 1 ounce of carbon. Nine ounces of potatoes must contain nearly 1 ounce of carbon. Four ounces of butchers' meat, and 2 ounces of cheese, would have together somewhere about 3 ounces of carbon, if Gay Lussac's experiments be nearly correct. Thirty-one ounces of milk, estimating the carbon at 3 per cent., gives eleven twelfths of an ounce. Twenty-two ounces of tea and beer would contain only a small fraction of an ounce of carbon, not easily estimated, but of little account, by reason of its smallness.

From this, it would appear that about 11½ ounces of the element carbon is taken into the stomach by one kind of aliment or another, in the course of the day, in some state of combination.

Chemical analysis has been applied with considerable success to the animal product, urine. According to Berzelius, the urine of healthy persons differs materially according to circumstances. Upon the average it may be reckoned to consist of 93 or 94 per cent. of water, and the rest is a complication of a great many articles. The carbon contained in these ingredients cannot be estimated at more than 1 or 1¼ per cent. from the analysis hitherto made. This will give .5 or .6 of an ounce of carbon, upon $48\frac{1}{2}$ of urine per day. Berzelius has not neglected the analysis of the fæces; of 100 parts, three-fourths may be estimated as water, and the rest do not seem to contain more than 10 parts of carbon. This would give half an ounce of carbon in 5 ounces. Hence we may infer that one ounce, a little more or less, of carbon, is carried off from the body daily through these two channels. The remainder, $10\frac{1}{2}$ ounces, must therefore be spent in the insensible perspiration.

The quantity of insensible perspiration from the skin, cannot be easily determined by direct experiment. That from the lungs may be approximated from known facts. I have shewn (See Manchester Memoirs, vol. ii. new series, page 27,) that I produced by breathing, in the space of twenty-four hours, 2.8 lbs. troy of carbonic acid gas. This is equivalent to .78 parts of 1 lb. troy of carbon = .642 parts of 1 lb. avoirdupois = $10\frac{1}{4}$ ounces nearly. Now, when I estimated the quantities of carbon in the several articles of food, &c. just related, I had no recollection of this quantity of carbon expended in breathing; it may be well supposed, then, that I was highly gratified to find by the calculation, that the difference of the two quantities, found by such different modes of investigation, was only a quarter of an ounce.

With respect to the aqueous vapour exhaled from the lungs, I have determined, in the essay quoted above, (page 29) that the highest estimate of the quantity I exhale, cannot exceed 1.55 lbs. troy = 1.275 lbs. avoirdupois, = $20\frac{1}{2}$ ounces avoirdupois; if to this we add $10\frac{1}{4}$ ounces of carbon, we have $30\frac{3}{4}$ ounces for the carbon and water expended from the lungs in one day, and this taken from $37\frac{1}{2}$ leaves $6\frac{3}{4}$ ounces per day, for the insensible perspiration from the skin, which, if the above estimate be allowed, must consist of $6\frac{1}{2}$ ounces water, and one quarter of an ounce carbon. According to this, the matter perspired from the lungs is five times as much as that from the whole surface of the body.

If, instead of carbon, we trace the element azote into and out of the body, we shall find from our data, that from butchers' meat, cheese, and milk, about $1\frac{1}{2}$ ounce of azote is taken into the stomach daily, and nearly as much passed off by urine and fæces.

Upon the whole we may observe, that of the 6 lbs. of aliment taken in a day, there appears to be nearly 1 lb. of carbon and azote together; the remaining 5 lbs. are chiefly water, which seems necessary as a vehicle to introduce the other two elements into the circulation, and also to supply the lungs and other membranes with moisture. Very nearly the whole quantity of food enters into the circulation; for the fæces constitute only one-eighteenth part, and of these a part, bile, must have been secreted; one great portion is thrown off by means of the kidneys, namely about half of the whole weight taken, but probably more or less according to climate and season, &c.; another great portion is thrown off by means of insensible perspiration, this last may be subdivided into two portions, one of which goes off by the skin, amounting to one-sixth part, and the other five-sixths are discharged from the lungs in carbonic acid, and in water or aqueous vapour.

Such are the deductions I have drawn from my early experiments, and from the light which modern chemistry has diffused over the animal and vegetable products. This branch of science belongs more peculiarly to the physician. What the profession may have done in it of late years, I am not aware, my studies not having been in that line. But it must be allowed to be a subject worthy the attention of professional characters, and not uninteresting as a branch of physics.—*Memoirs of the Manchester Philosophical Society*, Second Series, vol. v.

Barometric Measurement of the Height of Cheviot. By Lieutenant-Gen. Sir THOMAS MAKDOUGALL BRISBANE, K.C.B., President of the Royal Society of Edinburgh, LL.D. &c., and Mr WILLIAM GALBRAITH, Oxon., A. M.

FROM repeated measurements of altitudes by the barometer, carefully performed, various important consequences may be deduced relative to the expansion of air, affected with temperature and different degrees of moisture. By the same means the decrements of heat, in proportion to the height, of which the law is not yet probably so well determined as might be desirable, will also be determined. With these views, it was agreed by the observers just named, to make a series of observations at

Holy Island, where Sir T. M. Brisbane was residing, and where he had a good set of instruments for the purpose; while Mr Galbraith, with another set of similar instruments, should make a corresponding series on the top of Cheviot, at times previously agreed upon.

On the 14th of September 1832, two corresponding series were made, under rather favourable circumstances, between the hours of 11 and 12 noon, of which the following are the means, indicated by general symbols.

At Holy Island, 59 feet above the mean level of the sea,

$$B = \overset{\text{in.}}{29.849}, \quad \tau = 57^\circ.0, \quad t = 57^\circ.0$$

on the top of Cheviot, near the eastern extremity, and a few feet under the mark lately erected by Sir T. M. Brisbane, in the place of that formerly occupied by the theodolite, used in the trigonometrical survey *,

$$b = \overset{\text{in.}}{26.993}, \quad \tau' = 44^\circ.5, \quad t' = 44^\circ.5$$

In like manner, a series was taken in Mr Adie's shop, 58. Prince's Street, Edinburgh, at 207 feet above the mean level of the sea at Leith, by Mr R. Adie, to see what influence horizontal distance might have on the results, where

$$B = \overset{\text{in.}}{29.591}, \quad \tau = 60^\circ.0, \quad t = 60^\circ.0$$

In which B denotes the height of the mercury in the barometer at the lower station, τ the temperature of the mercury in the barometer by the attached thermometer, t that of the air by the detached thermometer, while b, τ', and t', mean the same at the higher stations, though, for the purpose of avoiding all uncertainty of the real temperature of the mercury in the barometer tube and cistern, it has been thought desirable, in these observations, to allow both thermometers to come to the same temperature, by exposing the instruments to the free action of the atmosphere for an hour before recording the observations from which the deductions are made, since it appears doubtful that

* It is much to be regretted that substantial permanent marks, which might have been prepared at a trifling additional expense, are not universally left by the Ordnance surveyors at all their stations; such as a roughly dressed block of stone, with the King's mark, the arrow, upon it, and a cross to point out the exact centre of the theodolite, as it is probable that, in the course of a very few years, they will be generally irrecoverably lost.

the attached thermometer shews it in every case, however unequally the instruments may be affected by heat from the observer's body, or other causes.

As barometers, however well made, even by the same artist, show small differences from one another, depending upon slight variations in the specific gravity of the mercury, its different degrees of purity, and the perfection of the construction, it was considered indispensable to institute a rigorous comparison, to determine the differences, which have been denominated Index Errors. If, therefore, Sir T. M. Brisbane's barometer be called A, Mr Galbraith's B, Mr Adie's C, then A being taken as a standard, the index errors will be

$$A = \overset{\text{in.}}{0.000}, \quad B = +\overset{\text{in.}}{0.093}, \quad \text{and } C = +\overset{\text{in.}}{0.108};$$

that is, if the three barometers were all standing together on the same level, and having the same temperature, it would require 0.093 inch to be added to the height read from Mr Galbraith's barometer B, to render it the same as Sir Thomas Brisbane's, and it would require 0.108 inch to be added to Mr Adie's, C, to make it of the same height as Sir T. M. Brisbane's. These numbers were obtained by comparing Mr Galbraith's barometer, first with Sir T. M. Brisbane's at Holy Island, and afterwards at Edinburgh with Mr Adie's. Whence, these corrections being applied,

Sir Thomas Brisbane's will shew

$$B = \overset{\text{in.}}{29.849}, \quad \tau = 57\overset{\circ}{.}0, \quad t = 57\overset{\bullet}{.}0.$$

Mr Galbraith's, corrected, will give

$$\begin{array}{lr} & b = 26.993 \\ \text{Index error} & +\ \ 0.043 \\ \hline \text{Corrected} & b = 27.086, \end{array} \quad \tau' = 44\overset{\circ}{.}5, \quad t' = 44\overset{\bullet}{.}5.$$

Mr Adie's, corrected, will give

$$\begin{array}{lr} & B = 29.591 \\ \text{Index error} & +\ \ 0.108 \\ \hline & B = 29.699, \end{array} \quad \tau = 60\overset{\circ}{.}0, \quad t = 60\overset{\circ}{.}0.$$

With these, then, the final results are determined by the formula investigated in this Journal for October 1831, From Sir Thomas Brisbane's and Mr Galbraith's,

$B = 29.849$,	$\tau = 57.0$,	$t = 57.0$	57
$b = 27.086$,	$\tau' = 44.5$,	$t' = 44.5$	44.5
$B - b = 2.763$,	$\tau - \tau' = 12.5$,	$t + t' = 101.5$	300)101.5
$B + b = 56.935$		6	
			.34
		6090	2.42
		48400	
			2.76
		54490	$t + t' = 12.5$
$B - b$ (inverted)		367.2	
			1380
		108980	552
		38143	276
		3269	
		163	$-$34.500
$B + b$	56,935)	150555 (	2644.5
		113870	$-$34.5
		66 85	2610.0
		34161	Sea $+$59.0
			Cairn $+$15.0
		2524	
		2277	2684.0
		247	
		228	
		19	
		25 +	

Mr R. Adie's and Mr Galbraith's,

$$B = 29.699,\quad \tau = 60^\circ.0,\quad t = 60^\circ.0$$
$$b = 27.086,\quad \tau' = 44.5,\quad t' = 44.5.$$

Substituting, then, in the formula

$$H = \{48400 + 60\,(t + t')\frac{B - b}{B + t} - 2.75\,(\tau - \tau');$$

there will result H = ...	2473 feet
Height of Mr Adie's barometer above the sea . . .	207 feet
Summit of Cheviot above the barometer	15 feet
Total height above the sea	2695 feet;

which exceeds the other by 11 feet, a quantity not very great, considering the distance, and the weather not in the most favourable state. It shows, however, that even at considerable distances, such as 50 or 60 miles, in this case, as well as in our measurement of the height of Benlomond in 1828, that considerable accuracy in the results may be expected, when the observations are carefully made with good instruments.

The important consideration of the decrement of heat, according to the distance from the earth's surface, may now be considered. From various measurements of heights by Messrs Galbraith, Adie, Henderson, &c., it will appear, that, near the surface of the earth, in this country, at about latitude 56° N., Fahrenheit's thermometer falls about 1° for 70 yards of ascent, in heights not exceeding 2000 or 3000 feet. Thus, the measurements of

Benlomond from Edinburgh gave	243 feet
Do. from Rowardinnan (its base)	205
Bennevis and its base	216
Carnethy and Edinburgh	183
Cheviot and Holy Island	212
Mean of the whole	212

It may, therefore, be concluded, that, to depress the thermometer 1°, near the surface of the earth, the ascent of 70 yards, or 210 feet, in round numbers, must, in this climate, be pretty near the truth. It is probable, however, that this does not hold good either towards the equator or poles.

By analyzing the results recorded in Ramond's work on the barometric formula, it will be found that this increases with the height. In heights of 5000 feet, the elevation necessary to depress the thermometer 1°, is about from 230 to 250 feet, obtained by dividing the height by the difference of temperature*. In fact, it may, *a priori*, be inferred, that at immense distances in absolute space, from any of the celestial and planetary bodies, where no contiguous body exists to influence the thermometer, that it could be moved considerably in any direction, without any change of its indications. From some late investigations relative to astronomical refractions, similar inferences have been made.

It may therefore be concluded, as well from experiment as general reasoning, that the ascent for 1° increases with the height, though the irregularity of this quantity derived from different observations, so liable to be affected with extraneous causes, renders an investigation of the law of increase difficult and somewhat uncertain. From a consideration of various re-

* Hence it follows, that at the highest point the depression for 1° must be somewhat more than the mean for the whole, and that near the surface it must be less.

sults, Mr Galbraith has inferred that the increase may be tolerably well represented by the common hyperbola, which satisfies the heights of Ramond, those by the Earl of Minto, and some others very nearly.

The equation to the hyperbola is

$$y = \frac{b}{a}\left(x^2 - a^2\right)^{\frac{1}{2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1.)$$

y being the total height in feet, and x the ascent necessary to depress the thermometer 1° of Fahrenheit's scale.

If two values of x and y be taken from observations, that can be depended upon, the values of a and b will become known. Let

$$y = 5000 \text{ feet, and } x = 250 \text{ feet,}$$
$$y' = 10{,}000 \text{ feet, and } x' = 300 \text{ feet,}$$

which, from the best observations, they are known to be nearly. Now, if these be substituted in formula (1.), it will be found that $\frac{b}{a} = 55$ nearly. But at the surface of the earth $a = x = 210$ feet, as has been just found from experiments, whence $b = 55a = 55 \times 210 = 11550$, in round numbers, without sensible error in the final results; therefore a and b are known, and consequently x, the depression to any given height, y may be computed.

From the general equation

$$y = \frac{b}{a}\left(x^2 - a^2\right)^{\frac{1}{2}}$$

it will be found that

$$x = \frac{a}{b}\left(b^2 + y^2\right)^{\frac{1}{2}} = a\left(1 + \frac{y^2}{b^2}\right)^{\frac{1}{2}}$$

But $b^2 = 133400000$. Hence, if d be the depression, h the height, and $a = 210$ feet,

$$d = 210\left(1 + \frac{h^2}{133400000}\right)^{\frac{1}{2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2.)$$

which is a general formula to compute the ascent in feet necessary to depress Fahrenheit's thermometer one degree.

In the Table in the margin are given the corresponding numbers of feet required to depress the thermometer one degree by this formula, that agree pretty well with observations, in which, for the same height, there are often considerable discrepancies, depending on causes not well known.

TABLE.

Height in feet.	Depth in feet.
5,000	229
10,000	278
15,000	344
20,000	420

The first numbers agree nearly with our own observations, as well as those of Dalton and others, made at moderate elevations above the earth's surface; the second with Ramond's height of Col du Géant from Geneva, which, for 10,000 feet, gives 277 feet, almost exactly the same as the Table, 278, from our formula; while Chimborazo, for about 21,000 feet, gives 400 feet, a little less than the formula that assigns 420 feet for this height.

In most works respecting this subject, the object of the writers has been to deduce a mean value to be applied generally, and stating it as from 270 to 300 feet, which, by consulting our Table, corresponds to heights of 10,000 and 15,000 feet, and, consequently, must be wide of the truth in both very small and very great heights. Our formula is, doubtless, of an empirical character, but supported by an appeal to the most accurate experiments that could be obtained; and in that case will, it is hoped, prove serviceable, till a better be obtained, though, from its variable nature, we are aware that no formula will ever be produced strictly applicable in every case.

As the centesimal thermometer is frequently used, it has been suggested that a formula for obtaining heights, when that instrument is employed, would be useful, it has been subjoined. The small corrections for height, latitude, &c., may all be conveniently simplified, and readily appended to the first part of the formula, to render it general and complete, though they are only wanted in great heights, seldom measured, and not to be met with in Britain.

1. For Fahrenheit's Thermometer.

$$H = \left\{ 48400 + 60\,(t + t') \right\} \frac{B - b}{B + b}\, s - \left\{ 2.42 + \frac{t + t'}{300} \right\} (\tau - \tau')$$
$$+ h\,(0.00268 + 0.00268 \cos 2\lambda + 0.00000005\, h)$$

in which H is the true height in feet, t the temperature of the air by detached thermometer at the lower station, t' that at the upper; τ the temperature of the mercury in the barometer at the lower station by the attached thermometer, τ' that at the upper; B the height of the mercury in the barometer at the lower station, b that at the upper, h the height, and λ the latitude

2. For the Centesimal Thermometer, giving H in feet.

$$H = \left\{ 52250 + 110\,(t + t') \right\} \frac{B - b}{B + b}\, s - \left\{ 4.56 + \frac{t + t'}{100} \right\} (\tau - \tau')$$
$$+ h\,(0.00268 + 0.00268 \cos 2\lambda + 0.00000005\, h).$$

3. For either the English Barometer or French metrical barometer and centesimal thermometer, giving H in French metres.

$$H = \left\{ 15926 + 33\,(t + t') \right\} \frac{B - b}{B + b}\, s - \left\{ 1.40 + \frac{t + t'}{300} \right\} (\tau - \tau')$$
$$+ h\,(0.00268 + 0.00268 \cos 2\,\lambda + 0.00000005\, h).$$

In all these three formulæ, the second part may be omitted in small heights, not exceeding 2000 or 3000 feet, without sensible error, which renders this mode very ready in practical cases, when Tables are not at hand, or are inconvenient in their application.

EDINBURGH, 54. SOUTH BRIDGE,
September 1832.

Outline of the Geology of the Bhurtpore District. By JAMES HARDIE, Esq. Bengal Medical Establishment. (Concluded from p. 336 of preceding volume.)

I HAVE, in a former communication, given you a very general account of the "Indian new red sandstone formation," and I took the opportunity of hinting, that the complete identity of this formation with that of England, had not been demonstrated in a perfectly satisfactory manner; and I also hinted, that perhaps some of the beds of the Indian series might eventually be discovered to be synonimous with the "inferior new red sandstone formation," or red sandstone interposed between the magnesian limestone and coal formation. The more I have thought on the subject, the more I have felt disposed to believe that such will prove the result. Sandstones, associated with rock-salt and gypsum, do undoubtedly occur in the north-west of India and elsewhere, but these minerals have not heretofore been observed in connexion with the southern Gangetic series. Limestones, containing numerous organic remains, said to be identical with those of the lias, also occur in the northern and western districts; while the organic remains of the limestones of central India, Bundelcund, &c. are, to say the least, exceedingly obscure. The latter, with their accompanying sandstones, perhaps belong to a series inferior to the saliferous sandstones and conchiferous limestones of the north and west, and perhaps may be identified with the magnesian limestones of other countries. Many objections may undoubtedly be urged against such a supposition, but at the same time we must bear in mind, that objections, founded on the external characters of rocks, and even upon their mode of occurrence, and the position of their strata, ought to be received with extreme caution. In the mean time, the absence of rock-salt and gypsum in the sandstones, and the great scarcity of well defined organic remains in the limestones, are negative proofs which ought not to be lost sight of; more especially as it has now been ascertained, that *an absence of organic remains is not, as was formerly supposed, a characteristic feature in the geology of Indian formations in general.* The limestones of Central India contain a proportion of associated carbonate of magnesia, but upon this argument, for reasons stated in my last, I do not place any reliance. I have at the same time shewn, that we are not entitled to draw any conclusive inference from the occurrence of brackish wells and saline efflorescences, in particular districts.

I have already observed that sandstones, probably of anterior date to those which have just come under consideration, here and there crop out, more especially in the northern portion of the Bhurtpoor district. These rise into low hills and hill-ranges, many of which present an abrupt escarpment to the west. The hill of Futtypoor Sickree, though, strictly speaking, in the modern district of Agra, may be quoted as an example of this formation; and numerous other detached hills of a similar nature may be seen in the neighbourhod. These rise abruptly from an alluvial platform, like islands from the bosom of an ocean. The sandstones composing them are hard, quartzose, and gritty; they occasionally incline to coarse granular, and are very generally ferruginous. They are much fissured and broken, and are in consequence not well adapted for building. They are, however, employed in the fabrication of native millstones (*chukeron*), and are well fitted for the purpose. They vary in colour from reddish to greyish white, and are arranged in strata which are considerably inclined with an easterly direction. I have met with no organic remains in this formation, but specimens have been shewn to me as such, which were examples of those beautiful dendritical delineations of metallic origin, which have so often deceived those unacquainted with their nature. Such appearances are often met with in these sandstones. I have not sufficient data to enable me to decide relative to the age of this formation; the strata appear to dip under the newer rocks, and they may probably be identified with the old red sandstones of England.

I have but little to say regarding the belt of rocks which I have mentioned as flanking the Bhurtpore district to the west. About three miles W.S.W. from the city of Bhurtpore, we meet with a low hill-range, which, as before stated, forms a portion of the eastern limit of the belt. This range runs in a direction N.E. and S.W.; the hills are low, (about 150 or 200 feet), and the rocks composing them belong to the transition series. On approaching the range from the east, the first rock observed is a variety of greywacke; it is subcrystalline; is composed of quartz, felspar, and talcose matter; colour light grey, passing through various shades into dark blackish grey; texture rather fine angulo-granular, occasionally inclining to compact. The quartz grains, when magnified, appear in many cases rounded, and some of the specimens much resemble sandstone. The rock is generally minutely porous on its weathered surface; the pores are filled occasionally with a ferruginous ochre, occasionally with a white talcose earth; breathed upon, it exhales a strong aluminous odour. In the narrow beds, the rock is more compact than in the other, and is harder and more difficultly frangible. The whole of the eastern slope is formed of this rock. We next come upon a bed of soft friable slate, which may be described as a talco-argillaceous schist; colour light grey, soft, so as to crumble between the fingers; has a soapy feel; a somewhat silky lustre, and an earthy cross fracture.

The strata are nearly vertical, with a slight inclination to the N.W., and are traversed by numerous quartz veins, running in a direction generally N.W. and S.E., with a north-easterly underlie. On the summit and slope of the hills there are a great abundance of rolled stones, consisting of rounded masses of ferruginous conglomerates, iron and manganese ores, and quartz rock. The ascent from the S.E. is by a series of steps formed by the outgoings of the strata.

To the west of this position, the plains are still covered with a deep soil, through which protrude hills and hill ranges, many of them exhibiting a bold and craggy outline. The predominating rocks are different modifications of quartz-rock, many of which are ferruginous. These belong to the clayslate series.

This series appears to be continued on towards Delhi. The celebrated hills of Governdhun, near Bindrabund, is in the line of direction, and is composed of a quartz-rock, which occurs abundantly to the westward of Bhurtpoor. It is characterized by enormous cracks and fissures, which often divide the mass into huge *apparently* detached blocks; the hills, in many instances, appearing to consist of a series of such blocks, piled the one on the other.

Near the city of Biana, which lies about fifty miles W.S.W. from Agra, there occurs a series of alternations, of a ferruginous quartz rock, with a peculiar conglomerate, containing imbedded agates, agate jaspers, and similar minerals, with adularia, &c. The cementing medium is exceedingly hard and compact, and is itself of the nature of agate. These rocks occupy the rugged termination of a hill-range, which stretches from this point in the direction of Ajimeer. The strata, which are much distorted, are arranged in a similar manner to the older sandstones of Futtypoor Sickree, and probably form the inferior beds of the formation to which the latter belong. The Biana rocks may probably be continued on into the Gewalior country, at least agates, jaspers, and quartzose conglomerates, would appear to be exceedingly abundant in that district. As surface rocks, they occupy but a small space in the Bhurtpore country.

I have been told that copper mines were at one time worked somewhere in the belt of transition rocks which flanks the Bhurtpore district,—the exact locality I am not acquainted with. Iron, too, is of abundant occurrence in this belt, and might perhaps be manufactured with advantage.

From the above description it appears that the Bhurtpore district is situated, geologically speaking, to the eastward of the Jeypoor branch of the great primary formation of Rajpootana; and that it is separated from this branch by a belt of transition rocks*. The newer sandstone of this district would also appear to belong to a great series of rock formations, which has been traced through a large portion of Hindustan, and which forms, with but little interruption, the southern and northern barriers of the valley of the Ganges and Jumna. This series is probably continued on both to the north and south of the primary branch just alluded to, making, on one side, a sweep into the *Punjab*, flanking, in its course, the great Himalaya formations, and afterwards following a southerly direction through the districts to the west of the Aravulli mountain plateau, which separates Ajmeer from Marwar; while, on the other side, the same series may be traced into Harowtee†, Malwa, and Meywar, where it makes a deflection to the south, and is still seen skirting the primary formations of the latter district, being interposed between them and the overlying trap of Malwa. On the border of Guzerat, too, the same series may be observed; and in this portion of the country, the Meywar sandstones seem to take a sweep eastward, so as to unite with the branch to the west of the Aravulli plateau‡. There is also every reason to suppose that the above series is continued on across the Indus into Persia.

In the above general description are included the limestones, and saliferous sandstones, which in some localities appear as the surface-rocks. Under the former, and perhaps also under the latter, the sandstones of the Gangetic series occur; but the whole, undoubtedly, belong to one grand system of formations, identical with the secondary class. Rocks of the transition series, or argillaceous schist series, would also appear to be very

* I use the word "transition" in compliance with custom, but with no theoretical view. The distinction, in India, between the primary and transition series is, to say the least of it, exceedingly ill defined. I have been in the habit of considering *all* the rocks of Rajpootana as members of one grand formation, which, for the convenience of description, I have separated into three subordinate series, viz. the *granitic series*, the *micaceous schist series*, and the *argillaceous schist series*.

† This word, by an error of the press, has uniformly been printed *Parvistee* in my last communication.

‡ This rapid sketch will, I trust, in some degree fill up a hiatus in my friend Mr Calder's excellent outline of the geology of India. See Transactions of the Physical Class of the Asiatic Society, part first, p. 1.

generally interposed between the newer strata and the rocks of the mica-slate and granitic series of Rajpootana; and future observation may probably discover, in this portion of India, the outcroppings of other strata, which may complete the series between the new and old red sandstones. The latter I have described as occasionally appearing, as surface-rocks, in situations the most remote from each other*.

The supporters of the theory of upheaving agencies will not fail to perceive, in the above arrangement, an argument strongly corroborative of their opinions. The fact alone, that the primary rocks of Rajpootana are skirted, or rather, I may say, isolated, by newer formations, corresponding with each other, even at the greatest distances, is a strong presumptive evidence that the former were elevated, or rather forced through a superjacent formation, the remains of which are still found skirting the primary district, which now occupies a central position in reference to the newer formations. The skirting belts are frequently very narrow, and the above seems to be the simplest way of accounting for the appearances observed.

Strong internal evidence of the truth of this theory may be perceived in the structure of the rocks,—in the position of the strata,—in the relative direction of the hill ranges,—and in the different levels at which the newer rocks exist. To this subject I may at a future period revert, and shall at present content myself with remarking, that, posterior to the formation of the newer limestones and sandstones, the agent concerned in the elevation of the great overlying Malwa trap, must have exerted its enormous energy, and that a cause so energetic must have produced effects far beyond the immediate sphere of its operation. Perhaps, too, we may trace in the distribution of the Rajpootana formations the effects of that tendency in the newer marine deposits, to be ruptured along fracture lines at right angles, or nearly so, to one another. Mr Scrope † has supposed that this cause, slight though it apparently be, may have had a great influence in determining the direction of our mountain ranges; and, in the instance before us, we have seen the skirting belts of newer rocks, first pursuing a northerly and southerly direction

* See Edinburgh New Philosophical Journal, p. 87, No. 21.

† See his late work on Volcanoes.

in Bhurtpore, subsequently a westerly direction into Meywar, where they are deflected towards the south; again following a westerly direction on the borders of Guzerat, and eventually stretching north on the western side of the Aravulli plateau, where they are perceived to form a continuous series with the rocks which skirt the Rajpootana formations, to the north of Jeypoor and Aymeer.

I am sorry that, in this communication, I have been obliged to leave so much to conjecture. To complete a geological survey, with any degree of minuteness, requires the undivided attention of the observer, and infers the power of travelling in whatever direction may be deemed necessary for the determination of doubtful points. A public servant, who has other avocations, must be satisfied with the few observations which he may be enabled to make in the neighbourhood of the line of route, which his duty compels him to follow.

On the Frontal Sinus. By Thomas Stone, M. D. (Communicated by the Author.)*

In this memoir I propose communicating to the Society the general results of my observations concerning the mode of formation, average extent, and peculiarities, which characterize the frontal sinuses in the human cranium; and when we consider the influence which their development has over the configuration, not only of the cranial, but also of the facial bones, we shall attach due interest to every investigation into their history. With the existence of these sinuses the older anatomists, at least those who immediately succeeded Galen, were not unacquainted, for they were described by Columbus, and Laurentius points them out as demanding especially the consideration of the operating surgeon. It need scarcely be observed, that Vesalius, Albinus, Paaw, Winslow, Cheselden, Monro, and other distinguished anatomists, have likewise described them: but with reference to their origin, they state only, in general terms, that they arise from the diploë having, where they exist, become ex-

* Read before the Royal Medical Society, March 1831.

hausted between the cranial tables; which, after all, amounts to no more than a bare acknowledgment that such cavities do exist. Sœmmering, in speculating on their origin, hazards the supposition, that bony substance, or diplöe, is first deposited, and then absorbed for the purpose of leaving these spaces; an explanation which appears somewhat clumsy, and which, at any rate, he did not support by any corroborative testimony. Ackermann has had recourse to a theory which appears to me still more fanciful and untenable: he states, that air being drawn up, in the act of inspiration, through the nasal passages, insinuates itself between the tables of the frontal bone, and, by striking against them, mechanically separates them from each other; which hypothetical explanation is refuted at considerable length, under the article *Crâne*, in the Dictionnaire des Sciences Medicales. It is remarkable that even Sabatier attaches some importance to this vague surmise;—but, without proceeding to adduce other theories which have been proposed to explain their origin, and which appear alike unsatisfactory, I may briefly premise, that the one which has been recently propounded by the learned and ingenious Dr Milligan, appears to me sufficiently satisfactory; yet, before explaining how his views are coincident with my observations, I must state, which I shall do briefly, the general results of my inquiries concerning the growth of the head at different periods of life.

It is evident that the most conclusive method of obtaining information on this subject, would be to measure the same head at different successive ages; but this, for obvious reasons, has not been hitherto in my power. To supply this desideratum, therefore, I ascertained the extent of the required dimensions of the head in a great number of subjects of the same age, and then found the average extent of each dimension at that period of life. I then arranged in another class the heads of persons of the same, but of a more advanced age; and, after obtaining the individual, found the average dimensions of these; then, by comparing these averages together, deduced the general amount of these dimensions at the ages chosen, and their average increment between the periods allotted to each class. It appears by this investigation, that, during the first four years of life, the head increases equally in all its directions, *i. e.* in its longitudinal, transverse, and vertical dimensions, and, at the same time, the face increases nearly an inch in length, and a full inch in breadth. The growth of the head is more rapid during this than during any subsequent period of life. Immediately after this, between four and seven years of age, a remarkable difference in the mode of development is observed, for the head does not continue to maintain a similar ratio of growth in all its different directions; but, instead of this, the transverse gains on the longitudinal dimension, and there is scarcely any increase in its growth behind the meatus externus.

This accords well with the observations of Sir William Hamilton, who, by weighing the cerebellum and measuring the size of the cerebellar cavities, ascertained that the cerebellum attains its maximum relative size at three years of age. By taking a profile view of the posterior region of the head of a child, and comparing it with a profile view of the head of an adult, the eye will soon familiarise itself with this fact.

From the age of four to that of seven years, it has just been said that the transverse gains on the longitudinal dimension; and it is worthy of remark, that immediately after this period, *i. e.* from seven to fourteen, the head increases so much in length, that the longitudinal now gains sensibly on the transverse dimension. This increase of development takes place, it is to be remembered, anterior to the external meatus, and is nothing more than the progress which the external table of the frontal bone makes in accompanying the growth of the facial bones to which it is attached, and which, at the same time, extend their distance considerably from the meatus. The frontal bone, however, during this period, increases little or nothing in breadth, the growth being principally from the meatus forwards; hence it becomes obvious, that, instead of maintaining a similar ratio of growth in all its directions, one dimension of the head exceeds in the rapidity of its growth another dimension, and one region of the head increases in size, while another remains stationary.

Having thus stated the general results of these investigations concerning the growth of the head, let us consider the application of these facts, and the mode in which, consistently with them, the frontal sinuses become developed. Before the head increases so much in its longitudinal dimension, that is, before seven years of age, the cranial tables are closely approximated, but about that age (*i. e.* seven), the brain having attained its full complement in size, the internal table is fixed in its position. It is now the true osseous case of the full sized brain, and every farther bony deposition takes place interstitially, which accounts for the superior hardness of this, which has been, consequently, called the "vitreous" table of the skull. That the brain does attain its full size at this early period of life, as was suspected by the Wenzels, whose induction resting only on *two* cases, proved nothing, was shewn by Sir William Hamilton, who not only confirmed their opinion, by weighing the encephalon at every age, but also shewed that the skull of a child does not contain more sand than that of an adult, although the dimensions viewed externally differed extremely. Now, at this period, the brain requiring no further deposition of cerebral substance, the branches of the external carotid arteries will assume a greater activity of function *, and deposit that osseous matter which visibly increases the size of the facial and frontal bones. Connected as the external table of the frontal bone is to the facial bones, it is evident that when these facial bones start forward, the frontal bone must accompany their development, which it does without sympathizing with, or carrying along with it, the internal cranial table. What then happens? It is clear that, when the external table is gradually, in its advancement forwards, separating from the internal table, an opening must be thereby made, which would be filled with diplöe; but that the vessels of the Schneiderian membrane in contact at this point, irritated by the change of position, and forming the membrane with much greater vigour and rapidity than the bony diplöe, extend into this nasal cavity. Hence, as stated by Dr Milligan, a membrane is speedily shot into the nascent hollow or sinus, which attaching itself to the outer aspect of the vitreous table and the inner aspect of the osseous table, forms an insurmountable obstacle to the rudest diplöe that might join these two layers, for it is a mucous membrane, a class of tissues which scarcely ever forms adhesions, and is here almost a shut sac, whose sides are every day brought farther and farther asunder †."

* This law of "*re-stagnation*" is explained at length, and applied to other phenomena of evolution, by Dr Milligan, in his valuable Appendix to his Translation of Majendie.

† Ibid. p. 604.

In confirmation of this view, numerous facts present themselves, which are of a positive, not of a negative character:—

1. I may refer to the period of life when these sinuses become developed, for although it has been asserted by a celebrated cranial theorist, that the sinuses do not exist in young persons, but only in old persons, or after chronic insanity, yet this assertion is contrary to all previous authority, and opposed to the most direct evidence of Nature. Eyssonnius, Coiterus, Fallopius, Riolan, Vidus Vidian, Bartholin, Ruysch, Duverney, Portal, Bertin, Sabatier, Bichat, and others, state the non-existence of these sinuses in infants, but describe them as occurring about puberty; and the latter, especially, attributing their expansion to its proper cause, viz. the development of the external table of the skull, states that they can only be formed at that period when this development takes place, which, as we have seen, commences after seven years of age. The anatomy, too, of the inferior animals refutes, it would appear, the asseveration, for Cuvier remarks, " C'est une régle générale pour tous les carnassiers, ils (les sinus frontaux) ne prennent leur developement qu'avec age *."

II. Every sinus is lined with a mucous membrane, a fact known to the earliest anatomists who paid attention to this subject; and here it may be remarked, that when, owing to any impediment, such as the narrowness of the nasal passage, this mucous membrane has not been able to extend between the cranial tables, then the sinus does not exist, and its place is supplied by a deposition of bony diplöe, which now meeting with no obstacle, is freely deposited, and occupies what would otherwise have been the space of the frontal sinus. This view satisfactorily explains the observation of the present Dr Monro, who, alluding to crania without these frontal sinuses, remarks, that " in such cases the tables are as far separated as if the sinuses existed, for their place in this case is filled up with diplöe †."

III. It has been shewn that the average increase in the growth of the head, when its longitudinal gains on its transverse dimension, which is entirely owing to the development before the meatus, is $\frac{4}{10}$ths of an inch, which I found, subsequent-

* Cuvier, Recherches sur les Ossemens Fossils, tom. iv. p. 358.

† Monro, Elements of Anatomy, vol. i. p. 134.

ly, to be the average depth of the frontal sinuses. Such, then, is the connection which evidently exists between the general growth of the head and the formation of these sinuses.

The average extent of these sinuses next claims consideration, on which subject anatomists have not recorded hitherto any definite observations. Albinus describes them as "cavernas magnas amplissimas prope nasum;" and extending upwards and laterally over the orbits, as far as the middle of the superciliary ridge. Ruysch states that they are often very large, and cites the case of a puella gigantea, in whom they extended above the coronal suture, and some way between the tables of the parietal bones. Winslow, Lieutaud, and Palfin, state they vary much in different individuals; but it does not appear that they paid any attention to their average extent. Dr Monro (the present Professor) gives, in his Elements of Anatomy, some measurements of the frontal sinuses; but the sinuses to which he refers, are stated to have been unusually large, consequently they do not represent the universality of Nature. I have measured these sinuses in upwards of a hundred crania, and consider that the following may be regarded as their average extent. 1st, Their extent in height is 1 inch $\frac{7}{20}$ths;—2d, their extent in breadth is 2 inches $\frac{4}{10}$ths, this is, for each sinus;—and their extent in depth $\frac{4}{10}$ths of an inch.

Such was their *average* size in the crania examined by me; but, of course, in some individual cases they may be much smaller, or much larger. I shall conclude this memoir by stating the peculiarities by which these frontal sinuses are characterised.

1. The frontal sinuses originate under each os unguis, and thence extend, in the manner described by Albinus, laterally and vertically, over the orbits. Their origin at this point is evidently owing to the extension of the mucous membrane lining the nasal cavities, which creeps from under this bone, to extend between the cranial tables.

   It is remarkable that Gagliardi has not only erroneously described, but has given a plate to his work, in which these sinuses are represented in an erroneous position *.

2. The sinus is most commonly divided by a septum, which generally runs down the mesial line; but often inclines much to the right, or much to the left side. In illustration of this, I may refer to the Anatomical Museum of the University (Dr Monro's), wherein will be found five skulls sawn open, to show these sinuses, rather large. In No. 104,

* Gagliardi Anatom. Ossium, 1723.

specimen B, the septum inclines to the left. In specimen D (same case) it inclines to the right.

In the collection of crania labelled by Dr Spurzheim, now in the Edinburgh College Museum, and which Professor Jameson permitted Sir William Hamilton to open, the septum appears in a great many to have been incomplete; that is, not extending from the posterior to the anterior wall of the sinus. As Bertin and other anatomists have observed, in such crania, the sinus of the right communicates with the sinus of the left side.

3. Palfin, Sabatier, Monro secundus, and other anatomists, have stated that the frontal sinus is often divided by many *complete* septa; but in upwards of one hundred crania, not one appeared corresponding to this description.

4. The frontal sinuses are on each side generally unequal in size; but the remark of Vieussens is not correct, that the right cavity is always larger than the left, (quorum dexter sinistro *semper* amplior est *). In the collection preserved in the Natural History Museum, specimens 42 and 47 will be found to have the left larger than the right sinus; but in the specimens 9, 5, 4, 26, the right sinus is larger than the left. Many anatomists have remarked, that the sinuses are on each side generally equal; but this is evidently incorrect. It may, however, be stated, that the right sinus is more frequently larger than the left, than the left is larger than the right sinus.

In some instances the sinus is found of its usual size on the *right* side, and only a mere vestige of its existence on the *left*, as may be seen in specimens 17, 36, 45, of the same collection; and, in some instances, the sinus appears of its ordinary dimensions on the left side, with only its rudimentary cell discernible on the right; which may be observed in specimens 28, 33, 50, of the same collection.

5. The non-existence of the frontal sinus is very rare; and many anatomists, who have affirmed the contrary, have misguided themselves, by not looking for it in the proper place,—a fact which did not escape the observation of Sabatier, who, contradicting the authority of Fallopius on this point, remarks, " C'est sans doute une inadvertence de sa part, car on les rencontrent aisément quand on a la precaution *de scier la crâne plus bas qu'à l'ordinaire* †."

It is worthy of observation, that Winslow remarks, " the frontal sinuses are sometimes completely wanting, and in such subjects the internal cavity of the nose is larger than ordinary ‡."—I may add, that, in the collection of crania in the Edinburgh University, there are only three specimens in which the frontal sinuses appear to be wanting; but in each of these, its elementary cell is visible under each os unguis;—so that not one specimen in this collection completely wants the frontal sinus.

* Vieussens Neurograph. Univers. lib. i. c. cxvi, p. 103.

† Sabatier, Traité d'Anat. tom. i, p. 32.

‡ Winslow, Anatomy of the Human Body, p. 23.

6. It is impossible by *any* external examination of the cranium to predicate whether it possesses a large or a small frontal sinus; an idea entertained by many, who imagine that the size of the sinus is indicated by the greater or lesser prominence of the superciliary ridge. This is an error. A large superciliary ridge often exists over a very small sinus; and scarcely any superciliary ridge at all is sometimes discernible, when a very large sinus exists underneath. In specimen 28 (in the collection of crania already referred to) scarcely any sinus is visible on the right side, yet the superciliary ridge above it is strongly marked. In specimen 49 only a vestige of the sinus exists, yet the superciliary ridge is large. In specimens 2 and 29 the sinuses are small, yet the superciliary ridges strongly marked. Whereas, on the other hand, in specimens 8, 23, 34, the superciliary ridges are nearly wanting, yet the sinuses beneath are large. No correlation whatever, therefore, exists between the size of the superciliary ridges and the extent of the frontal sinus.

   It may be added, that the greater or lesser fulness of the frontal bone in this region does not in the slightest degree assist our predictions; for the size of the sinus, depending entirely on the extent to which the mucous membrane has risen between the cranial tables, preventing there the deposition of diplöe, admits of no external sign.

7. The depth of the sinus bears no proportion whatever to its extent in breadth or height. The sinus (as in specimen 16) is sometimes nearly two inches in height, and three in breadth, yet the depth the same as in crania which have the sinuses very small, as in specimen 33, where the sinus does not extend either an inch in height or an inch in breadth.

8. Vidus Vidian, Duverney, Dupuytren, and many anatomists, agree in stating, that the frontal sinuses attain their greatest extent in old age; but neither my observations, nor those of Sir William Hamilton * corroborate this statement. On the contrary, it appears that the sinuses are generally very small in old age, as may be seen by the specimens 13, 21, 22, 50,—crania which bear all the indications of old age.

9. The frontal sinuses appear to possess some national peculiarities. They appear to be generally small in the crania of the Irish—but very large in the crania of the French, Swiss, and Germans. They are small in Negro and Carib crania; and in the crania of the Hindoos they extend high, but are not deep. In the cranium of the Red Indian, which is preserved in the Edinburgh Museum, they are very small †.

* Sir William Hamilton, whose critical acumen is well known, pointed out to me this, and many other curious facts connected with cranial anatomy. To his investigations, both on this subject and on the cerebellum, anatomists and physiologists are much indebted.

† The cranium of the Red Indian was brought from Newfoundland by one of Professor Jameson's pupils, William Cormack, Esq. and is the only specimen in Europe. It is very valuable, as the Red Indian tribe is now extinct.

Observations on the Ignis Fatuus, or Will-with-the-Wisp, Falling Stars, and Thunder Storms. By L. Blesson, Major of Engineers, Berlin.

The first time I saw the Ignis Fatuus, or Will-with-the-Wisp, was in a valley in the Forest of Gorbitz, in the Newmark. This valley cuts deeply in compact loam, and is marshy on its lower part. The water of the marsh is ferruginous, and covered with an iridescent crust. During the day bubbles of air were seen rising from it, and in the night blue flames were observed shooting from and playing over its surface. As I suspected that there was some connexion between these flames and the bubbles of air, I marked during the day-time the place where the latter rose up most abundantly, and repaired thither during the night; to my great joy I actually observed bluish-purple flames, and did not hesitate to approach them. On reaching the spot they retired, and I pursued them in vain; all attempts to examine them closely were ineffectual. Some days of very rainy weather prevented farther investigation, but afforded leisure for reflecting on their nature. I conjectured that the motion of the air, on my approaching the spot, forced forward the burning gas; and remarked, that the flame burned darker, when it was blown aside; hence I concluded that a continuous thin stream of inflammable air was formed by these bubbles, which, once inflamed, continued to burn—but which, owing to the paleness of the light of the flame, could not be observed during the day.

On another day, in the twilight, I went again to the place, where I waited the approach of night: the flames became gradually visible, but redder than formerly, thus shewing that they burnt also during the day: I approached nearer, and they retired. Convinced that they would return again to the place of their origin, when the agitation of the air ceased, I remained stationary and motionless, and observed them again gradually approach. As I could easily reach them, it occurred to me to attempt to light paper by means of them; but for some time I did not succeed in this experiment, which I found was owing to my breathing. I therefore held my face from the flame, and also interposed a piece of cloth as a screen; on doing which I was able to singe paper, which became brown-coloured, and covered with a viscous moisture. I next used a narrow slip of paper, and enjoyed the pleasure of seeing it take fire. The gas was evidently inflammable, and not a phosphorescent luminous one, as some have maintained. But how do these lights originate? After some reflexion I resolved to make the experiment of extinguishing them. I followed the flame; I brought it so far from the marsh, that probably the thread of connexion, if I may so express myself, was broken, and it was extinguished. But scarcely a few minutes had elapsed, when it was again renewed at its source (over the air-bubbles), without my being able to observe any transition from the neighbouring flames, many of which were burning in the valley. I repeated the experiment frequently, and always with success. The dawn approached, and the flames, which to me appeared to approach nearer to the earth, gradually disappeared.

On the following evening I went to the spot, and kindled a fire on the side of the valley, in order to have an opportunity of trying to inflame the gas. As on the evening before, I first extinguished the flame, and then hastened with a torch to the spot from whence the gas bubbled up, when instantaneously a kind of explosion was heard, and a red light was seen over eight or nine square feet of the surface of the marsh, which diminished to a small blue flame, from two and a half to three feet in height, that continued to burn with an unsteady motion. It was therefore no longer doubtful that this ignis fatuus was caused by the evolution of inflammable gas from the marsh.

In the year 1811, I was at Malapane, in Upper Silesia, and passed several nights in the forest, because ignes fatui were observed there. I succeeded in extinguishing and inflaming the gas, but could not inflame paper or thin shavings of wood with it. In the course of the same year I repeated my experiments in the Konski forests, in Poland. The flame was darker coloured than usual, but I was not able to inflame either paper or wood-shavings with it; on the contrary, their surface became speedily covered with a viscous moisture.

In the year 1812, I spent half a night in the Rubenzahl-Garden, on the ridge of the Riesengebirge, close on the Schneekoppe, which constantly exhibits the Will-with-the-Wisp, but having a very pale colour. The flame appeared and disappeared, but was so mobile that I could never approach sufficiently near to enable me to set fire to any thing with it.

In the course of the same year I visited a place at Walkenried, in the Hartz, where these lights are said always to occur; they were very much like those of the Neumark, and I collected some of the gas in a flask. On the day after, I found by experiment that it occasioned cloudiness in lime-water, a proof of its containing carbonic acid.

I observed accidentally another phenomenon allied to this, at the Porta Westphalica, near Minden. On the 3d August 1814, we played off a fire-work from the summit, to which we had ascended during the dark, and where no ignis fatuus was visible. But scarcely had we fired off the first rocket, when a number of small red flames were observed around us below the summit, which, however, speedily extinguished—to be succeeded by others on the firing of the next rocket.

These facts induced me to separate the ignes fatui from the luminous meteors, and to free them from all connexion with electricity. They are of a chemical nature, and become inflamed on coming in contact with the atmosphere, owing to the nature of their constitution.

I think it highly probable that the fires that sometimes break out in forests are caused by these lights.

Falling Stars.—I have frequently observed on meadows and fields that slimy, leek-green matter, which is commonly taken for the product of falling-stars, fire-balls, &c. It speedily passes into a state of putrefaction, and dissolves into a whitish foam, which at length disappears. I cannot venture to speculate on its formation. That this slime appears to me to be intimately connected with the plants which generally surround it, although I cannot deny its flattened roundish shape. Once, indeed, I observed it on the bare ground, at a distance from vegetables of every kind. In Finland I observed it on rocks, but they were richly clothed with mosses. Whatever opinion may be formed as to it, the plants, particularly the cryptogamic ones in its vicinity, ought to be examined. I may add, that I observed this jelly, in a forest under a fir-tree, where there was no possibility of its having fallen from the sky *.

Thunder Storm.—On ascending a mountain, which rises rather more than 2000 feet above Teschen, I encountered a storm, concerning which the following particulars are not without interest. The wind blew from the south, and, shortly after I commenced my ascent, envelloped the upper part of the mountain in clouds. The oppressive feel of the air seemed to announce a coming thunder-storm, but hitherto neither thunder nor lightning had occurred. The nearer I approached to the clouds, the darker was their colour, but still the sun shone brightly upon Teschen. The clouds, as seen from below, which exhibited a remarkable rotatory motion, appeared sharply bounded, and I was therefore surprised, when I came near to them, to find, as usual, only a gradually denser and denser cloud, which speedily wet me through. A particular rotatory wind appeared to prevail in this region (above half-way up the mountain), occasioning a piercing cold, which was the more striking, as contrasted with the sultry heat and stillness below the clouds.

I had hardly entered the denser part of the cloud, where it was so dark, that I could with difficulty distinguish an object at my foot—(I name this dark, because I do not know any other expression for it; it is not, however, want of light; we have a white veil before us, which is constantly moving with a rotatory motion, which we cannot compare with any thing else). I was scarcely in the cloud before I felt throughout my whole body a kind of expansive tension, which was excessively oppressive, and seemed to affect the walking of my companion, a poodle dog, even more than it did myself. The hair appeared to bristle up, and it seemed to me as if something was drawn out of the whole of my body. But this electric tension was of a very different character from that from an isolator. I bent down, in order to see the grass that surrounded me, and on which no dew was observed,—when I was suddenly envelloped in a bright sea of light, with a yellow lustre, and per-

* The so called *Star-jelly* is said to be a kind of fungus, Actiomyce Horkelli.—*Vide* Oken Isis, 1830, ii.135.

ceived, along with a violent noise, a sudden cessation of the former tension. The noise may be best compared with a distant dull cannon-shot, only more continuous and louder, or may be compared with the explosion in a mine; but no rolling was heard. The grass was in motion, but I was too much surprised and confounded to make more particular observations. The convulsive motion of the cloud ceased for a moment, but immediately began again, and with it the tension was renewed. During the moments of rotation, the vaporic particles appeared to be arranged in rows into fibres, which moved still more violently amongst each other,—and after the explosion all was again calm, and a mere fog or cloud was visible. My poodle dog was the first object of my attention; it seemed to me to be thicker than usual, and his hair bristled up; I stroked it several times, and saw it bristle up under my hand. A new flash of lightning took place, and I could distinctly perceive, notwithstanding the light, that the whole body of my dog glimmered with a peculiar lustre, the hair, formerly bristled up, now fell flat, and he sunk down on his knees. This was a consequence of the stronger streaming of electricity from him than I experienced, and which seemed, as it were, to draw me from the mountain. Although during the tension, the feeling of drawing out was continuous and always increasing in intensity, still it was strongest at the moment when the electrical discharge took place; the hair bristled up more, and I felt something, as it were, passing from out my interior, and instantaneously all was past, and the hair flat again. On the next flash of lightning, I noticed the appearance of the grass; on the discharge it appeared shining at its extremities; it became erect, when I felt the tension increasing in my body, but became gradually wet, and then sunk down again.

Notice regarding the Asphaltum or Pitch Lake of Trinidad. By Captain J. E. Alexander, 42d Royal Highlanders, F. R. G. S. M. R. A. S., &c. Communicated by the Author.

One of the greatest natural curiosities in this part of the world, is the lake of asphaltum or pitch in Trinidad, situated about thirty-six miles to the southward of Port of Spain. The western shore of the island, for about twenty miles, is quite flat and richly wooded, and though only one or two houses are perceptible from the sea, the interior is well cultivated, and several small rivers, which empty themselves into the Gulf of Paria, afford great facilities for the transport of sugar to the ships which anchor off their embouchures. As Naparima is approached, and the singular mountain (at the foot of which San Fernandes is situated,) is plainly distinguished, then the shore assumes a more smiling aspect, here one sees a noble forest, there a sheet of bright green, points out a cane-field—Cocoa nut and palm trees are sprinkled over the landscape, and gently wave their feathered foliage; now and then a well built house appears close to the water's edge, with a verdant lawn extending from it to the sea, and the ground sometimes broken into sinuosities, and then slightly undulating. The beauty of this part of Trinidad is very great, though, from some undrained swamp, poisonous malaria exhale.

At Point La Braye are seen masses of pitch, which look like black rocks among the foliage; they also advance into the sea. At the small hamlet of La Braye, a considerable extent of coast is covered with pitch, which runs a long way out to sea, and forms a bank under water. The pitch lake is situated on the side of a hill, 80 feet above the level of the sea, from which it is distant three quarters of a mile; a gradual ascent leads to it, which is covered with pitch in a hardened state, and trees and vegetation flourish upon it.

The road leading to the lake runs through a wood, and on emerging from it, the spectator stands on the borders of what at a first glance appears to be a lake containing many wooded islets, but which, on a second examination, proves to be a sheet of asphaltum, intersected throughout by crevices 3 or 4 feet deep, and full of water. The pitch at the sides of the lake is perfectly hard and cold, but as one walks towards the middle with the shoes off, in order to wade through the water, the heat gradually increases, the pitch becomes softer and softer, until at last it is seen boiling up in a liquid state, and the soles of the feet become offensively warm. The air is then strongly impregnated with bitumen and sulphur, and as one moves along, the impression of the feet remains on the surface of the pitch.

During the rainy season, it is possible to walk over the whole lake, nearly, but in the hot season a great part is not to be approached. Although several attempts have been made to ascertain the depth of the pitch, no bottom has ever been found. The lake is about a mile and a half in circumference; and not the least extraordinary circumstance is, that it should contain eight or ten small islands, on which trees are growing close to the boiling pitch.

In standing still for some time on the lake near the centre, the surface gradually sinks till it forms a great bowl, as it were; and when the shoulders are level with the general surface of the lake, it is high time to get out. Some time ago a ship of war landed casks to fill with the pitch, for the purpose of transporting it to England: the casks were rolled on the lake, and the men commenced filling, but a piratical looking craft appearing in the offing, the frigate and all hands went in chase; on returning to the lake, all the casks had sunk and disappeared.

The flow of pitch from the lake has been immense, the whole country round, except near the Bay of Grapo (which is protected by a hill) being covered with it; and it seems singular that no eruption has taken place within the memory of man, although the principle of motion still exists in the centre of the lake. The appearance of the pitch which has hardened, is as if the whole surface had boiled up into large bubbles, and then suddenly cooled; but where the asphaltum is still liquid, the surface is perfectly smooth.

Many experiments have been made, for the purpose of ascertaining whether the pitch could be applied to any useful purpose. Admiral Cochrane, who is possessed of the enterprising and speculative genius of his family, sent two ship loads of it to England; but after a variety of experiments, it was ascertained, that, in order to render the asphaltum fit for use, it was necessary to mix such a quantity of oil with it, that the expense of the oil alone would more than exceed the price of pitch in England. A second attempt was made by a company, styled the Pitch Company, who sent out an agent from England; but finding that Admiral Cochrane had failed, and being convinced that any farther attempt would be useless, he let the matter drop.

Forty miles to the southward of the pitch-lake is Point du Cac, which forms the south-west extremity of the island, and on one side of the Boca del Sierpe. On this cape is another natural curiosity which is well worth seeing, although the distance from Port of Spain renders it rather a difficult operation to proceed thither. What renders this point so interesting to the stranger is an assemblage of mud-volcanoes, of which the largest may be about 150 feet in diameter: they are situated in a plain, and are not more than 4 feet elevated above the surface of the ground, but within the mouths of the craters boiling mud is constantly bubbling up. At times the old craters cease to act, but when that is the case new ones invariably appear in the vicinity. The mud is fathomless, yet does not overflow, but remains within the circumference of the crater. From what I recollect of the Crimea, I should say that there is a remarkable similarity between it and Trinidad;—geologically speaking, in both there are mud-volcanoes, in both there are bituminous lakes, and both have been frequently visited with earthquakes.

Berwick Barracks,
September 1832.

On the Youth—Age—Diseases—Sleep, and Death of Northern Birds. By Frederick Faber.

In tracing the gradual development of birds from the egg to the period of puberty, we find that the time of youth, or their unfruitful age, lasts but a short time, as many species breed the very next spring. If we assume that, as well as the mammalia, the period of their existence bears to that of their growth the proportion of five to one, they reach, as far as we know, a very advanced age. It is impossible to give correctly the maximum which each species attains, and I shall not attempt to investigate it with regard to the northern birds, for the results would be too vague to excite much interest. The reason of the difficulty in determining precisely the age of birds, is in the impossibility to trace a bird from its birth to its death, except in the case of tame birds, which live a much shorter time than the same species would doubtless do in the wild state, and partly from the advanced age of birds being marked out by no striking phenomenon, and that most of them become a prey to enemies before reaching the natural limits of existence.

As far as we know, the larger birds live longer than the smaller. In all, the length of their lives is in direct proportion to that of their unfruitful period, that species living longest which is latest in arriving at maturity. We have some positive observations on this head. The great age of the eagle is well known: it amounts even to a hundred years, and is several years before breeding. I am acquainted with an instance of a tame fishing eagle, which was taken in the year 1806 out of the nest, and in its tenth year had not received the white tail characteristic of the breeding state. Olafsen notices two eider-ducks, which returned for twenty years to the same breeding-place. The male of this species spends also four or five years in its unfruitful state. Those species to which the inhabitants of the north attribute a high age, are all more than a single year before breeding, as the *Colymbus glacialis, Cygnus musicus, Sula alba, Falco islandicus.* But certainly the age of the swan and the raven is placed too high when estimated at a hundred years.

According to the ideas which I have on the age of northern birds, and which scarcely admit of being precisely demonstrated, the unfruitful period in those species which are several years of propagating their kind, is to the whole life as one to ten. Upon this principle, the fishing eagle would live a hundred years, being ten years unfruitful; the male eider-duck forty years, being four years in the young plumage; *Larus glaucus, marinus, Leucopterus tridactylus, Sula alba,* or solan-goose, and *Cephus grylle,* thirty years; *Lestris, Anas clangula, glacialis, histrionica,* twenty years, &c. This proportion seems to hold in those smaller species which are only one year before breeding, as the singing tribes, for these little birds scarcely exceed an age of ten years. In the larger species, however, which are only one year of reaching puberty, as most of the Grallæ and of the Palmipedes, the guillemot *(Uria),* auk *(Alca), Mormon,* the near proportion seems to be as one to twenty, which increases or diminishes according as the bird is larger or smaller. It is evident that aquatic birds live long in proportion to their short youth, from the immense number of individuals in the north, although most of the species are monogamous so exclusively, that both male and female share the labours of hatching, &c. when there is but one fruitful egg for a whole summer; and more than the half of the species which breed in Iceland, and of the young birds, are annually taken away by the inhabitants. More than 20,000 or 30,000 young of the Fulmar *(Procellaria glacialis)*, are annually taken on the Westmannoe Islands alone, which must be the product of from 40,000 to 60,000 old ones, without their numbers suffering any apparent diminution. And although the majority of the young *(Mormon fratercula)* are every year taken from the holes, as well as numbers of the adults, yet every year the rocks are covered with birds, as if nothing had happened. The same is the case with the *Uria Brunnichii*, *troile*, razorbill *(Alca torda)*, and *Larus tridactylus*, on Grimsöe; with the eider-duck on Widæe; and the other species of *Anas* at Myvatn, which seem in fact yearly to increase in numbers, although regularly the natives fill several boat-loads with their eggs. It would be impossible, in these circumstances, to preserve the species, if the same individual did not continue to propagate its species for a long succession of years.

We have just observed that the advance of old age in birds is marked by no peculiar appearances. In many of the mammalia, as the horse, the hair becomes white with age, or falls out altogether, as I have seen in the *Phoca barbata.* The teeth become blunted, which is a mean of recognising the age of many of our domestic animals. Such does not happen with old birds; their feathers retain the hues which they possess in the adult state; nor do their bill or claws become perceptibly blunter. Some ornithologists even maintain that the unusually white colour of some individuals, in species where this is not the hue, is a sign of old age, or at least of their being beyond the age for propagation. I cannot, however, concur in this idea, but think that it is not a variety depending upon age, but a regular albino. The white varieties of the buzzard, swallow, and starling, exist even in the young while in the nest. Horrebow asserts the same of the Iceland falcon, in his Account of Iceland, p. 148, and many of the natives have maintained the truth of the fact. The white-bellied parasitic *Lestris*, is not an older variety of the brown-bellied, but both these colours are found even in the nest. The same is the case with the white magpie, and the white cormorant of the Faroe Isles; and certainly so with the Rotche (*Uria alle*), Tyste (*Cephus grylle*), and *Anas histrionica*, in Greenland. But although the tint of colour does not alter with age, the lustre of the feathers diminishes in the males, and the appendages of the feathers when they occur elongate. The older the heron, the longer is his beard. It is the same with the lapwing, with the collar in the *Podiceps* and *Charadrius*, and with the long tail feathers of the Arctic gull (*Lestris parasitica*), *Anas glacialis* and *acuta*. It is, therefore, very uncertain to estimate the age of birds by the length of these parts. When the female as well as the male is provided with these ornaments, they also lengthen with age. There is, however, one appearance in the female indicative of an advanced age. When the sexes are of different colours, as in some gallinaceous birds, when they cease to lay eggs, assuming the splendid plumage of the male, as the young male at first resembles the female. I have also seen old females of the *Mergus merganser* and *serrator*, *Anas glacialis*, *histrionica*, and *crecca*, with somewhat of the plumage of the male.

Disease does not seem to characterise the old age of birds. In the wild state, they are seldom affected by sickness, and certainly by no regular debility. Only whilst moulting, they are sluggish, depressed, and conceal themselves; but this change is, in the wild state, seldom mortal. There is no doubt that the young eider-duck is often preyed upon by a growth in the abdomen, about the size of a goose's egg; and the *Uria troile* and *Brunnichii* are often in winter exhausted by some unknown weakness, and found dead on the sea-shore. In certain years, the *Sula alba* seems to be subject to a contagious disease, and then is thrown up in great numbers on the coast of Iceland. Otherwise the northern birds are only subject to disease, except such as are brought on by accidental causes, as when their legs are frost-bitten, or frozen to the ice, as often happens with the *Alca torda*, *Uria troile*, *Brunnichii* and *alle*; or when their wings are broken in a storm, of which I have seen an example in the *Procellaria glacialis*; and when they are sometimes famished with hunger. It is characteristic of the Palmipedes, that those species which spend their whole lives at sea, and scarcely ever leave the water, without exception seek the land when they are sick, where they end their lives on the same medium in which they commenced them, although, during the whole interval, they shunned it as much as possible. It is accordingly the best proof of the *Uria*, *Colymbus*, eider-duck, &c. being sick, when they are seen to approach the shore, and repeatedly endeavouring to gain it, although they should be driven back.

A disease which affects most water birds, is an enormous accumulation of intestinal worms. This, however, seems to give them as little annoyance as it does the seal, especially the *Phoca barbata*, the whole of whose stomach is often studded with ascaridæ. I have found in the stomach of the *Mormon fratercula*, a small ball of grey convoluted ascaridæ, without the individual being at all emaciated; and rarely do we open a *Uria*, *Cephus*, or *Alca*, without finding in the intestines either tæniæ or ascaridæ. In an excursion to some of the Danish Islands, in the summer of 1824 and 1825, I found the intestine of the *Podiceps subcristatus* filled with tæniæ, the largest of which was twelve inches long, and yet the bird was fat and healthy. Several of the northern birds appear to suffer from external parasitic animals, especially from lice, which, at the breeding season, swarm in the bird-cliffs and their nests. Each bird has a species of vermin peculiar to itself. None are so much molested by them as the *Uria troile* and *Mormon fratercula*, in which the animal is broad, flat and blue, nearly the size of the sheep's louse, and sucks with great vigour. The lice of the *Sula* and *Carbo* are long, slender, and proportionally small, much smaller than the human louse. In other species, as the *Larus* and *Corvus*, they are still smaller, and resemble mites.

Birds manifest indisposition by sleepiness, hanging feathers, loss of appetite, emaciation, and by putting their heads constantly under their wings; and they end their existence with a few convulsive struggles and movements of their wings. There are no other phenomena accompanying their *Death*. Of some northern birds, as the musical swan, it is a common saying, that it announces its death by melodious notes, which have been called the swan's death-song. This, however, is entirely the creature of the fancy of a southern poet, and while it is repeated in the writings of the learned, it is quite unknown to the nations among whom the *Cygnus musicus* lives and dies. I have never heard the Icelanders hint in the least that this bird emitted any sound at its death. The opinion takes its origin from the harmonious trumpet-like sounds which issue from its complicated wind-pipe when it flies high in the air, and from which it has obtained its trivial name. As it is chiefly heard in clear moonlight nights, these sounds may excite the fancy, in the same way that the nocturnal sounds of the wild owl have given rise to the story of the hunting of King Waldemar, or the Wild Hunter.

Most birds, however, die neither of age nor disease, but become a prey to their *enemies*. It is wisely provided by nature, that one animal should prey upon another, that their carrion might not contaminate the air, nor their reproduction be disproportionate to their means of subsistence. Yet, on land, this mutual murder is by no means carried on to the same extent as at sea. Birds are not in the north so much exposed to birds of prey as in more temperate countries. In Iceland, there are only three proper rapacious species, with the exception of some of the omnivorous forest and aquatic birds, which occasionally become true birds of prey, as the raven, which attacks ptarmigans and pigeons; *Larus marinus*, which attacks sick, and *Lestris catarractes*, even vigorous, birds; *Lestris parasitica*, which preys on eggs, &c. The polar fox is their most active enemy among the mammalia; and a solitary *Uria* or *Alca*, when diving to the bottom of the sea, may be snapped up by the sea-horse. Man, however, is their most dangerous enemy, who, taking advantage of their tameness and sociability at the breeding time, every year destroys a greater number of individuals than all their other enemies taken together.

When birds are aware of danger, they are affected with *Fear*, and being destitute of the moral self-command given by reason, they take refuge in flight when it is not necessary for their safety. They sometimes manifest alarm by a cry which, in some domestic birds, as the singing tribes, the swallow and siskin, is quite peculiar. But few species have sufficient confidence in their physical powers, to attempt self-defence, when they are conscious of the superiority of their foe. This, however, is done by some of the Accipitres, as well as different Grallæ and Palmipedes, as the lapwing, gull, sea-swallow, when they have young. Therefore birds of prey are not so dangerous to man as quadrupeds, as the wolf, the bear, &c. When they cannot escape, however, even pusillanimous birds defend themselves, the same as the most cowardly man fights when all retreat is cut off. Thus, the little singing birds bite the finger of the person who catches them, and gulls or ducks which have been shot in the wing, endeavour to free themselves by pecking at the fingers of the hunter. Only the wading birds, provided with a long and soft bill, as the snipe, attempt no resistance when taken. The innate hatred which other birds bear to the Accipitres, is seen by some of the best fliers, when they could easily escape by flight, overcome by their fears, pursuing them with cries and provocations. Thus the swallow, raven, crow, lapwing, sea-swallow, whenever they see a rapacious bird, immediately fly after him and pursue him with loud cries in the air.

I have already, on different occasions, noticed the ***Repose*** and ***Sleep*** of the northern birds. Most sleep in the dark, only a few, as some owls and the *Puffinus*, are true nocturnal birds. Some species, however, which, at other times, are true diurnal birds, migrate in the night-time. The ducks, in particular, are constantly in movement on the clear moonlight nights. The bittern, *Limosa melanura*, *Gallinula crex*, and nightingale, prefer emitting their noise in the twilight; and gulls and lapwings often cry in the night-time. With these exceptions, darkness is the signal for a universal stillness in the ornithological world. In the northern regions, therefore, the duration of their sleep varies very much with the seasons, as in summer they scarcely sleep one or two hours, and in winter more than sixteen or eighteen hours. The long winter's sleep, and the consequent inferior degree of locomotion, and diminished appetite, are all in accordance with the scanty products for their subsistence in the polar regions at that season. Birds give a preference to certain breeding places. Some species hardly sleep at all, as the *Sula* *alba*; others very easily, as the *Anas*. Some prefer the water, as the Diver *(Colymbus)*, and Grebe *(Podiceps)*; others the land, as the land birds, Tern *(Sterna)*, Heron *(Ardea)*, Plover *(Charadrius)*, Oyster-catcher *(Hæmadopus)*; others prefer flying, as the species which perch on trees; others partly standing, partly flying, as the Duck *(Anas)*, Swan *(Cygnus)*; some during sleep conceal the head beneath the wing. On break of day, all are in immediate action; the singing birds salute the rising sun with their notes,—the Accipitres begin to hunt—the Grallæ to run about,—and the Palmipedes to retire from the land into the sea.

Sketch of the Life of A. H. L. Heeren, Knight of the North Star and Guelphic Orders, Aulic Counsellor, and at present Professor of History in the University of Gottingen, &c. &c.

Arnold Herman Louis Heeren, the son of a Protestant minister, and the oldest of four children, was born, on the 25th October 1760, at Arbergen, a small village near Bremen. The celebrated astronomer Olbers, who discovered Pallas and Vesta, was born three years before, in the same village. Heeren's earlier years were passed in the country in solitude. He received his first lessons in Latin and geometry from his father. M. Hasselman, one of his masters, inspired him with a taste for historical studies, by connecting with his lessons in the Æneid the history of the earlier periods of Rome. The pupil also took a great liking for Quintus Curtius; but Robinson Crusoe made him forget it all. He then read a translation of Milton's Paradise Lost, whose descriptions of the combats of the good and bad angels, and of the flight of Satan across the abyss, strongly excited his imagination.

In 1775, his father was called to Bremen in the quality of minister of the cathedral. Then ceased the domestic education of young Heeren: he was sent to the college of Bremen, and there continued his Latin, Greek and Hebrew studies, but made little progress. The only exercise by which he pro-

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fited was an argumentation of two hours every other day, and in that he excelled. When out of school, and left to himself in consequence of his father's occupations, he frequented the best society in the city. The spirit which prevailed in a free and commercial town could not but influence his manner of thinking. It was then the time of the American war, during which the limited commerce of Bremen began to assume great activity. Nothing was spoken of but enterprises in the East and West Indies. Without imagining that he was one day to write on commerce, he formed a high idea of it, and acquired some knowledge of its nature. The citizens of this town possessed that degree of liberty and equality which is consistent with a well organised and happy community. This public spirit, and these impressions of youth, could not but influence the historical studies to which he subsequently devoted himself; and if in his works he has rightly apprehended the spirit of institutions, he could say that he owed this apprehension not to books only, but to the circumstances and the society in the midst of which he lived.

In 1779, he was sent to the University of Gottingen, to study theology, being intended for the church. Hitherto he was but ill versed in Latin, Greek, and Hebrew; he found his mind little adapted for philosophical speculations; and from ecclesiastical history he derived no advantage. One day, in strolling through the town, he met with two of his friends who were attending the lectures of the celebrated Heyne, on Greek antiquities, and who induced him to accompany them as an amateur. These lectures from the first made a strong impression upon him. They unveiled to him a new world, and carried him back to the times that have passed away. Heyne's lectures imparted a new direction to his mind, and of all his teachers it was he that had most influence upon his future pursuits. Theology was not entirely to his taste, and at Michaelis's lectures he imbibed a disgust for the exigesis. The first two years which he passed at the University were in a manner lost to him. He felt that he could do nothing without a profound knowledge of the Greek language. A prospect presented itself to him of being appointed professor to the Gymnasium at Bremen. From this period his studies were pursued on a fixed plan. In the winter of 1781, he laid all aside for the purpose of devoting himself to the study of Greek. In this study he was encouraged by Heyne, who directed his labours, and his progress was rapid. Spittler, the historian, was, next to Heyne, the master to whom he owed most: the lectures of that professor on the History of the Treaties of Peace, and on the History of the German States, were very useful to him. From them he learned to view history on the grand scale, and acquired the method to be followed in studying it. As to philosophy, Feder's lectures were of less advantage to him than his friendship, and the practical wisdom of which he furnished an example. His humanity studies, therefore, took a historical turn: languages had less attraction for him than facts, and in this manner he prepared himself for studying history in its sources. For each period, he took the principal historian as a basis, and made chronological extracts from him. He then read the other authors, and noted on the margin the points in which they differed.

Heyne's lectures on Pindar and the Greek tragedians brought him into the poetic world. Heyne engaged his pupil in collecting fragments of lyrics, which led him into the remote regions of Grecian literature. In this task he had to dive among the grammarians, scholiasts, and rhetoricians; but he merely collected the fragments, without commenting on them, having been deterred by the difficulties of the prosody.

M. Heeren now saw the period approaching when he was to leave the University. Feder offered him the situation of tutor in Italian Switzerland, with pecuniary advantages, and the promise of a pension. He had almost decided upon accepting it, when a letter from his sister increased his hesitation, and Heyne succeeded in making him reject the offer, by representing to him the precarious and miserable life of a tutor. Before aspiring to the office of professor, it was necessary for him to receive the degree of doctor. On the 29th May 1784, he sustained his thesis *De Chori Græcorum Tragici natura et indole.* There yet remained for him to acquire some degree of public reputation, by means of writing a commentary upon some author. The rhetorician Menander had not yet exercised the learning of any critic, and had even been confounded with another rhetorician named Alexander. Some happy corrections of the corrupted text inspired M. Heeren with the idea of its republication. A bookseller received this first performance of our young critic, and printed it in 1785, under the title of *Menander Rhetor, de Encomiis*, &c.

About this period he fell into bad health. Living in solitude, he allowed himself to be affected with melancholy, and found it necessary to travel. A small legacy, which a grand-uncle had left him, afforded him the means of doing so, and he resolved to betake himself to Rome, and to visit the whole of Italy. Travelling was not yet in fashion in Germany. M. Tychsen, one of his friends, returning from Spain, had brought from the Escurial the collation of a manuscript, the *Eclogæ* of Stobæus. He gave it to M. Heeren, to whom the present was of great value. The *Eclogæ* of Stobæus were known only by the edition of 1575, published from a very defective manuscript, and reprinted in 1609; and these two editions were scarce. The collation of the manuscripts of the *Eclogæ,* for the purpose of publishing an edition, thus became an object of his journey. This undertaking, while it prepared for him recommendations for a professorship, of which he was ambitious, afforded an exercise to his mind, which needed occupation. There were only six or seven manuscripts known of this work of Stobæus, scattered in Spain, Germany, Italy, and, as was supposed, in Holland. This circumstance determined the plan of his journey.

On the 17th July 1785, he left Gottingen, and went first to Augsburg. The journey had a salutary effect, and dispersed his melancholy. The public library of Augsburg possessed a manuscript, which was entrusted to him, and which he collated in a fortnight. He then went to Munich. It was at this time that the Illuminati were in all their glory, and every where formed the subject of conversation. After carefully inspecting the library of Munich, he followed the course of the Danube to Vienna. He there fell in with one of his class-fellows, who also intended to visit Italy, and they agreed to travel together. From Vienna he went to Trieste. This city, which is more Italian than German—the view of the Adriatic sea and its shores, with their numerous gulfs—the sight of the harbour filled with ships mostly from the Levant—the proximity of

Greece, which announced itself in so many ways—and the effect of a southern climate, have a magical effect upon him who sees them for the first time. Our traveller was not insensible to their beauties. He visited the ruins of Aquileia, and went by land to Venice. The age of this decayed republic impressed him the more, in comparison with Trieste, which flourishes in youthful vigour. In the rich library of St Mark, M. Heeren found nothing for the object of his inquiries. Winter had commenced when he passed through Padua, Verona, and Mantua, where he fell sick. Towards the end of the year he betook himself to Florence. There the Gallery and Library de Medicis afforded him ample occupation. But the remains of his weakness, and the cold, against which, in Italy, they are unable to protect themselves, prevented him from enjoying the pleasures of Venice as much as he might have done.

All his wishes tended towards Rome, which he entered on the 10th February 1786. His first impression did not equal his expectation. The Piazza del Popolo and the Obelisk are little calculated to excite enthusiasm. But Rome has a very peculiar charm. The infinite diversities of her beauties unfolds itself but gradually to the spectator; each day she becomes more charming; nowhere is the stranger more valued, and nowhere does he so easily become naturalized. One may arrive at Rome with indifference, but cannot leave it without emotion. Rome was the principal object of M. Heeren's voyage: the Vatican possessed the most important manuscript of Stobæus, and a prolonged residence in that city could not but familiarize him with the chief performances of ancient arts. He attached himself to the learned Zoega, who was his guide in every scientific excursion, initiated him in the secrets of Archæology, and introduced him to Monsignor Borgia, since made cardinal.

M. Heeren mentions Borgia as one of the few persons to whom he owed most gratitude. While his erudition and museum contributed to instruct, his gentle disposition and affectionate character attached the young student. The principal object of Heeren's solicitude was Borgia's collection of antiques at Velletri. Borgia was then secretary of the Propaganda. At a later period, having sunk in adversity, and being driven into exile, he found consolation in the sciences. He died at Lyons where he had come in 1804, in the suite of the Pope, for Napoleon's coronation.

During the carnival the libraries are shut. Then M. Heeren visited the museum of the Vatican, where the statues, sarcophagi, and bas-reliefs particularly drew his attention. In the museum was a sarcophagus, the figure of which Winkelman has erroneously explained by the murder of Agamemnon. Heeren discovered that it represented the murder of Clytemnestra by Orestes and Pylades. Having his head still full of the Greek tragedies, it was easy for him to demonstrate that by reference to a scene of Æschylus, which the artist had almost exactly copied. He printed a paper on this sarcophagus (*Commentatio in Opus cœlatum Musdæi Pii Clementini, Romæ* 1786) subsequently inserted in German in the *Bibliotheque de la Litterature et de l'Art Ancien.* He wrote a second dissertation on a fragment of marble covered with small bas-reliefs and inscriptions in the style of the Table of Isis. He did not, however, forget the special object of his journey, but collated a manuscript of Stobæas in forty-three leaves, which furnished him with a multitude of variations and corrections. He speaks with enthusiasm of the happy life which he led at Rome, in the study of antiquities and bas-reliefs; and of the vivid impression made upon him by the Coliseum, with its gigantic shadows in the moonlight; the interior of the Pantheon, when the light clouds are seen flying past its cupola; the magic light of the Church of St Peter, and its luminous cross during Passion-week.

After a residence of seven months, he left Rome on the 16th of September, to go to Naples, where he admired nature in all her magnificence. The library *Al Capo di Monti* contained two manuscripts of the Eclogæ, one of which is the oldest manuscript of that author that has come down to us. At Naples he knew the celebrated Filangieri. On the 1st November he left Naples, and returned to Rome, where he met with Goethe and Moritz. At length he returned by Florence and Milan. In the Ambrosian Library at Milan, he found some fragments of Stobæus. He passed through Genoa, Turin, Geneva and Lyons, and arrived on the 18th February 1787 at Paris, where he spent two months. Villoison and Belin de Ballu, to whom he was recommended, were absent. Barthelemy, Larcher, An quetil Duperron, and Vauvilliers received him with politeness and respect. The Abbe Begot, conservator of the manuscripts of the Royal Library, placed at his disposal a manuscript of Stobæus. In April he passed through Holland and Leyden, where he saw Ruhnkenius and Luzac. At length, in the month of June 1789, he returned to Gottingen, after an absence of two years. From thence he betook himself to his native city, to visit his father, and some weeks after returned to Gottingen. On the 27th August he received from Hanover an appointment to the professorship of Philosophy, three weeks before the celebration of the jubilee of the 50th year from the founding of the university. On the 20th October he pronounced his introductory discourse, *De codicibus manuscriptis Eclogarum J. Stobæi.*

Here commences the second period of the life of Heeren. The professorship opened to him a new career. He already possessed considerable knowledge, but it was not perfected. The branches of history that were most familiar to him were already taught in the University of Gottingen. He had to make room for himself. During his two first years in the professorship, he gave lectures on the history of the belles lettres, on Roman antiquities, and on Tacitus and Sallust. He felt a powerful attraction towards political history. In 1790 he commenced his course of lectures on ancient history. At the same period he became editor of the *Bibliotheque de Litterature Ancienne*, conjunctly with M. Tychsen. Several years after, he collected materials for his edition of Stobæus; and, in 1792, appeared the first volume, dedicated to the Cardinal Borgia, and the second in 1794. The two last volumes, comprehending the *Ethica*, so important for the profound knowledge which they contain of the Grecian systems of philosophy, appeared in 1801. The pains which he had bestowed upon this edition, convinced him that he was ill-adapted for the criticism of words. It was his last performance of the kind.

In the course of his studies, he derived but little satisfaction from all that he had read respecting Carthage. This led him to conceive the project of examining more profoundly the history and character of that city. He commenced with Polybius, and successively added the other historical sources. This investigation, which he pursued without intermission, became more and more interesting to him. The spirit and character of the first great republic, at once commercial and conquering, unveiled themselves to his sight. As his views extended, antiquity shewed itself to him under the new relation of the commerce and constitution of the ancient states. Thus was formed in him the idea of contemplating them in this two-fold point of view. Such was the task of his life, and the origin of his great work entitled, *Of the Policy and Commerce of the Nations of Antiquity.* The first part appeared in 1793. He then commenced with Africa. The vast horizon which extended before him, and the applause which the first appearance of his book received, encouraged him to continue his task. Asia required longer and more profound preparations; in a word, the knowledge of the geography, history, constitutions, and commerce of the whole East. The author began with Persia. He explored that ancient empire which afterwards became that of the Parthians and Sassenides; then in succession the kingdoms and nations of the southern or Central Asia. Having arrived at the Arabian period, he prepared himself by an assiduous perusal of the Koran. He consulted all the then known or accessible sources of Asiatic history. In consulting every author, ancient and modern, he did not forget the most important travellers. Two years of serious study familiarized him with the East; and, in 1796, appeared the first volume of Asia, which, in the subsequent editions, became the first part of the work. To form a just estimate of it, we must refer to this period. In 1805, M. Heeren published a second edition of his book, entirely recomposed. During the preceding ten years, geography and ethnography had made immense progress, in consequence of the expedition to Egypt, the discoveries of the travellers in Africa, and the domination of the English in India. Asia at length emerged from the obscurity in which for ages she had been enveloped. Faithful to his method of comparing together the ancient and modern authors, he cast new light upon these difficult researches, and even participated in some measure in the new discoveries. The taste for scientific expeditions spread in the University of Gottingen, and the travellers Leetzen, Hornemann, W. Hamilton and Burkhardt, were pupils or friends of

Heeren; and if his ideas were the occasion or cause of their journeys and discoveries, these in their turn had a useful influence upon his work. The third edition, published in 1815, with the commencement of the researches respecting the Greeks, was more than double the size of the first. There are also in it important additions respecting India. The continental blockade had shut up Germany, not only from the manufactures, but also from the ideas and writings of England. The great events of 1813 and 1814 overturned that obstacle, and re-established the long-interrupted communications. Our author published the result of his most recent investigations in two fragments, one on the point at which the knowledge which we have of ancient India stops, the other on the policy and commerce of ancient India.

In 1796, M. Heeren married a daughter of his master, Heyne. Three years after, he succeeded Gatterer in the chair of History, the duties of which he had already performed. This situation afforded him an opportunity of embracing history in its whole extent. However, he had always little taste for the history of the north and of Germany, and never taught it. But what appeared most interesting in his eyes was the study of the relations of the modern states. He did not stop at the surface of events, but penetrated into their interior, explored their causes, seized the predominating ideas and views of each age, and the personal character of the men who directed affairs. It is in this manner that political interest and philosophical interest are blended; and as the commercial relations have acquired an always increasing action upon the public state of Europe, he was led to consider the influence of commerce and colonization, which produced in 1809 his Historical Manual of the political system of the European States and their Colonies, from the discovery of the two Indies. Ten years before, he had published the Manual of Ancient History *. The circumstances in which Europe was then placed, gave more value to the Manual of Modern History. The domination which extended over almost the whole Continent, rendered the remembrance of past liberty dearer, and the book, as presenting a full, though diminished pic-

* An English translation of this work was published last year, 1829 at Oxford.

ture, was received by the public with avidity. The first edition was bought up in the course of one year. A second appeared in 1811, as well as several counterfeits. To these labours is to be added a course of lectures on the Crusades, from which M. Heeren detached a memoir, which, in 1808, carried the prize at the Institute of France. In 1821, the Academy of Inscriptions and Belles Lettres elected him among the number of foreign associates, in the place of Wyttenbach.

He also published some details respecting a course of lectures on Statistics, which he delivered at the University, but taking the term in a much more extended signification than that usually given it. He did not confine himself to cyphers and tables, but included all that relates to the spirit of constitutions, as well as to the administration of states. Viewing nations, not as machines, but as moral beings, which have each their peculiar manner of acting, he took certain states as representatives of the principal forms of constitution and administration. For example, he took Great Britain as a monarchy with a free constitution and administration; France, as a free monarchy with an absolute administration; Russia with a constitution and an administration both absolute; and the United States of North America as a federative republic, with sovereignty of the people. Such are the ideas which enlivened his historical productions. What, in fact, is the study of states when they are considered as inert masses, without soul or life? It must be admitted, then, that in history there is something besides facts. Facts are delivered to us to serve as an exercise to the mind; the object of the philosophical historian is to discover their value and signification.

The learned author of the Manual of Ancient History presents to us, in his treatise on the Policy and Commerce of the Nations of Antiquity, the intellectual and political development of the nomadic and agricultural nations, and traces the origin and progress of the commercial relations down to the period of the discovery of America. The traditions of the ancients, the researches of all the writers of modern times, and the accounts obtained on the spot by the latest travellers, as Cailliaud, Belzoni, Porter, Niebuhr, and Champollion, are detailed and analyzed with impartiality in this admirable work,—a historical monument of which Germany is proud, which enables us to form a correct idea of ancient times, and throws great light upon Asia, the cradle of the human race, and especially upon India, as well as upon Africa and Greece.

The first three volumes treat of Asia. One of them makes known the political constitution of Persia, and its statistical division; another is devoted to the Phenicians and their colonies, the Babylonians, and Scythians; the third treats of the Indians and their monuments. To these researches are joined several supplementary articles, which are of the greatest interest for the understanding of Asiatic literature and history, which until then were so little known. Africa is spoken of in the fourth and fifth volumes. The sixth and seventh embrace Greece and its colonies. The eighth and last volume gives a succinct account of the political and commercial life of the Romans and other nations of Europe.

On the Malaria of the Campagna di Roma.

Every one has heard of the bad air which exerts its pernicious influence in the latter part of summer, and which depopulates Rome and its environs. Among the writers who have turned their attention to this subject, the greater number are of opinion that Rome has not always been so unhealthy as it is at present, and they attribute the change to the superior cultivation of the soil which was practised by the ancients. This opinion is not destitute of foundation; but it is valid, as may easily be conceived, only in relation to the time when Rome and the Campagna were in a very populous and flourishing condition. If we recede into times more remote, and consider what the country must have been when first settled by those ancient inhabitants, we shall be obliged to admit that it must have contained extensive marshes and low grounds. We know that, long after the foundation of Rome, there were considerable marshes between the different hills within its enclosures, especially between Mounts Aventine and Palatine, and between the latter and the Capitoline. Dionysius of Halicarnassus informs us, that they were very deep, and, according to Propertius, they were crossed in sail boats. Livy compares the country of Rome, at the time when the city was built, to a vast desert; and Ovid says that it was covered with frightful forests.

Experience teaches us that, in all marshy and uncultivated countries, the air is unwholesome; and as we know how rapidly the population of Rome increased, and to what a prodigious extent it arrived, notwithstanding these unfavourable circumstances; how many towns of consequence, such as Gabi and others, rose up in the vicinity of these pestilential lakes; that Ostea even, founded by Ancus Martius, in a place where now, in the unhealthy season, there is only a tavern supplying wine and bread to the herdsmen, formerly flourished, as well as Ardea, which at present contains only sixty inhabitants, and that Lavinium is reduced to the miserable chateau of Prattica,—we are compelled to inquire how the ancients sheltered themselves from the pernicious influence of their unhealthy atmosphere.

Opinions on this subject are very various. Many learned men believe that the Champaign of Latium was formerly less warm than at present; because, according to Horace, the Soracte was covered with snow, and, according to Livy, the Tiber was sometimes frozen; whence they concluded, that marshy exhalations were less active and pernicious. Others attribute the absence of disease in the midst of unwholesome air, to the more robust constitutions of the ancients, and say with Juvenal—

> "Nam genus hoc vivo jam decrescebat Homero;
> Terra malos homines nunc educat atque pusillos."

Others again pretend, that the air was purified by the great quantity of wood that existed within and without the city, because it is admitted that plants absorb carbonic acid, decompose it, and exhale oxygen gas. Although it may be true that plants exert such an influence, this theory cannot apply to the Campagna di Roma, for it would lead us to a result contrary to that which it is intended to establish. If the woods contribute in this manner to the purification of the air in the plain of Latium, they ought still to produce the same effect, since vegetation remains as vigorous as ever. On the contrary, we find that the woody districts, such as the environs of Ardea, of Prattica, of Nettuno, are the most unhealthy of all, and were so in the time of Tacitus. On this principle, the Villa Borghèse, the Villa Medici, and others, which are not deficient in trees, ought to be more healthy than places which are deprived of them, which is not the case; in fact, the Vatican, like the Janicula, which are to a great extent covered with gardens and groves, are infected with the most unhealthy air. It results from all these facts, that woods, in countries where, from the physical constitution of the soil, malaria prevails, as in the Campagna di Roma, are injurious, because they check the winds which sweep away pestilential exhalations and renew the air.

Brocchi is of opinion, (and we think his views correct), that the chief protection of the ancient Romans consisted in their woollen garments, which kept their bodies in a constant state of transpiration. This opinion is justified by the observation, that, since the period at which the use of woollen clothing came again into vogue, intermittent fevers have very sensibly diminished at Rome. At present, even in the warmest weather, the shepherds clothe themselves in sheep-skins, and it is surely for the purpose of protecting themselves against the bad air. The toga of the ancients, whose texture and shape was so well adapted to the body, has disappeared, and has been replaced, as Brocchi expresses it, by those garments of patch-work, so flimsy, so ridiculous, and so unfit to guard those who wear them from the hurtful effects of an unhealthy atmosphere. It is worth while to ascertain whether the monks, in their frocks, suffer less from bad air, than the other inhabitants within and without Rome. Their great numbers would certainly incline one to believe in the propriety of such an inference.

The adoption of light clothing, on the one hand, and the neglect of good culture on the other, caused by the devastations which Rome and its suburbs have undergone, have given to the *malaria* an energy which, by rendering the Campagna very sickly, has unpeopled the city to the extent which we now behold.

Before we terminate these considerations, we should say something of the diseases which, at different epochs, visited the ancient Romans, and which they denominated plagues. Plutarch, Livy, Dionysius, and others, speak of those pestilential diseases which overtook the city of Rome under its kings, and during the republic, and which must have occasioned a frightful mortality. But though we may not admit the term plague in its most rigorous sense, some of those diseases which manifested themselves at distant intervals came from Egypt by passing through Greece, as that in the year 573, and ravaged not only Latium, but the whole of Italy; other plagues mentioned by Livy were evidently *camp diseases*, as those of 287 and that of 365, when the Gauls besieged the Capitol. In short, they might be other epidemic diseases, which manifest themselves every where under certain conditions. But they were certainly not those intermittent fevers which now afflict Rome every year with greater or less severity.

From the preceding observations, we obtain the following result:—

The first inhabitants of Latium, who established themselves on the hills of that desert and marshy country, and who had to struggle against many obstacles in order to reduce the soil, were shielded against the unwholesome atmosphere by their woollen clothing, which maintained a continual perspiration, whilst their assiduous and improved culture of the land contributed to purify the atmosphere itself. But as this culture was again neglected on account of the numerous devastations which desolated Rome and the Campagna, the unhealthy exhalations of the soil were again multiplied, and the introduction of a lighter dress gave to this unhealthy air an influence which it had never before possessed. Brocchi relates that, in 1818, there were admitted into the Hospital du Saint Esprit, in the course of the months of July, August, and September, above 6000 patients, attacked by fever by reason of the malaria. The soldiers who occupied the forts on the borders of the sea, had to be relieved every three or four days, and nobody was willing to reap the harvest which covered the fields.

Opinions are very various respecting the cause of this foul air. Some attribute it to exhalations of sulphuretted hydrogen, others to those of carbonic acid gas; but, as Brocchi observes, those reasoners seem to have forgotten, that all these gases are exhaled in abundance in different parts of Italy and Sicily, which are nevertheless considered as very healthy.

The effect has also been imputed to exhalations of azotic gas; but this gas being lighter than atmospheric air, would necessarily rise, and thus render the heights more unhealthy than the valleys, while experience proves that the contrary is the fact*.

The Campagna of Rome is an extended country, cut up by little hills, and mostly in an uncultivated state. During the rainy season, the water collects in the valleys, and forms pools where it stagnates; and having brought with it all sorts of vegetable substances, as well as animal refuse, it becomes corrupted. At the return of the warm season, which augments the putrefaction, these ponds and marshes send forth their vapour; but as the process of evaporation goes on slowly, the heat being still moderate, the atmosphere is not much changed, until the month of July brings with it a greatly increased temperature, which accelerates the evaporation, and which is accompanied by fevers whose duration equals its own, that is to say, it is prolonged to September.

If the Campagna were every where properly cultivated, as it was formerly, the air would not be subject to the alteration; for the rains of winter would not then collect as they do in the low grounds, but would be absorbed by a mellowed soil, and evaporated by the influence of the heat.

It must not be urged against this opinion, that in Lombardy, especially in the plains which extend from Bologna to Ferrara, the vast fields of rice are, during the whole winter, covered with water, and that the country is nevertheless not unhealthy, or at least not so much so as that of Rome. These artificial lakes or inundations, as I have myself observed, are first, on account of their extent, always agitated by the wind, like a lake of water, and also by the action of the sluices, by which they are supplied and drained; the current of water is continually entering and

* While we admit with the author, that azotic gas is not the probable cause of epidemic fever, we must object to the soundness of his conclusion with respect to its elevation. Although somewhat lighter than atmospheric air, it is, we believe, most conformable to established facts in chemistry, to conclude, that the particles of any gas, if set free in the atmosphere, will [ultimately] arrange themselves in the same manner as if the atmosphere itself did not exist, provided they have no affinity for, or do not combine with, the constituents of the air.

passing from them. These two causes combined prevent putrefaction.

The learned Moscati thinks he has discovered that the basis of the foul air which causes these pestilential fevers, is an aqueous humour, which contains an animal mucus in which the venom resides. Brocchi has made some experiments upon the nature of the malaria. He selected for this purpose the country which surrounds the basilica of St Laurent, without the walls, one of the most unhealthy of Rome, and continued his labours during several successive nights. A robust young man, whom he took for his assistant, slept several hours during the first night, and was seized the following morning with an intermittent fever, which he retained for several weeks. Brocchi condensed, in various ways, the air which he had collected, and obtained, in every case, a notable quantity of putrid water.

It remains for us to say a few words on the manner in which this foul air acts upon the animal organization. With respect to the mode by which it penetrates our bodies, Brocchi has several reasons for thinking that it penetrates rather by the pores of the skin than by respiration. When once the noxious particles are introduced into our organs, they combine with the humours; the general organization, or more properly the force which tends to preserve it in its integrity, opposes this combination, and from this results the fever.

It is worthy of remark, that this foul air exerts no evil influence over the flocks which ramble night and day over the Campagna di Roma. This would seem to justify the idea that it penetrates by the pores of the skin, since these animals are defended by their hair or their wool; and hence we perceive a new proof that the best means which the ancient inhabitants of Latium employed as a defence against this pernicious atmosphere, before an excellent state of cultivation had weakened its effects, was precisely the same kind of woollen clothing; so that the dress of the present age is very ill adapted to a country where an insalubrious atmosphere constantly prevails.

Observations on a Collection of Fossil Bones sent to Baron Cuvier from New Holland. By WILLIAM PENTLAND, Esq. In a Letter to Professor JAMESON.

MY DEAR SIR, *Paris, Nov.* 15. 1832.

SINCE I transmitted you the notes on the fossil remains from New South Wales, which you inserted in the 12th volume of the Edinburgh Philosophical Journal, I have had occasion to examine a collection from the same locality (Wellington Valley), which was presented to my lamented friend M. Cuvier by Major Mitchel, the present Surveyor-General of our Colonial Establishments in Australasia.

In my former communication, I stated that the fossils you submitted to my examination were referable to nine distinct species of mammalia, belonging, with a single exception, to the order of the Marsupialia. The specimens sent by Major Mitchell to Baron Cuvier, enable me to add five more species to this list; viz. two species of Dasyurus, one of which does not seem to differ from the *D. Macrourus* of Geoffroy; a small species of Perameles; a species of kangaroo, of the subgenus Halmaturus, and certainly very different from every known species of this genus; a small animal of the order of the Rodentia, belonging to a new genus, and of which the bones are scattered in immense abundance in certain portions of the osseous breccia; and a Saurian reptile, nearly allied to the genus Gecko, but which the incomplete nature of the fragments I have examined, prevent my determining more accurately.

This examination has in no degree changed the opinion I expressed on a former occasion, that many of these fossils belonged to animals hitherto unknown to zoologists, the genera of which, however, still inhabit the same continent, and that some even would be ultimately referable to extinct species. In the imperfect state of our knowledge of the Fauna of the Australasian world, it would, however, be premature to give a decided opinion on this subject, although there cannot be a doubt that some of the remains found in the caves of Wellington Valley, belong to animals which are to be no longer found (such as the elephant) in that remote southern latitude.

Sketch shewing the manner in which the Osseous Breccia occurs in the Cave at Wellington, in New South Wales

The Cave in which the fossil bones are found at Wellington Valley is in Compact secondary Limestone, as discribed more fully in a memorandum which accompanied a very large bone sent by Mr. Rankin to Profr. Jameson. It is near a larger Cave where no breccia has been found, and which is very different in character from that of which this drawing is intended to convey an idea, the appearance of disruption with unshapely masses of rock overhanging being characteristic of all the situations where the fossil bones have hitherto been discovered in N.S. Wales. 12 Octr. 1830. The bone above mention'd is that of an Elephant.

E. Mitchell sculpt.

A careful inspection of the specimens of Major Mitchell's collection, leaves not a doubt that the bones of most of the animals collected in these caves, were transported thither by carnivorous animals, as in our bone-caves of Yorkshire, of Germany, of France, &c. I have discovered several fragments, evidently gnawed and worn down under the teeth of small carnivorous animals; and, among nearly 100 specimens of long bones, still enveloped in their stalactitic crust, I have not found one to which the epiphysis remained attached, although in adult subjects,—an evident proof of their having been gnawed off by the animals which formerly inhabited these recesses. What these animals were, it is easy to guess from the catalogue given in my former and present communication.

In addition to the fossil bones, Major Mitchell's collection was accompanied by an interesting geological suite of the rocks of the surrounding country, which enables me to add something to what has been already published in your Journal, on the geognostical position of the bone-caves of Wellington Valley. The rock in which these caverns is excavated, is a dark grey dolomitic limestone, which, like all similar rocks, appears to have been converted into that state subsequently to its deposition, under circumstances analogous to those so ably pointed out by my friend M. de Buch, in his remarkable papers on the Dolomites of the Tyrol and of the Alps of Lombardy. The specimens before me offer all the passages from a compact grey secondary limestone to a semi-crystalline dolomite, and the view of a considerable mass of trap-rock, and of a large-grained pyroxenic rock, leave scarcely a doubt that the dolomites of Australasia owe their present form to changes similar to those which have converted the secondary limestones on the southern declivity of the Alps, into a crystalline dolomite, viz. the vicinity of pyroxenite eruptions.

It is probable that the limestone thus converted into dolomite is a continuation of that of Sass Plains, which contains fossil remains of madrepores, and which offers certain analogies with those of the oolitic series of the northern hemisphere, and which appears to repose upon the new red sandstone formation, which constitutes so large a proportion of the known portion of the Australasian continent.—Yours, &c.

Geological Remarks upon the Neighbourhood of the Caspian Sea. By M. EICHWALD of Wilna.

THE Caspian Sea, as regards Natural History, offers to view many peculiarities, which at once mark it out from all other lakes. Indeed its astonishingly low level, which is shewn to be below that of the Black Sea, and consequently under the level of the ocean, prove it to be a lake which lies 117,817 French feet deeper than the Sea of Aral. But, as the frequently unfathomable depth of the Baikal Lake, which is surrounded by lava and other volcanic masses, seems to be occasioned by the volcanic structure of its bed; so may a similar structure in part sufficiently account for low level, and the very considerable depth of particular parts of the Caspian Sea. This sea might gradually sink, from the powerful evaporation necessarily caused by the warmth of the climate; while the supply of water from few rivers could not balance the powerful evaporation.

But since many of the shores of the Caspian, particularly the east coast, at the bay of the Balchan, display numerous masses of burnt porphyry, and even lava; and since pseudo-volcanic causes are now existing in operation on the west coast, near Baku; so we at once see that great subterranean cavities must be thus formed, which would draw off the water, and consequently lower the surface of the lake. The two porphyry masses of Kasbek and Elbrus, which exceed in height the summit of Mont Blanc, as well as the whole Caucasian chain, which is of a volcanic nature, lead us to expect, from their formation, a considerable lowering of the level of the Caspian Sea; since, during their formation, subterranean apertures must have been formed, into which the waters of the sea would gradually retire.

Likewise, the Caspian Sea is distinguished by the great quantity of salts which it holds in solution, particularly sulphate of magnesia, by means of which the water will be unpalatable, and doubtless prejudicial to animal life. The water of the Black Sea, it is true, seems to be still salter; but it is not so bitter, because it contains mostly muriate of soda; while the water of the Caspian Sea is strongly impregnated with sulphate of magnesia. Hence it comes to pass that the former sea abounds with animal life, while the latter is very poorly stocked. This particularly relates to those animals of the Caspian which live in shells, and these are the proper inhabitants of this sea; while the fish, as fresh-water animals, mostly live at the mouths of the larger rivers, and thus avoid the water of the sea containing sulphate of magnesia.

Tjukkaragan.—The calcareous chain of Tjukkaragan, upon the east coast, rises close to the shore to a considerable height; farther to the south it gradually recedes from the coast. The rock of this mountain-chain is a limestone, which, towards its under strata, is without petrifactions, or it contains only a few fossil shells; while, towards its upper part, on the contrary, it consists entirely of bivalve shells, which are so close together that they quite compose the mass of the rocks.

The compact limestone is mostly of a muddy white, or grey colour; it also becomes bluish-grey, and then passes into a yellowish tint. It is, however, not firm, but neither does it crumble. Its grain is tolerably fine and compact; but sometimes it becomes compacter and firmer; however, it seldom contains petrifactions. We see only here and there a shell differing somewhat from the *Cardium edule* of the sea. This Cardium appears to be more drawn out lengthwise, and thus to be narrower; the valves are flatter, and the hinge-end is not so blunt as in the *Cardium edule;* the longitudinal streaks are besides very fine, and not so coarse as they are in the *Cardium edule* or *rusticum*, but the ribs, on the contrary, project prominently. The size of most of them does not exceed a quarter of an inch.

The yellowish-coloured shell-limestone is that which contains the greatest number of petrifactions. In it well defined *Mytili* and *Donaces* accompany the small Cardium. The Mytili differ but little from the *Mytilus edulis* or *polymorphus* at present living in the sea; they have the same length, but with a greater breadth, and are not so pointed. The Donaces, on the contrary, are quite foreign to the Caspian Sea, and are only found in the Black Sea. But the *Donax trunculus*, which is found alive in the Black Sea, is different in its external shape from the fossil species found upon the east coast of the Caspian, which is much smaller. There are likewise other shells, resembling the *Venus*, varying in size, which appear, like the former species, as casts and indistinct impressions in the limestone. *Venus Gallina* is very abundant in the Black Sea; but, in the Caspian Sea, it is found no longer in the living state, and it is but seldom that on the north and west coasts of the same that we find the decayed remains of the above shell. In other masses of limestone, on the contrary, the number of fossil shells is much more considerable. This limestone, which is of a pale rose-red colour, is not particularly compact, and may rather be called crumbling; since, from the many shells which adhere together, empty spaces are found over the whole of it. It evidently forms a calcareous tuffa, containing shells of the newest *tertiary* formation, the *calcaire moellon* of the French, such as it is found upon most European coasts, as on those of Norway, France, Spain and Italy. It is found particularly extensive upon the north coast of the Black Sea; for I have observed it from the mouth of the Dnester, as far as the Bug and the Dnieper. The shells it contains, which are in the form of casts, often appear very large, and mostly belong to a species of *Venus*. But they are not formed like the existing *Venus Gallina* of the sea. Their hinge end is not so pointed, and besides the shell is much broader, at the same time thinner; hence it is transparent, and so fragile that it is quite destroyed, the cast only remaining. We easily observe upon these casts large impressions of the animal, which appear here as considerable projections, and are situated on each side of the hinge. The hinge is in this case nearer the middle, and not, as in *Venus Gallina*, very much to one side. Upon the outside of the shell we see on every part likewise cross stripes.

There is another and extensive mountain mass which rests upon the limestone, which does not contain shells: it consists entirely of casts of fossil shells, which are all of a medium size, adhere close to one another, and form nearly the whole of this formation, without any intervening mass to bind them together.

It is but seldom that we see thin white shells, which from their shape resemble the Venus, and also exhibit cross lines. To judge from the position of the hinge, this appears to be the same as the preceding, only smaller. The rock itself is white, and its hardness is greater than that of the rock above named. So far as I traced along the coast, and observed the rugged towering cliffs, which reach to the height of 480 feet, I found this *tertiary* shell-limestone to prevail everywhere. It is mostly placed horizontally; it seldom deviates from this position, and composes the whole of the inlet of the Tjukkaragan. Upon the coast, vast blocks of this limestone, mixed with fragments of another limestone without petrifactions, are observed thrown together in wild confusion, through which it is with the greatest fatigue and difficulty that we can make our way. They appear to have been torn asunder and thrown down by means of some great convulsion. Above, on the contrary, there is a very flat country, formed of the same shell-limestone, which is covered with a very stinted vegetation.

We may mention lastly, as worthy of notice, a greyish-black and tolerably soft *tertiary* limestone, which generally forms the upper covering of both the species of shell-limestone already mentioned. It consists throughout of small fossil *Serpulæ*, hardly a line thick, of an unknown species *. These sea animals live no longer in the Caspian Sea, but in the Black Sea. I have observed a species of Serpula, very nearly allied to the above, but which, however, is smaller, and there lives upon a fucus. But fossil spiral tubes of Serpulæ are found more abundantly in Volhynia and Podolia, in *tertiary* limestone over chalk, of which they form the principal material. Equally remarkable is another *Solen*-shaped fossil which is found in the above serpulitic limestone: it occurs only in single specimens, with many small siliceous pebbles intermixed, and generally does not exceed nine lines in length. This *Solen* likewise is entirely awanting in the Caspian Sea; but I have found it upon the east coast of the Black Sea. *This furnishes us with a new proof of the similarity of the former animal kingdom of the Caspian Sea with what at present exists in the Black Sea; whence we infer the early union of both seas in the ancient world.*

Somewhat to the south of the promontory, there are seen in the inlet of Tjukkaragan, hills of the same height, composed of the same *tertiary* limestone. The shell-limestone contains here

* At least I have never found these (Serpulæ) any where, neither did Pallas; although S. G. Gmelin mentions (in his Travels, iii. p. 248) *Serpula triquetra* and *conglomerata* as living in the Caspian Sea; but they are as little found there as the shell which he names *Chama cor.*

likewise only shells adhering closely together, almost without any calcareous cement. It is, besides, of the nature of *tuff*, soft and porous, since the shells leave empty spaces between them throughout the whole mass. But since the shells lie so closely together, their impressions are so obscure that we can scarcely recognise their species. A *mytilus* appears to be most clearly expressed. The remaining much more numerous impressions of broken shells belong probably to the genus *Venus*, still fewer to the *Cardium* tribe. Somewhat farther off, we find two hilly summits, which have been employed by the Truchmen as a fort; this is constructed of masses of rock heaped above one another. The rocky mass of these hill summits, which is soft, is likewise of the nature of tuff; the fragments of shells are mostly loosely aggregated, and scarcely united by means of a calcareous cement. But the shells are fine and thin, and completely calcined; here and there calcareous folia shine upon them, and all of them resemble but one species of shell, of the genus *Donax*. These shells adhere closely to one another, and by this means form of themselves the shell-limestone. It is a striking circumstance, that this limestone likewise is composed of only one species of shell.

The rocky masses which prevail upon the high table-land situated between the Caspian and Aral Seas, border very much upon the new formation of the hills of Tjukkaragan. Here hills of marl and *tertiary* limestone everywhere occupy the summits and plains. Thus we see in a yellowish and tolerably firm marl, decided *Cardia*, strikingly allied to *Cardium edule;* likewise small *Paludinæ*, which are often only three lines long, as they at present exist in the Caspian Sea. At other places the marl becomes calcareous, and assumes a pure red colour, but always contains the same *Cardia* and *Paludina*. In other pieces, on the contrary, which appear rather a pale yellow, these two species, which entirely compose the calcareous marly mass, are accompanied by small *Ampullaria*, such as are abundantly found in the tertiary limestone over the chalk formation of Volhynia and Podolia. They are scarcely a line in length, and a quarter of a line in thickness, but they do not live at present in the Caspian or in the Black Sea. Lastly, much more remarkable still is a calcareous marl, that consists entirely of *Cycladæ;*

the white shells of these are about two lines long, and appear to be completely calcined. They lie so thick together, that they compose the whole of the marl, and contain only single *Paludinæ* between them. The species of *Cyclada* appears at present to be a stranger to the neighbourhood, since I did not find it alive any where on the east coast; perhaps because rivers or low standing fresh-water are almost no where to be seen. This marl, therefore, forms an interesting *tertiary fresh-water formation*, which, without doubt, covers the above *lacustrine shell-limestone*. Lastly, I must mention a limestone of the nature of roe-stone, which is mostly without petrifactions, but sometimes contains remains of the above mentioned *Cycladæ;* hence it must be contemporary with the fresh-water formation already mentioned. It consists of very small concretions, which lie closely together, and among them are distributed fragments of a few shells. It might easily be mistaken for the roe of testaceous animals or fishes, did it not occur in such great quantity. Besides, this mass consists of carbonate of lime mixed with some clay, and is sometimes of a reddish-brown, sometimes of a grey colour.

Tarki.—Near the sea-shore of Tarki, upon the west coast of the Caspian Sea, there is a small hill, which consists of a compact limestone. It is mostly of a greyish colour, rather passing into black, and contains a great many small bivalve shells. The shells have often disappeared, and oxide of iron is found collected in their empty cavities. Upon the shore itself there are a great many fragments of shell-limestone, which are of a very loose texture, and consist entirely of bleached or calcined shells. The town itself is situated upon a high limestone rock, which is rather rugged, and forms the last slope of the Caucasian chain. In the rock of the fortress, we observe a very varied construction of the individual strata. From the principal street being cut many feet deep in the rock, owing to this having been blasted, we can thus observe very well the opposite strata of the different formations. The first formation which is here exposed, is a *tertiary* limestone of a grey colour, or of a yellow and brown mixed; it has a splintery fracture, and is of considerable hardness, but with single cavities, in which calcareous spar is collected. It contains no petrifactions. But upon this limestone there lies another containing fossils, and of peculiar texture It is compact and firm. The shells appear here changed into a bluish calcareous spar, and some oxide of iron is found collected in the cavities. Upon this there rests another more compact limestone of a fine grained texture, and with fewer traces of fossil shells. Over this last there follows a limestone which is completely *porous*, and almost of the nature of *sinter;* it is traversed by very large holes, which appear to be occasioned by fossil tubes of *Serpulæ.* These holes are often a quarter of an inch thick; but are mostly much thinner, and are formed of the same yellowish *calcsinter.* Likewise there are found *Serpulæ* tubes, which are scarcely half a line thick; they are formed of a very thin and friable white calcareous mass, and lie grouped together in the hollow cavities of the limestone. As to their species, they are evidently different from the *Serpulæ,* resembling *Planorbis,* of the east coast near Tjukkaragan, since they appear much longer, and very irregularly rolled up; so that they seem to be much nearer the fossil *Serpulæ* of Volhynia. The porous limestone consists throughout of tolerably large particles, and shews that it has exactly the structure of tuff; so that a mass of this same species, lying over the former shell-limestone, would be proved to have been formed at a very late date. There next rests upon this another limestone which does not contain petrifactions; upon this again is found a layer of loose sand, the quartz particles of which appear fine, and of a yellowish colour. This layer is not more than one foot thick. Upon this sand there lies a calcareous marl, of a blackish-grey colour and firm texture. It is placed horizontally like all the superimposed and subjacent formations here, and springs readily into square fragments. Farther, upon this last there lies limestone, which, however, is not purely calcareous, but contains within it particles of quartz. There are likewise found in it, sometimes, cavities with crystallized calcareous spar. Towards the upper part it passes into stratiform sandstone, which again is calcareous. This contains the same sort of quartz grains as the underlying loose sand. Upon this last there follows anew a compact limestone without shells; but upon this there is a shell-limestone, like that mentioned above, of a yellow or even of a grey colour: it contains shells broken into fragments. Towards the upper part, this shell-limestone becomes grey and richer in fossils. Over this limestone there lies a marl formation, which may be compared to the stratum of marl which we have already remarked as lying deeper. It is a grey, passing into a yellowish colour, and contains within it a layer of calcined shells. The stratum of marl is almost three feet thick from top to bottom; the intermediate layer of calcined shells is thinner. These shells lie here in a yellowish marly limestone, which has sometimes a spongy, sometimes compact, texture. The shells are often found in the marl itself. Their species is difficult to be made out, but they resemble the *Cardia*. Upon the marl which is without petrifactions, there lies a shell-limestone, which is rather of loose texture, and of the nature of *Tuff*: it has a whitish colour, and is rather crumbly, and consists only of bleached or calcined shells. The shells lie thickly together; and here and there we observe likewise yellowish oxide of iron collected in the cavities. Sometimes the fragments of shells disappear; and the limestone becomes more free from petrifactions and more compact, assuming a grey colour. This, then, is the highest stratum of limestone which is found in the pass that is hollowed out of the rock in which the fortress is situated.

In this vicinity we find in some of the limestones *Mytili* and a striped *Glycymeris*. The mytilus is very thick, and appears to be distinguished, by well marked characters, from any of the present species, and the same appears to be the case with the Glycymeris. In other limestones, along with mytili, are fossils resembling *Cerithum*. They are probably small Ceritha, which may still, although as different species, occur in the Caspian and Black Seas. In other limestone hills near Tarki, there are some shells apparently belonging to the genus *Corbula*, and to a species resembling those very frequently found at the estuary of the Wolga, and probably also at Tereks. The above and other details which might be laid before the reader, show that much of the limestone is a *shell-limestone tuff* of various textures, belonging to the newest tertiary period; and which, along with the older and similar formations on the east coast, belong to an extensive lake of the tertiary period, as the same masses form on the north coast by the Black Sea around Odessa, the newest *land-coast formation* (Küstenland Formation.)

Derbend.—The hills of Derbend are pretty uniform in structure, and consist of a tuffaceous shell-limestone of the *tertiary period*, which alternates with sandstone. The tertiary limestone which forms the hills around Derbend is of a yellowish colour, and is so compact, that all the houses, and also the walls of the town, are built of it; and even the grave-stones are cut of the same material. Some limestones are without fossil shells; others, and those of a loose texture, are principally composed of them. Those fossils have the same general characters with those already enumerated.

From the fossils in the shell-limestones, on the east and west coast, it follows that the former inhabitants of the Caspian Sea were principally *bivalve shells*, as is shewn to be the case at present by the, generally, dead inhabitants of the sea in the sand of the coast, and at the bottom of the sea. And as the Caspian at present supports few species of shells, we find principally only these or others closely allied to them, among the petrifactions of the shell-limestone. Single species that occur petrified in great numbers in particular localities, occur at present either as rare inhabitants of the Caspian, as the *Glycymeres*, *Corbulæ*, and *Veneres*, or are not found at all in the Caspian but in the Black Sea, as *Donaces* and *Serpulæ;* only the *Mytili* and *Cardia* are as numerous in the living as in the fossil state. They are even with difficulty distinguishable as a species from the fossil ones. In the same manner, we find also small *Paludinæ*, both living and fossilized, on the coast and bottom of the sea.

As we do not find in the strata any petrifactions but of the testacea, no fish for instance, it follows either that these animals, the fishes, as they died, were dissolved and destroyed, so that no traces of them were left behind, or that they did not exist as inhabitants of the Caspian, at the period of the deposition of the *tertiary limestone*. This appears the more probable, as the fishes of the Caspian are chiefly river fishes, which would first find their way there on the sinking of the level of the sea, and from the rivers which would then pour into the Caspian; while the testacea, as inhabitants of the sea, shew plainly a former connexion with the Black Sea. Now, however, the testacea begin gradually to die out, so that they fill, with their calcareous remains, all the coast of the sea, and the sands of the islands, as well as the deepest sea-bottom.

Baku.—The neighbourhood of Baku, as well as the islands in the bay of Baku, every where display rocks of shell-limestone of the *tertiary* period. The soil through which the *perpetual fire* of Baku rushes, is a shell-limestone, in which we observe many shells, but can distinguish only small Cardia. Its colour is often blackish, which may arise from the penetration of the naphtha, for it has a strong naphthic smell. It is disposed in horizontal strata, sometimes porous, and appears as if fire had acted on it. Other limestones occur, with conchoidal fracture, and with few or no shells; but, as we approach the naphtha springs, the limestone becomes less and less abundant; at length its place is taken by a blackish earthy loam, which is deeply impregnated with naphtha.

The naphtha pits or wells are here very numerous, and differ in depth. The best colourless thin naphtha shews by the aræometer 18⅔°; the worst, and consequently the thickest, only 11 per cent.: the one is pure and perfectly liquid; the other, when poured from one vessel into another, is very tenacious. The annual quantity collected of black naphtha amounts to 243,600 pud; while the white kind is only 800 pud.

Here, also, occurs the great salt lake, the Massassir, about fifteen wersts from Baku, which, when at its greatest height, is about five wersts long, and half as broad. Its circumference is about twelve wersts. Every summer it affords about 150,000 pud of salt, but, in case of urgency, could yield 320,000 pud. The Lake of Sich, about seventeen wersts from Baku, is only one and a-half wersts long, and about one werst broad, and five wersts in circumference. It never dries up. The salt forms a layer on the bottom three inches thick, and annually affords 20,000 pud, but 200,000 could be collected from it. The other lakes, many in number, afford annually 160,000 pud, but could produce 566,000, if there was demand for the salt.

The perpetual fire, about fifteen wersts N.E from Baku, in front of the town of Ssarachani, is not, as earlier travellers maintain, burning naphtha, but hydrogen gas (probably carbonated hydrogen), which rises through cracks and openings of the calcareous rocks, and, on the approach of a flame, takes fire, and continues to burn. It never takes fire spontaneously, nor by the approach of red coal, if not burning with flame. The gas, as it escapes from the rock, is without smell—is not sensibly warm—and, on being respired, does not occasion any disagreeable feeling. It burns with a yellowish-white flame, and forms with atmospheric air an exploding gas.

This perpetual fire, worshipped by the holy Indians of Baku, does not differ from other ephemeral phenomena of the same kind known in other parts of the world.

Naphtha volcanoes, in a state of activity, occur at Baku and Sallian, as also in several of the islands on the west coast. They agree pretty nearly with the mud volcanoes in the peninsula, Kertsch, and the Isle of Taman, described by Pallas; and deserve more the name of naphtha volcanoes than mud volcanoes, as their eruption always terminates with a pouring out of naphtha. Near to Baku, about one-fourth werst from the perpetual fire, a heat rises out of a fissure of the shell-limestone, which is so strong that the hand can scarcely bear it: hence, from all these circumstances, we can scarcely doubt of the existence of a subterranean heating process in the peninsula of Apscheron.

(*To be concluded in next Number.*)

On the Limit of the Law of Symmetry, and the Forces which determine the actual Forms of Inorganic Bodies. Communicated by the Author.

A LITTLE observation is sufficient to shew, that when material masses are separating into parts, or, conversely, individual particles aggregating into masses, they have been subjected to some law whose office is to produce symmetry along with individuality. Whether we look to the animal, the vegetable, or the mineral kingdom, so universal is our expectation of finding symmetrical forms, wherever we find individuals which are the spontaneous produce of nature—and such an expectation can be founded on nothing else surely but on general observation—that, almost with instinctive decision, we characterize as monstrous or imperfect, whatever productions we meet with, which, while they possess unity, are found to be defective in symmetry. The occasional occurrence of monsters, however, and of individuals defective in that symmetry which their species usually possess, renders it no less obvious, that, while there are forces tending to develope symmetry in natural bodies, there are also forces acting as antagonists to the former, and modifying the result, to which the law of symmetry, if taking effect alone, would give rise. In this paper it is proposed to inquire into the law of the phenomena alluded to. They are of the greatest curiosity and importance, and have bearings upon every branch of science, and on art, as well as nature.

Now, in endeavouring to detect the law by which the particles of bodies group together, it is plain, that, in preference to the organic kingdom, we must turn to the phenomena of the inorganic. For the forms of plants and animals are obviously determined by a more complicated apparatus than those of minerals; the forces which evolve and modify their symmetry are obviously more complex in their operation, and their analysis is therefore proportionally more difficult. Directing our attention, then, to inorganic nature, we observe, as a most remarkable feature, when we inspect it minutely, that all its parts either already possess a crystalline structure, or (to judge from all the evidence which such short-lived beings as we are can obtain) that they tend to acquire such a structure. Fluidity, mechanical disturbances, cohesion, and such like forces, act as antagonists indeed, and may often prevent, for long periods, the evolution of that state of existence; nevertheless, every material mass or group of particles seems to be constantly tending towards it. Let us first examine the phenomena of the liquid element.

More than three-fourths of the earth's surface are covered by water, and though over a great extent of it, crystallisation is prevented by the temperature of the particles which implies a degree of motion among them, and of mutual distance between them, incompatible with that state of fixed relationship and symmetrical union, wherein a state of crystallisation consists;

still, as soon as the temperature falls to the requisite degree, spicula symmetrically related to each other instantly make their appearance. These presently become so numerous as to constitute laminæ, which, in their turn, decussate each other symmetrically, and become the frame-work of a tissue so essentially crystalline, that even after the intimate symmetry of the mass has been very much broken up by the freezing and expanding of the last portions which congeal, still, when inquired into by the aid of polarised light, it declares itself to possess a crystalline structure. The element whose tendency to assume a symmetrical structure, when permitted to pass from the liquid to the solid state, is thus shown by the ordinary phenomena of congelation, exists also in the atmosphere, from which it is occasionally precipitated in solid masses. Now, of these also, it is to be remarked, that always, except in cases of great atmospherical agitation, their forms are of most exquisite symmetry. Whether we inspect the hoar-frost which fringes the leaves in a winter morning, or the snow which covers the ground, we shall equally find matter of a beautifully crystalline structure. And this will, I presume, be assented to by all, that the greater the stillness in which the atmospherical aggregation of the aqueous particles takes place, the more perfect will be the resulting symmetry.

But while it is thus obvious that there is some power which produces symmetry, it will also be perceived that there is some power which circumscribes and limits it, so that forms only which belong to one series do constantly result. Thus, where entire individuals may be developed, as, for instance, when aqueous particles aggregate together from solution in the atmosphere, the lineaments of a hexagon are constantly to be detected in the snow-flakes that result; and whatever be the particular form of each particular snow-flake, this may be affirmed of them all, that they may be inscribed in a circle. In hoar-frost, in like manner, and masses of ice (in which, either from connexion with foreign bodies, or with each other, a complete insulation of individuals, and consequently a complete evolution of form, is prevented) angles of 60°, and forms known to belong to the same crystallographic series with the six-sided table, are alone to be met with. In plants also, in which what may be called an aqueous tissue, preponderates over the carbonaceous, as is the case in most monocotyledonous species, traces of the same forms are constantly occurring. But in this place, as we proposed to confine our regards to the inorganic kingdom, more need not be said on that subject.

Extending our observations from the aqueous strata to those which are permanently solid, analogous phenomena everywhere present themselves to view. Those strata, indeed, which are of more recent deposition, which have been aggregated by their weight merely, and consist of the debris of older ones, are still, in most cases, in a muddy and mechanical state, their *integration* being still incomplete. But, as we go deeper into the geological series, and come into the region of those rocks which have continued for a longer time unbroken, we find that they have all, to a greater or less extent, acquired a crystalline structure. And that rocks, now in a mechanical state, are ever tending to pass more and more into the crystalline, as many arguments might be brought forward as the case admits of. If one introduced into a saline solution or mass of mobile particles, as, for instance, into a solution of alum, or a cask of sugar, any body possessing a permanent form, such as a little crystal of alum, or sugar, or even a little bit of stone, or chip of wood, it is well known that it will become a nucleus, around which crystallization will take place, which had otherwise required a longer time to be developed; and no one will doubt, that, unless prevented, this process of crystallization once begun, will extend itself more and more, till some circumstance prescribes a limit to it. Now, phenomena perfectly analogous to these are presented in those rocks whose matter occurs, in the present era of the world, in a mechanical state. Thus in a bed of chalk, where an organism has been inclosed, the matter within the organism and around it (unless the bed be very recent), is invariably more highly crystalline than the other parts. Nay, in certain mechanical strata, even balls of air, having been included, or somehow generated, have, like any other dissimilar bodies, served as nuclei, where the process of crystallization has commenced; and the cavities they occasion are not only often drusy in their interior, but the rock around them is often sensibly more crystalline than the general character of the bed. And besides such cases, and where the presence of a foreign body cannot be detected, nuclei of a peculiar character may often be discovered, which, by all the phenomena they present, we should infer to be centres of emanation from which the crystalline arrangement was gradually diffusing itself over the whole formation, so as, in the course of time, to assimilate what is now a mechanical deposit to the more ancient strata. If it be said by any one, that, in order to such a process as the change of mechanical into crystalline strata, heat is necessary, I will not deny it: but is there not heat enough in every stratum, as it exists at present, to effect this transition, if time enough be supplied?

In water, then, and in the solid strata, we see that there either is already a crystalline or symmetrical arrangement among the constituent particles, or a determination towards such a state. But, in order to learn the law more minutely by which the aggregation of the particles of bodies is regulated, we must descend from generals to particulars, and enter somewhat more into the details of crystallography. Now, in the case of water, it has been already said, that, where there are fewest obstructions to the action of the individualizing power, the symmetry which results is the most perfect. The same truth, also, is so universally displayed in the processes of the laboratory during artificial crystallizations, that I presume it need not be dwelt upon. But let us see what evidence the mineral kingdom supplies of it.

Now, in the case of *imbedded crystals*, we cannot but regard the *individual* as more perfect, than in the case of *implanted* ones, and, consequently, the individualizing power as having taken effect more fully. Are imbedded crystals, then, more symmetrical than implanted ones? The fact is so certain, that the question seems needless. But this is not all. It is a very important fact, for the illustration of our subject, that *the actual form of a crystal, viewed as complete, is almost invariably more symmetrical than the primary or cleavage form.* But, in order to illustrate this position, which may not be so readily assented to, it is necessary, in the first place, to inquire as to what form is entitled to be regarded as the most symmetrical.

To answer this inquiry, however, it is only necessary to consider, that our idea of symmetry is merely similarity of relationship, from which it follows, that that form must be the most symmetrical, which has the greatest number of parts similar in relationship in a given space. Guided by such an idea, in determining what form is the most symmetrical, we are at once necessitated to fix upon the regular polyhædron, whose facets are all similar to each other, equally distant from the centre, and so minute as to be single particles. For, in such a figure, the relationships of all the parts are identical, and, at the same time, the number of such parts in a given space is a maximum. Of all possible forms, therefore, the regular polyhædron, whose facets are single particles, is the most symmetrical. But such a polyhædron is just a sphere. *The sphere, therefore, is the limit towards which bodies, while their symmetry is becoming more perfect, must tend.* And all bodies, did the particular forms and forces of their particles not present obstructions in the way of such a result, and were they aggregated into individuals, according to the law of greatest symmetry alone, wholly unmodified, must have been contained under spherical contours. All this results from our idea of symmetry. Let us see, then, what are the forms which the power of crystallization, so far as we can obtain evidence, tends to develope. And here it must be remarked, that, so long as we are not at liberty to assume any thing as to the forms of the crystallizing molecules of mineral bodies (and certainly nothing could justify such assumptions, as that they are all cubes, or spheres, or spheroids, or identical with the cleavage forms, or the like), we must just make use of such knowledge of the structure of crystalline bodies as we possess, and of such observations, as their actual forms, and the phenomena of their increment and decrement, display.

Proceeding in this way, we find that about a fourth part of the whole crystalline series, possess such a structure, that their cleavage forms are tessular, or such as may be inscribed in a sphere; and what is especially to be remarked of such crystals, is the fact, that *their actual forms are never less, and usually more nearly spherical than their cleavage forms.* Thus the diamond has an octohedral cleavage form, and its actual form is not only never more dissimilar to a sphere than the octohedron, but often, by replacements and truncations, is made to approximate the sphere to such a degree, that it more nearly resembles that form than the octohedron. And, in like manner, other species of minerals, of which there are about a dozen having the same cleavage form, are never found crystallised as rhomboids or prisms, or as any forms whatever, which are more dissimilar to spheres than the octohedron; but, on the other hand, their angles and edges, (those parts the presence of which make them to differ from spheres), are often thrown off. So exquisitely, indeed, is this change effected in some instances, that Mr Phillips informs us that he possesses a crystal of fluate of lime, whose cleavage form is of course bounded only by eight planes; but whose actual form is so bevelled, and bevelled again, that were the crystal complete, it would be bounded by no fewer than 322 planes, (Phillips' Mineralogy, p. 170). In like manner, when the cleavage form is the cube, as is the case in about another dozen of mineral species, analogous truncations and bevelments of angles and edges may be observed. And even where the cleavage form is the dodecahædron, as is the case with nine or ten species, though that form itself possesses much of the contour of the sphere, still replacements of the salient parts by planes, are often to be observed, all of them consisting in so many approximations to a spherical superficies.

Now, while it thus appears that the actual forms of such crystals as have tessular cleavages, do never depart farther from the sphere than their cleavage forms, but, on the other hand, usually approximate more nearly to it; with regard to those whose cleavage forms are not truly tessular, it may be remarked, that their actual forms do not unfrequently simulate the tessular aspect, thus shewing, even in still more adverse circumstances, a *conatus* towards a spherical contour. Such a phenomenon may, for instance, be often observed in vesuvian, oxide of tin, tungstate of lime, phosphate of titanium, mellite, and others, nature being sometimes able to produce this effect only having recourse to the process of hemitrope, as in carbonate of lead, chabasie, &c. In other minerals, also, whose cleavage forms are most diverse from tessular, such as bipyramids, rhomboids and prisms, the same phenomena may constantly be observed, namely, edges and angles subjected to replacement by planes, so that the most salient parts of the figure may be cut off, and the actual forms reduced to a nearer coincidence with that which is the limit of perfect symmetry. In imperfect crystals also, in which the summit only is complete, that summit will generally be found to display similar phenomena, indicating an approximation to a hemispherical contour. To conclude, let the reader inspect the 197 crystalline species, of which representations and descriptions are to be found in Mohs' Mineralogy, and in the whole series he will only find five or six which are destitute of those features of approximation towards the sphere of which I speak, while in all the others, the principle now advanced will be found most palpably displayed.

Nor is the fact to be viewed as in any degree adverse to the view now advocated, that many implanted crystals occur in prisms, whose length is frequently many times their diameters. For, in consequence of the manner in which, there is reason to believe, that implanted crystals are evolved, the prismatic form must necessarily be generated, or the process of evolution must cease. But on this subject I do not enter. Meantime it may be remarked, that the transverse striæ upon crystals of quartz, when viewed with a magnifier, serve well to illustrate the determination of crystals towards spheroidal forms, even when circumstances limit them to prisms.

During the increment and decrement of crystals also, well marked phenomena, pointing to the same principles, may be detected. Thus, when a cube of rock-salt is exposed to a damp atmosphere, from which it attracts moisture, the dissolution begins regularly at the edges, so that each of the original edges is speedily replaced by two planes. Then these gradually increase till the hexahedron is transformed into a trigonal icositetraedon, a six-sided into a twenty-four-sided figure, of very regular and symmetrical aspect, and very much more similar to the sphere than the original cube. (Mohs, vol. ii. p. 38).

In the external forms of crystals, when viewed with common light, however, but a small part of the spheroidal features and tendencies which their structure possesses are visible. The view now advanced is far more fully exhibited in crystalline bodies, when polarized light is applied to them,—nay, in light itself, whose phenomena may be called ethereal crystallizations, and wherein, as well as in that department of nature which we have just examined, symmetrical arrangements, and a *conatus* towards the form of greatest symmetry, are constantly to be observed. Can any thing surpass the symmetry which light displays in every case in which it can be rendered visible? When a ray falls upon a reflecting surface, not only does it rise up at the same angle, so as to produce a symmetrical reflected ray when the reflecting surface is smooth, but even a considerable roughness of the reflecting plane is inadequate to disperse it. The forms developed by diffraction, by polarization, by optical instruments, also, are all kaleidoscopic, remarkable at once for the perfection of their symmetry and the tessularity of their aspect. Look to those also which are seen with polarized light around the axes of untessular crystals, or transparent solids of artificial origin, mechanically compressed in certain regions, or unequally heated, or to those spectra which may be produced by light diffracted through small apertures, after the method of Frauenhofer; and whether it be lemniscoids, ellipses, or circles we see, does not every thing beheld present traces or projections of spheres, or figures indicating spheres or spheroids, involved in the angular form we look upon, but only to be detected by this refined instrument of analysis. Suppose, for instance, that we look along the axis of a rhomboid of calcareous spar, then, though every line discernible in the whole crystal by ordinary vision be straight, and the relationships of all the lines be oblique angular, directly when viewed in polarized light, is a series of concentric circles discovered to us, whose common centre is traversed by two lines rectangularly disposed to each other, so as to present a projection of a tessular combination If, again, we take a piece of glass to which a cubical form has been given by art, on inducing an unequal heat upon the exterior and interior, and viewing it with polarized light, we shall see four coloured circles in it, symmetrically related to each other, and similarly disposed in certain regions of the cube, thus indicating the existence of spherical or spheroidal arrangements of some sort subsisting within the confines of the hexahædron. In like manner, if we inspect those figures which were obtained by Frauenhofer in his experiments on diffraction, and which cannot but be regarded as cleavages of etherial crystallizations, do we not see the most beautiful exhibition of tessularity that can be conceived? In one word, the totality of the phenomena which the medium of light displays are perfect exhibitions of symmetry; and all of them can be well explained, by assuming that there is a tendency in those molecules which produce them to group in spheroidal assemblages, which, however, they are always prevented from effecting completely by particular forms or attractions, or some such circumstances, in the nature of the molecules of light themselves.

But let these remarks suffice as to the phenomena of crystalline bodies, in order that we may proceed to state, that it is not in those bodies only where the individualizing power has operated with sufficient force to give birth to crystals, that the tendency towards maximum symmetry may be detected. How often does that structure occur in mineral bodies, though almost in a mechanical state, to which the name of concentric lamellar is given? There is scarcely a rock in the whole geological series which does not sometimes display it. Granite, trap, rock-salt, and even sandstone, on the great scale, and pearl-stone, agate, and pisolite, on the small scale, either often or always exhibit this structure; and others, in which it cannot be detected when they are newly broke into, display it after being for some time exposed to the weather. It may be said, then, that all inorganic nature supplies evidence that the particles of inorganic bodies tend to assume the most symmetrical positions, in reference to each other, which circumstances admit of, and to associate in groups of a spherical or tessular contour, as often as some particular circumstance, either connected with the form of the molecules, or their peculiar attraction, does not prevent such a result.

But while I thus endeavour to shew that one of the elements of physical action is to determine towards the sphere, let it not be thought that there is any thing occult in such a determination. From the nature of matter and motion, it follows necessarily that it must be so, in order to perceive which, it is only requisite to attend to the following considerations:—The properties of matter usually enumerated are extension, mobility, elasticity, impenetrability, heat, luminousness, attractibility, elasticity. Now these, when viewed abstractly, and as properties of a single mass of matter, insulated in space, either vanish altogether, or prove themselves to be modifications of these two properties, extension and elasticity; for in the idea of these two all the others are involved. That mobility is implied in the idea of elasticity is obvious. That there could not be mutual elasticity without mutual impenetrability, is no less certain. Heat, in like manner, if it be a property of matter at all, can only be explained on the supposition, that it is the action of atomic elasticity. Luminousness is generally agreed to be a phenomenon depending on motions taking place in an elastic medium; and, with regard to attractability, no attempt was ever made to explain it, otherwise than by having recourse to elasticity, as an efficient cause in the media producing it. Elasticity, therefore, is the great comprehensive property of matter, to which very many phenomena in the present state of science is to be traced, and into the idea of which almost all the other properties of matter enter. But whether the reader assent to these remarks or no, to this certainly all will assent, that elasticity is a most important and paramount property of matter.

This granted, in order to see that any group of particles acting upon each other must ultimately settle in relative positions, the most symmetrical which, in the existing circumstances of the case, they possibly can assume, it is only necessary to consider for a moment what phenomena must ensue in a group of elastic particles, made to act upon each other, and, though free to move about, yet prevented from separating beyond the sphere of each other's action. The obvious tendency of the property of elasticity, in such circumstances, is to effect a balance of motion in the opposite regions of the whole group; and this, it is plain, can only be done by giving rise to a balance in the quantity of matter in opposite or symmetrical positions. That the positions of greatest relative symmetry can alone be the positions of equilibrium and quiescence in elastic bodies, (their particular forms and tendencies of attachment neglected), results from the very nature of motion; for motion ever tends to persevere in a right line; and therefore, if embodied in a deformed line of particles, and forced to pursue a course along them, it must ever tend to rectify that line; or if made to circulate in a continuous but deformed chain of particles, it must ever tend to reduce it to a circle. In one word, if embodied in any group of particles whatever, it must tend to arrange them as a spherical mass, or a system of radii of equal length, surrounding that particle which is the fountain or focus of the motion. Were it desirable, these results might be illustrated at great length; but, after those which have been made, let this remark suffice, that it is the nature of elastic bodies to undulate, and that the only undulatory form which has not the element of change implied in it is the sphere. Through this form alone can motion which intrinsically agitates it, or is embodied in it as a *vis viva*, be propagated equally and symmetrically, so as not to subject its different parts to dissimilar forces, causing them to change their places. In fact, a sphere is the only form which, viewed as an elastic medium, possesses unity; and the effect of any motion embodied in any insulated group of elastic particles, viewed simply as such, must be the following:—First, to arrange them in the symmetrical positions most contiguous to those in which they happened to exist when the elastic action commenced; then to remove those particles, of which there is a smaller number similarly posited, into positions corresponding to those in which there is a greater number, and so to diminish the number of parts, and increase the stability and unity of the whole, till, if nothing prevents such a result, its stability and unity become a maximum, by its becoming a spherical mass.

Though such a state of things exist, however, it does by no means follow that spheres shall be frequently produced in nature. For if the particles aggregating possess peculiar and dissimilar faces, and tend to unite only by particular points, facets, or edges, and not by any region indifferently, then, of course, the form actually resulting may be very dissimilar to a sphere; though it still must be modified from what it otherwise would have been, had no such tendency existed as that which it has been shewn, the consideration of motion embodied in elastic particles leads to.

Thus, whether we apply ourselves to observation, or trace the phenomena which must necessarily result from the nature of matter and motion, it follows, that there is in the particles of inorganic bodies, while freely grouping together, a tendency to assume and settle in the most symmetrical positions possible. But it is no less certain that this tendency is opposed by others, whose agency is to give to those groups forms different from those of the sphere. From the conjunct agency of these forces, therefore, the actual forms of inorganic bodies and the phenomena of nature must result. According to this view, then, the specific forms of crystalline bodies are to be viewed as the result of conspiring or antagonist forces, one of which is of a general character, and ever tending to a constant effect; the others, of particular characters, taking their rise in particular circumstances, and tending to particular effects.

By adopting such a view, then, the study of crystallography may be assimilated to analogous branches of physical science. In mechanical philosophy, for instance, it is usual to analyze phenomena by referring them to two or more forces, one of which is regarded as of a determinate and general nature, and denominated a law of nature; while the other is usually regarded merely as a peculiar pressure or impulse, deriving its origin from some special circumstance, and acting, to a certain extent, as an antagonist to the law of nature, and modifying the result which would ensue were the latter to take effect alone. Thus, in analyzing the planetary motions, it is usual to view them as the result of the combined action of the law of gravitation, on the one hand, and of a particular impulse, on the other, modifying the result which would speedily ensue were gravitation by itself to take effect upon the planetary bodies. In philosophising on the descent of a heavy body, in like manner, it is usual to ascribe its fall to the same law of gravitation, and to account for its shortcomings in fulfilling that law by the resistance of the air as an antagonist element. Now, although, according to the understanding of all philosophers (I should hope), the law of gravitation be merely viewed as a general announcement in terms of space and time of the phenomena themselves, (though it is vulgarly believed to account for them); and though that be but a *mixed philosophy* which is contented to view a phenomenon as the resultant of two such incommensurable factors, as an abstract idea and a material body (as, for instance, when we ascribe the fall of a heavy body to gravitation on the one hand, and to the pressure of the air on the other), still this is a mode of viewing phenomena which is possessed of many advantages. By its aid the powers of mathematical science can be very advantageously applied to physics; by its use the mind, when seeking gratification to its curiosity, is led away from the invention of hypothesis; and, until the natural mechanism is discovered by which attraction, repulsion, rotation, and revolution are affected, such a mode of conceiving of these phenomena may form a very legitimate resting place for the mind.

In conformity with this method, then, adopted in other branches of science, I have, in the preceding pages, endeavoured to shew that the form of every inorganic body, possessing individuality, may be regarded as the result of antagonist forces: One, which may be compared to a central force, ever tending to group the aggregating particles in the most symmetrical manner possible, and possessing therefore a uniform definite agency, and entitled as much as any other phenomenon to the name of a law of nature; the others, of specific characters having their origins in the particular forms of the particles aggregating; or, in other circumstances, of unknown nature.

August 14. 1832.

A few Remarks on the Relation which subsists between a Machine and its Model. By EDWARD SANG, Teacher of Mathematics, Edinburgh. Communicated by the Author.

AT first sight, a well constructed model presents a perfect representation of the disposition and proportion of the parts of a machine, and of their mode of action.

Misled by the alluring appearance, one is apt, without entering minutely into the inquiry, also to suppose that the performance of a model is, in all cases, commensurate with that of the machine which it is formed to represent. Ignorant of the inaccuracy of such an idea, too many of our ablest mechanicians and best workmen waste their time and their abilities on contrivances which, though they perform well on the small scale, must, from their very nature, fail when enlarged. Were such people acquainted with the mode of computing the effects, or had they a knowledge of natural philosophy, sufficient to enable them to understand the basis on which such calculations are founded, we would see fewer crude and impracticable schemes prematurely thrust upon the attention of the public. This knowledge, however, they are too apt to regard as unimportant, or as diffi-

* Read before the Society of Arts for Scotland, 28th November 1832.

cult of attainment. They are startled by the absurd distinction which has been drawn between theory and practice, as if theory were other than a digest of the results of experience; or, if they overcome this prejudice, and resolve to dive into the arcana of philosophy, they are bewildered among names and signs, having begun the subject at the wrong end. That the attainment of such knowledge is attended with difficulty is certain, but it is with such difficulty only as can be overcome by properly directed application. It would be, indeed, preparing disappointment, to buoy them up with the idea, that knowledge, even of the most trivial importance, can be acquired without labour. Yet it may not be altogether unuseful, for the sake both of those who are already, and of those who are not, acquainted with these principles, to point out the more prominent causes, on account of which the performance of no model can, on any occasion, be considered as representative of that of the machine. Such a notice will have the effect of directing the attention, at least, to this important subject. In the present state of the arts, the expense of constructing a full-sized instrument is, in almost every instance, beyond what its projector would feel inclined, or even be able, to incur. The formation of a model is thus universally resorted to, as a prelude to the attempt on the large scale. An inquiry, then, into the relation which a model bears to the perfect instrument, can hardly fail to carry along with it the advantage of forming a tolerable guide, in estimating the real benefit which a contrivance is likely to confer upon society.

In the following paper, I propose to examine the effect of a change of scale on the strength and on the friction of machines, and, at the same time, to point out that adherence to the strictest principles which is apparent in all the works of nature, and of which I mean to avail myself in fortifying my argument.

Previous, however, to entering on the subject-proper, it must be remarked that, when we enlarge the scale according to which any instrument is constructed, its surface and its bulk are enlarged in much higher ratios. If, for example, the linear dimensions of an instrument be all doubled, its surface will be increased four, and its solidity eight, fold. Were the linear dimensions increased ten times, the superficies would be enlarged one hundred, and the solidity one thousand, times. On these facts, the most important which geometry presents, my after remarks are mostly to be founded.

All machines consist of moveable parts, sliding or turning on others, which are bound together by bands, or supported by props. To the frame-work I shall first direct my attention.

In the case of a simple prop, destined to sustain the mere weight of some part of the machine, the strength is estimated at so many hundredweights per square inch of cross section. Suppose that, in the model, the strength of the prop is sufficient for double the load put on it, and let us examine the effect of an enlargement, ten-fold, of the scale according to which the instrument is constructed. By such an enlargement, the strength of the prop would be augmented 100 times; it would be able to bear 200 loads such as that of the model, but then the weight to be put on it would be 1000 times that of the small machine, so that the prop in the large machine would be able to bear only the fifth part of the load to be put on it. The machine, then, would fall to pieces by its own weight.

Here we have one example of the erroneous manner in which a model represents the performance of a large instrument. The supports of small objects ought clearly to be smaller in proportion than the supports of large ones. Architects, to be sure, are accustomed to enlarge and to reduce in proportion; but Nature, whose structures possess infinitely more symmetry, beauty, and variety, than those of which Art can boast, is content to change her proportions at each change of size. Let us conceive an animal having the proportions of an elephant and only the size of a mouse; not only would the limbs of such an animal be too strong for it, they would also be so unwieldy that it would have no chance among the more nimble and better proportioned creatures of that size. Reverse the process, and enlarge the mouse to the size of an elephant, and its limbs, totally unable to sustain the weight of its immense body, would scarcely have strength to disturb its position even when recumbent.

The very same remarks apply to that case in which the weight, instead of compressing, distends the support. The chains of Trinity Pier are computed to be able to bear nine times the load put on them. But if a similar structure were formed of ten times the linear dimensions, the strength of the new chain would be one hundred times the strength of that at Trinity, while the load put upon it would be one thousand times greater; so that the new structure would possess only nine-tenths of the strength necessary to support itself. Of how little importance, then, in bridge-building, whether a model constructed on a scale of perhaps one to a hundred support its own weight! Yet, on such grounds, a proposition for throwing a bridge of two arches across the Forth at Queensferry was founded. Putting out of view the roadway and passengers altogether, the weight of the chain alone would have torn it to pieces. The larger species of spiders spin threads much thicker, in comparison with the thickness of their own bodies, than those spun by the smaller ones. And, as if sensible that the whole energies of their systems would be expended in the frequent reproduction of such massy webs, they choose the most secluded spots; while the smaller species, dreading no inconvenience from a frequent renewal of theirs, stretch them from branch to branch, and often from tree to tree. I have often been astonished at the prodigious lengths of these filaments, and have mused on the immense improvement which must take place in science, and in the strength of material too, ere we could, individually, undertake works of such comparative magnitude.

When a beam gives support laterally, its strength is proportional to its breadth, and to the square of its depth conjointly. If, then, such a beam were enlarged ten times in each of its linear dimensions, its ability to sustain a weight placed at its extremity would, on account of the increased distance from the point of insertion, be only one hundred times augmented, but the load to be put upon it would be one thousand times greater; and thus, although the parts of the model be quite strong enough, we cannot thence conclude that those of the enlarged machine will be so.

It may thus be stated as a general principle, that, in similar machines, the strengths of the parts vary as the square, while the weights laid on them vary as the cube of the corresponding linear dimension.

This fact cannot be two firmly fixed in the minds of machine makers; it ought to be taken into consideration even on the smallest change of scale, as it will always conduce either to the sufficiency or to the economy of a structure. To enlarge or diminish the parts of a machine all in the same proportion, is to commit a deliberate blunder. Let us compare the wing of an insect with that of a bird: enlarge a midge till its whole weight be equal to that of the sea-eagle, and, great as that enlargement must be, its wing will scarcely have attained the thickness of writing-paper;—the falcon would feel rather awkward with wings of such tenuity. The wings of a bird, even when idle, form a conspicuous part of the whole animal; but there are insects which unfold, from beneath two scarcely perceived covers, wings many times more extensive than the whole surface of their bodies.

The larger animals are never supported laterally; their limbs are always in a position nearly vertical: as we descend in the scale of size the lateral support becomes more frequent, till we find whole tribes of insects resting on limbs laid almost horizontally. The slightest consideration will convince any one that lateral or horizontal limbs would be quite inadequate to support the weight of the larger animals. Conceive a spider to increase till his body weighed as much as that of a man, and then fancy one of us exhibiting feats of dexterity with such locomotive instruments as the spider would then possess!

The objects which I have hitherto compared have been remote, that the comparisons might be the more striking; but the same principles may be exhibited by the contrast of species the most nearly allied, or of individuals even of the same species. The larger species of spiders, for instance, rarely have their legs so much extended as the smaller ones; or, to take an example from the larger animals, the form of the Shetland pony is very different from that of the London dray-horse.

How interesting it is to compare the different animals, and to trace the gradual change of form which accompanies each increase of size! In the smaller animals, the strength is, as it were, redundant, and there is room for the display of the most elaborate ornament. How complex or how beautiful are the myriads of insects which float in the air, or which cluster on the foliage! Gradually the larger of these become more simple in their structure, their ornaments less profuse. The structure of the birds is simpler and more uniform, that of the quadrupeds still more so. As we approach the larger quadrupeds, ornament, and then elegance, disappear. This is the law in the works of Nature, and this ought to be the law among the works of Art.

Among one class of animals, indeed, it may be said that this law is reversed. We have by no means a general classification of the fishes; but, among those with which we are acquainted, we do not perceive such a prodigious change of form. Here, however, the animal has not to support its own weight; and whatever increase may take place in the size of the animal, a like increase takes place in the buoyancy of the fluid in which it swims. Many of the smaller aquatic animals exhibit the utmost simplicity of structure; but we know too little of the nature of their functions to draw any useful conclusions from this fact.

Having said thus much on the relative strengths of a machine and of its model when at rest, I proceed to compare their strengths and actions when in motion.

This subject naturally divides itself into two heads; the one relating to the ability of the structure to resist the blows given by the moving parts, either in their ordinary action, or when, by accident, they escape from their usual course; the second treating on the changes which take place on the friction of the parts when these are enlarged or diminished.

The ability of a support to resist the impetus of a moving body, is estimated by combining the pressure which it is able to bear with the distance through which it can yield ere disruption take place. In the case of a support which acts longitudinally, the strength is proportional to the square of the linear dimension, while the distance through which it can yield is as the linear dimension itself. Altogether, then, the ability to resist a blow is proportional to the cube of the length; that is, to the weight of the body which is destined to act upon it. If, then, the linear velocity of the machine is to be the same with that of the model, these parts, so far as this action is concerned, will be in keeping with each other.

In the case, however, of a lateral support, the distance through which it can yield without breaking is not augmented by an enlargement of the scale; so that, in these parts, the large engine is comparatively weak, even although the velocity of the motion be the same on the large as on the small scale.

But those motions which are most likely to produce accidents in this way, are generated by descents bearing a fixed proportion to the dimension of the engine: the velocity, therefore, is generally greater in the large engine than in the small one, so that large machines are more liable to accidents arising from the derangement of any of their motions than small ones are: they possess, however, more absolute strength, and are better able to resist any extraneous force. We must carefully distinguish between the absolute strength of any structure, or the power which it has of resisting impressions from without, and the ability of that structure to withstand the effects of derangement among its own parts.

Every one knows that a thermometer bulb is broken by a very slight blow, and that yet it may fall from a considerable height without injury. Yet a large ball, of a proportionate thickness, though able to resist a much severer blow, is dashed to pieces by a fall. The insect is crushed by a touch; yet many species of insects possess the power of leaping to distances inconceivable, when compared with the minuteness of the animal.

Whether we consider its ability to resist mere pressure, or its ability to resist an impulse, the performance of an engine is not at all commensurate with that of its model. It remains for me to shew, that as great a disparity is perceived when we consider the friction of the parts. As, perhaps, I have been rather general in my previous statements, I shall, when speaking of the friction, confine my attention to that very important instrument the steam-engine. A little consideration will enable any one to apply similar remarks to other machines.

The steam-engine moves on account of the pressure of the steam against the surface of the piston; which pressure may be estimated at about ten pounds per circular inch. The friction which this pressure has to overcome may be divided into three parts: the first including all friction caused by the packing of the piston and stuffing-boxes, and which is proportional to the linear dimension simply; the second including that part of the friction on the gudgeons which arises from the pressure of the steam upon the piston, and all other friction proportional to the square of the linear dimension ; and the third including all that friction which arises from the weight of the parts, and which is thus proportional to the cube of the dimension.

Suppose now, for the sake of an example, that, in an engine whose cylinder is 20 inches across, and whose inciting pressure will thus be 4000 lb., the friction of each kind is 100 lb., the entire friction being thus 300 lb. or about 1-13th part of the moving force. And, to make a handsome enlargement at once, let us propose one of which this may be a mere model, on the scale of 20 to 1 ; the new cylinder will be 4000 inches in diameter, and the pressure on the piston 1,600,000 lb. The friction of the first species would amount to 2000, that of the second to 40,000, and that of the third to 800,000 lb., so that the sum-total of the friction, no less than 842,000 lb., would be fully more than half of the inciting pressure.

It is then clear that such an enormous engine would be highly disadvantageous as a mechanical agent, and that, if the enlargement were pushed a little farther, the whole of the moving force would be expended in overcoming the friction. There is, then, a greatest size beyond which it is impossible to proceed in the construction of the steam-engine. But there is also a least.

Let us, in fact, take an engine similar to our first, but with a cylinder of only 1 inch in diameter. In such an engine the pressure of the steam upon the piston would only be 10 lb. ; the three kinds of friction would amount respectively to 5 lb. 1 qr. and 1-80th part of a lb., the first kind alone being equal to half the inciting force. Were the diminution still farther continued, the friction of the packing of the piston might equal the pressure of the steam.

From this it is apparent that, for each shape of steam-engine, there are two extreme limits as to size, at which the utility of the engine ceases altogether, and between which there is placed a best size, or one which is accompanied by the most complete development of the powers of the instrument. A skilful arrangement of the parts may, indeed, extend the limits both ways, and may thus change considerably the most advantageous size, yet, even with that assistance, very small or very large engines are less productive of force, in proportion to the quantity of coal they consume, than moderately-sized ones are; and, in many instances, it would have been better to have employed two or three middle-sized engines than a single one possessed of two or three times the nominal power.

Every instrument, whether it be used for the generation or for the transference of power, has a best size and a best form. The contemplation of the whole animal and vegetable kingdoms teaches this truth. Each species of animal attains to a determinate size, beyond which it seldom proceeds, and short of which it seldom stops, unless man has interfered with the regular course of nature, and deranged, as his contrivances too often do, that determinate succession of events which is conspicuous in the history of each tribe of what we are pleased to call the lower animals. Each animal and each vegetable, in its progress from infancy to maturity, assumes, at each stage of that progress, such a form as best assorts with the consolidation of its parts, and with the mode of its living. The wisdom and the beneficence of this arrangement, and the skilfulness with which it is made, become the more apparent when we carry our contemplations beyond the globe which we inhabit to those other worlds which circulate round the same sun. Were man, in his present state, and with his present powers, planted on the surface of Jupiter, he would be crushed beneath his own weight: and if, on the surface of that planet, there do exist beings of the same structure and of the same material as man, one of us would be a Man-mountain among them. If, on the other hand, we were transported to the surface of the Moon, or of one of the Asteroïds, our strength would fit us for progressing rather in the manner of the grasshopper than of the man: bipeds, living and moving as we do, would there realize the counter-vision of Gulliver.

The sizes, then, of the objects which, on the surface of this earth, surround us, are not fixed by chance, but determined by the immutable laws of nature; and, in every case, Nature has pushed her exertions to the utmost. There is a limit, both ways, to the size of quadrupeds; there is a limit, both ways, to the size of birds; and, although myriads of insects may be as yet unknown, I hesitate not to affirm that, among these also, we have the double limit. These are not mere speculative truths; they teach us this useful and needful lesson, that there are bounds beyond which no ingenuity can carry us, and toward which we can only hope to approach. How often have men attempted to plume themselves with wings? How many years were spent in search of the golden secret? How many fortunes have been wasted in the contrivance of perpetual motions! And, to come nearer the present moment, how many have ruined themselves with the locomotive engine! This last is the bubble of the present day, and on it I shall make a few observations.

At the surface of Jupiter a steam-engine of twenty horses' power would be unable to move: at the surface of our Earth, one of perhaps 1000 horses' power might perform pretty well; but at the surface of the Moon they might be made of perhaps 20,000 horses' power,—supposing the pressures of the atmospheres in the three cases to be alike. On Jupiter a steam-carriage would be an absolute chimera; on the earth it is barely possible; but on the moon nothing would be more usual. An intensity of gravitation slightly greater than that which the earth exerts, would altogether preclude the hope of obtaining a locomotive engine. As it is, on flat rail-roads they perform well; as the road becomes inclined, they become less practicable; and, on common roads, nothing but the most consummate skill in the selection and in the use of the material, as well as in the contrivance of the parts, can ever be successful in their construction. Security demands strength, strength requires weight, weight increases the friction, friction calls for additional power, and power can be procured only by an increase of weight. To reconcile these conflicting claims is not the task for a beginner in mechanical contrivance, but for one well versed alike in the theory and in the practice of the arts. Models are of no use, for, although the model be able to climb a considerable ascent, that fact is no guarantee that the full-sized instrument will be able to follow its prototype. Let those who speculate on this matter remember that the elephant inhabits the plains, and leaves the mountains to be tenanted by the smaller tribes; and let them also recollect, for the fact bears more upon the subject than at first may appear, that the larger animals are most easily exterminated; that we have the fox and the rat, though the wolf be long since gone.

In the remarks which I have made, it has been my wish to place the subject in such a light as might enable all to perceive the importance of its bearings; and I have refrained from being practical, lest, in making myself better understood by some, I had rendered my meaning obscure to others. My intention throughout has been to inculcate the important truth, that no machine ever can be enlarged or diminished in proportion.

32. St Andrew Square,
12th November 1832.

On Fossil Woods from Newcastle, New South Wales. With a Plate.—By William Nicol, Esq. Lecturer on Natural Philosophy. In a Letter to Professor Jameson.

Dear Sir,

Having finished the examination of the fossil woods which the Reverend C. P. Wilton sent to you from the coal formation in the vicinity of Newcastle, New South Wales, I shall now give you a very brief account of the result of that examination.

The specimens operated on were fourteen in number. They are all siliceous, most of them have the hardness of flint, and a specific gravity of 2.759. Their colours are generally dark, but some are grey, with occasionally a very slight shade of red and brown. A specimen of the latter colour, marked No. 1. in the catalogue from the Castle Hill at Newcastle, and 200 feet above the level of the sea, is somewhat softer than the rest, and has the property of absorbing water and other fluids to a considerable extent. A portion of this specimen, weighing 120 grains when dry, weighed 126 grains after lying a few minutes in water. It was then exposed to the air, and in the course of a few hours the absorbed water had entirely evaporated.

In one or two of these specimens, there is not the slightest trace of organization. In all the rest, the organic structure is sufficiently apparent, and there could be no hesitation in referring the whole to the coniferous order. Some of the specimens retain the reticulated structure of the Coniferæ in the greatest perfection; others possess the perfect structure only in certain portions, the remaining parts being modified in a very singular manner.

Of those retaining the perfect structure, a very fine example occurs in a specimen, which, if the label has not been misplaced, was found at the bottom of the cliff, about three miles south from Newcastle. There are several small rents in it, but these seldom extend through more than three of the annual layers, and they are filled with white calcedony. A representation of this specimen, exhibiting a portion of one of the rents, calcedonic veins, is given in Plate III. Fig. 1.

Of all the specimens in this collection, the above is the only one in which, throughout its whole extent, the ligneous structure has sustained no modification. In some, the structure, although perfect in certain parts, is modified in a most singular and diversified manner in other parts; and, in others, there is nothing but the modified structure observable. Figure 2. Plate III. is a magnified representation of a portion of a specimen, in which the reticulated structure rather predominates over modified portions. In some few parts of it the medullary rays and concentric partitions, preserve nearly their natural positions; but in the greater part of the whole, the medullary rays are bent into curves, with very different degrees of obliquity. The uppermost layer has these rays bent into a zig-zag form; but it will be observed, that however much they are contorted, they may be traced individually into the most perfect parts. The reticulated structure in the under part of the uppermost layer is obliterated in consequence of the compression of the concentric partitions. This is a most curious and interesting specimen, and its locality is the Lake Macquarrie, about twelve miles from Paramatta.

Several of the specimens present a structure somewhat similar to the above. In many of them, however, the modified greatly predominates over the perfect structure. Figure 3. Plate III. is an example of this kind. The under part of the figure is the only spot in the whole specimen where the regular net-work is observable. All the rest of the specimen, which is more than ten times the extent of the portion represented, is more or less in the modified state of the upper part of the figure. Throughout the whole of the distorted part, the concentric partitions have vanished, and only the bolder of the medullary rays, which are more or less bent into a zig-zag form, present themselves.

In some of the specimens, particularly in those which possesses the property of absorbing fluids, there is not a single regular pore to be seen. The medullary rays, which are extremely minute, and of a pale grey colour, are the only observable remains of the vegetable structure.

They are very much compressed, and bent throughout into a zigzag form, exhibiting a very beautiful appearance.

The petrified woods which you lately received from Mr Burnet of Sydney, and which are stated to have been found imbedded in the sandstone on the coast, in the vicinity of Newcastle, New South Wales, are, like Mr Wilton's collection, decidedly Coniferæ. They are all so much alike, both in external appearance and internal structure, that they might be considered as forming a part of one individual tree. They are more or less of a greyish-black colour. They are all considerably denser than any of the specimens in Mr Wilton's collection, and one specimen I examined has a specific gravity of 3.817. They are also less hard than any of Mr Wilton's specimens. Some of them are hydrated iron, others carbonate, and some red oxide.

In consequence of their opacity, it is necessary to reduce these specimens to the greatest possible thinness, before the internal structure can be seen. When that is done, the coniferous structure appears in the most perfect state, there being not the slightest deviation from the natural position either in the medullary rays or concentric partitions.

The whole of these specimens differ materially both in external appearance, composition, structure, &c. from any one of Mr Wilton's collection. Indeed they so closely resemble several specimens in the College Museum from Van Diemen's land, that I should have pronounced them as belonging to that island, had their locality not been stated by Mr Burnet to be the sandstone in the vicinity of Newcastle, New South Wales.

In the coal formation of New South Wales, as well as in the older and newer deposits of that mineral in this island, coniferous fossils are the only remains of ligneous bodies, retaining an organized structure, that have hitherto come under my observation. Various speculations might be indulged as to the cause of this prevalence of Coniferæ in coal deposits; but I shall leave it to you and others, who are much better qualified than I am, to throw light on the subject.

Fig. 1. Plate III. is a transverse section of a small portion of a petrified conifera, in which the natural structure is nearly as perfect as in any living tree of the pine or fir tribe. At *a* there is a rent filled with calcedony in the specimen, shewing a dislocation in some of the rows of pores. *b* is the outer, and *c* the inner edge of the annual layer *d*.

Fig. 2. is a transverse section of another specimen of petrified conifera, in which the reticulated structure, though variously twisted from its natural position, is perceptible throughout the greatest part of the whole. At *e* the reticulated structure is quite obliterated, the medullary rays alone being preserved.

Fig. 3. is a section of a very small portion of a petrified conifera, in which the reticulated structure is observable only in a very few places. The greatest part of the whole specimen has the appearance of the layer at *f*, and the few places retaining the reticulated structure have the appearance as represented at *g*.

On the Coniferæ at present growing in Australia.

As nearly all the fossils and woods hitherto brought from Australia belong to the coniferous order, the following observations on the *present* coniferæ of Terra Australis, communicated by Mr D. Don. cannot fail to prove interesting to naturalists.

The species of this order are not numerous in Terra Australis; those already discovered amounting to about ten, the same number as has been hitherto observed in New Zealand. Of the Australian portion of the order *Phyllocladus rhomboidalis*, *Dacrydium cupressoides* (Huon pine), and a species of *Podocarpus* belong to Van Diemen's Land, and the remainder, consisting of *Araucaria Cunninghamii*, two species of *Podocarpus*, and four or five species of *Callitris*, are found chiefly in the principal parallel of New Holland, and mostly on its eastern side; for it is a curious fact, that they gradually become more rare as we advance westward. The genera are nearly the same as in New Zealand; but while the fir tribe (*Abietineæ*) is represented in New Holland by *Araucaria Cunninghamii*, the former country possesses also a single representative of that group in the *Dammara Australis;* and of the remaining genera, *Dacrydium*, *Podocarpus*, and *Phyllocladus* belong to the Yew tribe (*Taxineæ*), and *Callitris* to the Cypress tribe (*Cupressi-*

Edinr. new Phil. Jour. Vol. XIV. p. 153.

FOSSIL WOODS, NEW HOLLAND.

Fig. 2.

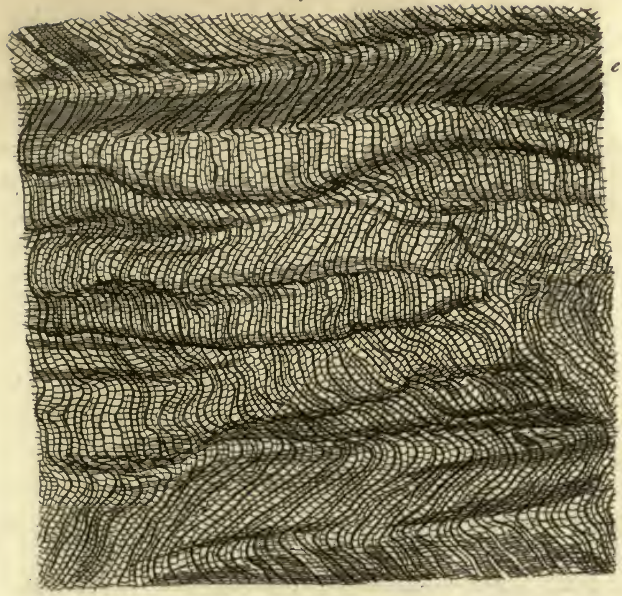
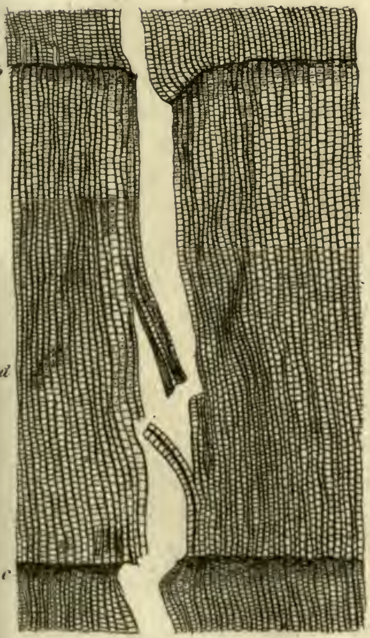


Fig. 1.



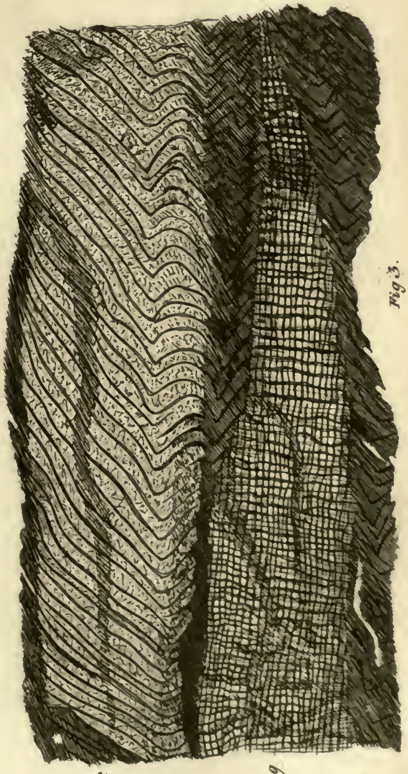


Fig. 3.

neæ). With the exception of *Podocarpus*, which of all the *Coniferæ* is the most widely diffused, and a single species of *Dacrydium* and *Callitris*, the above-mentioned genera are almost exclusively confined to the southern hemisphere. Two species of *Callitris* are found within the tropic, and the ultimate limit of *Araucaria Cunninghamii* extends beyond it: the rest are extra-tropical. As far as I have remarked, there does not appear to be a single example of a species common to New Holland and Van Diemen's Land or New Zealand.

The most remarkable among the Australian Coniferæ, is undoubtedly *Phyllocladus*, a genus akin to the Ginko of Japan (*Salisburia adiantifolia*), both equally curious for their singularly dilated lobed leaves, which separate them from the rest of the order. The branches of *Phyllocladus*, as in *Xylophylla*, are deciduous, and in form resemble the fronds of some ferns.

Before concluding these few desultory remarks on the *Coniferæ* of Terra Australis, it may be proper to notice the nearly related family of *Casuarineæ*, which are pretty extensively diffused throughout New Holland and Van Diemen's Land. Their branches bear a strong resemblance to the fronds of *Equisetum*; and as the trees grow to a large size, they consequently form a peculiar feature in the Australian landscape. The species are limited to Australia, except the *Casaurina equisetifolia*, whose geographical range extends from the northern coast of New Holland across the intratropical islands of the Southern Pacific to the continent of India.

Major-General Sir Howard Douglas, Bart. &c. &c. on Naval Tactics *.

When two hostile armies are ranged in order of battle, in sight of each other, the leader most skilful in strategy, and most

* This article is illustrative of a very important and animated memoir, entitled "Naval Evolutions; a Memoir by Major-General Sir Howard Douglas, Bart. K.S.C. C.B. F.R.S. &c. Containing a Review and Refutation of the principal Essays and Arguments advocating Mr Clerk's claims in relation to the Manœuvre of the 12th of April 1782; and Vindicating, by Tactical Demonstration and numerous authentic Documents, the Professional Skill of the British Officers chiefly concerned on that memorable occasion. Thos. and Wm. Boone. London, 1832."

fertile in expedients to deceive his opponent, will frequently gain a decided advantage. This may be accomplished by making some unexpected movement, in order to take his adversary by surprise, or to throw his forces into disorder, by which means the whole subdivisions may be beaten in detail. Such a mode of procedure is no new scheme, but has been put in practice by all distinguished commanders, as we learn from the earliest records of authentic history. The Grecian phalanx and the Roman cuneus were formed for the express purpose of *breaking the enemy's line by a superior force*, or for preventing the successful execution of that manœuvre.

At the battle of Placentia, according to Livy, Hannibal dispatched his Numidian cavalry to assault the Roman camp. The Roman cavalry, and part of the infantry, charged them successfully, and drove them across the river Trebia. Both armies were now drawn out for battle. It was commenced by the Balearians and the Carthaginian elephants. They in turn drove back the Romans, and the contest became general. By Hannibal's superior tactics the Roman infantry were surrounded; but, by their extraordinary valour, *ten thousand broke through the enemy's line*, and escaped to Placentia. Again, at the celebrated battle of Cannæ, the Carthaginian centre was formed in the shape of a salient wedge, which the Romans charging in front, drove back, till their front was formed in line. By continuing to press the Carthaginian centre, it still fell back, forming the hollow *cuneus* or *wedge*, supported on each side by the wings. The Romans continued incautiously to press forward till they were surrounded in their *attempt to break the Carthaginian line.* The disastrous result is well known. Thus the manœuvre of breaking the enemy's line at Placentia was attended with the desired success to the troops which effected it; while at Cannæ, the attempt led, in a great degree, to their complete overthrow. In many encounters in modern warfare, the same manœuvre has been attended likewise with various success. It was the practice of Napoleon, one of the ablest commanders of the age, to employ that means to overwhelm, by superior numbers, some particular point, frequently the centre of the army of his opponent, which was almost uniformly successful, till opposed by the invincible courage of the British soldiers, led by their consummate general, at the memorable battle of Waterloo.

The plan, therefore, of breaking the enemy's line, by a superior force, has been frequently practised by the commanders of armies from the earliest ages, and in this stratagem there is no novelty.

The naval tactics of the ancients were generally of the most simple description, and closely allied, in point of form, to those of the land-service. The war-gallies, preparatory to battle, formed such different lines as were thought desirable. A form generally employed was that of the letter V, called the phalanx, or wedge.

When a fleet of transports, or merchant-vessels, was under the protection of the war-gallies, the latter frequently formed a circle round the former, in order to secure them from the attacks of the enemy, as in the battles of the Pelasgian and Crissæan Gulfs, recorded by Herodotus and Thucydides. In the war between the Romans and Carthaginians there were several naval engagements; and the first Punic war was terminated, in a complete victory gained at sea by the Roman commander Catulus, over Hanno the Carthaginian. There is little known, however, with certainty relative to their tactics, which, without the use of artillery, must have been very different from those of modern Europe. The bows or beaks of their ships were fortified with brass, and with these they attacked each other when put in rapid motion, by sails or oars, accompanied with a discharge of missiles from the crews. In this kind of conflict, they endeavoured to throw the opposing fleet into disorder, by passing through their lines; but from the imperfect knowledge we have of their naval battles, complete information on the different manœuvres is not now easily obtained.

The modern method of working and manœuvring ships depends upon mathematical and philosophical principles. The Essays of Paul Hoste, of Bouguer, and of Euler, have been long known, and justly appreciated, though most of their deductions were drawn from principles too difficult for general use among ordinary seamen. They afforded materials, however, for more popular works, such as those of M. Bourdé de Villehuet, whose treatise, entitled *Le Manœuvrier*, contains an extensive collection of practical directions for the management of ships in different circumstances.

Nava tactics, and nautical evolutions, are circumscribed by the casualties of navigation, and are therefore less susceptible of that variety of strategy which is frequently practised by hostile armies. Though the naval commander cannot place his fleet in ambush, nor, from the state of the weather, can attack his opponent in the most advantageous point, yet surprise and contrivance are not excluded from this mode of warfare. On the contrary, they are frequently the protection of an inferior force, and often terminate the contest between equal powers. Of this, too, we may be assured, that the knowledge of what is possible to be accomplished by an enemy, may lead a commander to discover his intentions at the very commencement of an evolution. *To execute an unexpected manœuvre belongs to genius,—it cannot be learned from books, for the moment of conception is the instant of execution.*

Notwithstanding this, however, books of naval tactics are of great utility in teaching the elements of the science, without a knowledge of which, no man can be an officer adequate to a command.

The study of the science, too, trains even genius to extend and develope these grand movements which frequently fix the destiny of kingdoms. On this subject, one of the most copious authors is M. Morogues, whose work has been ra nslated into English, and to some editions of which, a division relative to the present practice of the British Navy has been appended*.

It is justly to be regretted, that few or no authors possessing the requisite science, accompanied with practical experience, have, in this country (with the exception, perhaps, of the small tract on Seamanship by Robison) devoted their attention to a subject of such vast importance to the prosperity of their country. The indifference of Britain, indeed, is so great, that the lately established Naval College at Portsmouth is suffered to languish, while men of little or no science are appointed to superintend the construction of our ships of war, thus rendering, by way of economy, the expense of a fifty gun frigate nearly equivalent to that of a seventy-four.

* The able work of Admiral Ekins on "Naval Battles," though not professedly a Treatise on Nautical Evolutions, ought to be read by every British Commander who wishes to make himself acquainted with naval tactics, illustrated by the examples of the most distinguished naval heroes.

Though the professed men of science in this country have not paid much attention to naval tactics, yet there have been some *gentlemen amateurs* who have devoted their leisure to the study of this subject; but how far their labours are likely to benefit the naval profession, is a question that perhaps may be doubted. Their works, at least, ought to be properly examined, and their merits or defects fairly pointed out. Of this class is the Essay on Naval Tactics, by the late John Clerk, Esq. of Eldin, which lately has been the cause of extensive discussion in relation to a claim for the discovery of an important evolution that is affirmed by him and his friends to be of such importance, that, for half a century, it has enabled the commanders of the fleets of Britain to conquer almost uniformly those of France. This is certainly a high claim for an amateur writer on naval tactics. That claim deserves to be well examined, and its merits thoroughly discussed, not by men partially or imperfectly acquainted with theoretical principles alone, but by those who, from their extensive scientific knowledge and undoubted practical experience, are fully competent to the task. It has been long asserted or insinuated by Mr Clerk's friends, that he gave a tract on naval tactics, or at least communicated the principles contained in it, either to Lord Rodney or to Sir Charles Douglas, the captain of the fleet, on which these two distinguished naval officers acted when the British fleet, under the command of the former, gained the great victory over the French fleet, commanded by Count de Grasse, in the West Indies, on the 12th of April in the year 1782.

This claim is thoroughly examined, and its merits, as a naval evolution, completely discussed in a tract by Major-General Sir Howard Douglas, a distinguished scientific and practical writer on military and naval warfare, which is now under our consideration. He is the son of the late Sir Charles Douglas, who was captain of the fleet on that memorable day, and possesses, undoubtedly, every requisite to enter effectually upon this just, though delicate, task.

It ought to be premised, that, in the British navy, it was the established practice to attack the enemy's fleet from the windward, or to bear down upon it, as it is technically called. To do this, it is necessary to gain the weather-gage, which is frequently an evolution of some difficulty. When an enemy discovers this, he stands on close-hauled, or within six points, or more commonly seven, of the wind, to allow leewardly ships to keep their proper stations in the order of sailing; and, consequently, if the two adverse fleets sail nearly on an equality, which they frequently do, the pursuing fleet will not easily weather that of the enemy. Accordingly, all the operations of the fleet under Sir George (afterwards Lord) Rodney on the 9th, 10th, and 11th of April 1782, were performed, to avoid the lee-gage, and get to windward of the enemy's fleet, under Count de Grasse. On the 12th, early in the morning, the French were to leeward, and afterwards formed on the larboard tack, close-hauled, to try to regain the weather-gage, in which it seems they succeeded, when they were approached by the British fleet. By a change of wind, it finally appeared to the British Admiral, that he would fail in getting to windward of the enemy, and he was compelled either to manœuvre afresh, or to meet the enemy on his own terms.

"The position," says Sir Howard Douglas, Naval Evolutions, page 27, "in which the two fleets now were, in relation to each other, and out of which the manœuvre arose in an unexpected and unpremeditated manner, resulted therefore from the British Admiral having failed in a deliberate intention, a systematic attempt, to gain a position (that to windward) the very reverse of that which the (Edinburgh) reviewer asserts was premeditatedly taken; and I shall moreover show, that even after the British Admiral was of necessity *obliged* to engage the enemy from the leeward, or not at all, there was still no intention whatever of attempting to break his line."

Now it must be kept distinctly in view, that, on breaking the enemy's line from the LEEWARD, *rests the whole of Mr Clerk's claim to the honour of having instructed the British admiral and his captain in this celebrated manœuvre.*

If, therefore, it can be satisfactorily established that neither Sir George Rodney nor Sir Charles Douglas had any communication, personally or by writing, with Mr Clerk, either directly or indirectly; and that his tract on Naval Tactics, of which a few copies were printed for distribution among his private friends, about the spring of 1782, did not contain any instructions relative to the mode of breaking the enemy's line from the *leeward*, it must follow as a matter of course, that the manœuvre executed by the British fleet on the 12th of April 1782, was not performed by any directions received from Mr Clerk, or his writings.

This proposition is, we think, made out incontrovertibly by the reasoning of Sir Howard Douglas, on documents, both public and private, in a manner as satisfactory and conclusive as could be desired.

That the late Mr Clerk was a man of talents and ingenuity cannot be doubted, and that his Essay on Naval Tactics is a remarkable production for a landsman, who had never been at sea to witness nautical manœuvres, is also true; but that it is dangerous, from the errors it contains, must, in like manner, be admitted; and that his method of breaking the line from the *leeward* is one of those which ought instantly to be corrected, since it has been recently so much applauded by unskilful tacticians. The family of Clerk has been distinguished for the talents which many of its members possessed. They reckoned among their personal friends such men as the late Professor Playfair, the *Advocate* who wrote the last paper in the Edinburgh Review in favour of Clerk's claims, &c., and these men would not, knowingly, we presume, deprive an officer of distinguished talents of the honours due to his merit; but that they have been mistaken, we, from a perusal of the Naval Evolutions of our author, must unhesitatingly admit. But, while *justice* is done to the family of Clerk, *injustice* to that of Douglas must not be permitted. This name has been long associated with the chivalrous deeds of our countrymen, and to rival the fame of their ancestors is an honourable ambition in those still bearing it in the present age. Sir Howard Douglas has every motive to vindicate the claims of his father,—filial affection, a consciousness of the justice of his cause, and a desire to clear from all doubt or suspicion the fame his late father had acquired, and to vindicate a title to the honours which his father formerly received, and are now inherited by himself. This has, undoubtedly, in our opinion, been done most triumphantly. Sir Howard Douglas has not contented himself with merely vindicating his father's claims to the grand manœuvre which crowned with success the glorious 12th of April,—he has done more,—he has shown that Clerk has not even the merit of first suggesting the manœuvre of breaking the line,—that it had been actually put in execution long before Clerk was born. That the evolution was practised by the ancients, we have shown in our introductory remarks, and that this mode has been followed in more recent naval actions, is proved by Sir Howard Douglas, by quotations from history, some of which may be here subjoined.

"On the 16th of August 1652," says Sir Howard Douglas, "Sir George Ayscue, with nine sail of his headmost ships, charged through the Dutch fleet, and got the weather-gage."

Again, in the Annales des Provinces Unies, in the battle of the 14th of June 1665, it is recorded,—

"That L'Amiral Hollandois, qui étoit au dessous du vent, prit le parti de *percer au travers de la flotte Angloise*, et Le Duc d'York, au lieu de l'arrêter sur son passage, en lui opposant ses gros vaisseaux, le laissa passer, et *perca à son tour au travers des vaisseaux Hollandois. C'étoit une faute considerable; car le Duc pouvoit aisement separer une partie de la flotte de l'autre, et la battre separement.*"

We may add from Paul Hoste, his remarks relative to this battle:—

"Cette ordre (l'ordre de battaille) fut exactment gardé pour la premiere fois, dans le fameux combat du Texel, où Le Duc d'York à present Roy d'Angleterre defit les Hollandois le 13 Juin l'an 1665, et c'est à sa Majesté Brittanique que nous en devons toute la perfection. Les Hollandois avoient pris un vaisseau Anglois, qui par une bravoure temeraire voulut seul *traverser leur ligne.*"

Again, Paul Hoste devotes a chapter principally to the various methods of *cutting an enemy's line.* See Evolutions Navales, page 388. At page 47, he suggests that, "Si l'armée qui est au-vent est plus nombreuse, elle peut faire un detachment qui venant fondre sur *la queue des ennemis, les met infailliblement en disordre.*" Hence the merit of discovering the method of cutting off a few ships in the *rear* of an enemy's fleet with a *superior force*, and taking or destroying them before assistance can be given them by the van, is incontrovertibly not Clerk's, though, on this manœuvre, his advocates mainly rest the importance of his discoveries in naval tactics.

"Again, at the battle of Malaga, on the 15th and 16th of August O. S. 1704, the (British) Admiral Shovel, still bearing down upon the enemy, insensibly found himself in the line a-head of them; which the French, judging to be a favourable opportunity, resolved to make their advantage of it by keeping their wind, and crowding all the sail they were able, *in order to cut off the van of the confederates from the rest of their line;* hoping, with reason, that, if it grew calm, which usually happens in a sea fight, their gallies might tow them off, so as *they might make a double, and weather Sir Cloudesly Shovel, and fire on him on both sides.*"

Neither, therefore, has Clerk the merit of the discovery of cutting off a portion of the *van* of an enemy's fleet, and destroying it by a superior force before assistance can be sent to its support. Hence the assertion of Professor Playfair, that, before Clerk's system was promulgated, "the method of bringing a whole fleet against a part of that of the enemy was never done," is *completely erroneous*, as these quotations incontestibly prove. More proofs have been produced by Sir Howard Douglas, but for these we must refer to the book itself. Though Mr Clerk did not himself assert that he had invented much new, yet the reviewer still holds that his client was "the inventor of the manœuvre of breaking the line, for Mr Clerk had never seen or heard of Paul Hoste's work." We must confess that this is a singular assertion, when it is notorious, that a Treatise on Naval Tactics, by Paul Hoste, a professor of that science, was translated from French into English by Lieutenant Christopher O'Brien, R. N. in 1762, just twenty years before Clerk's first tract, which was distributed among his friends, was printed!

Sir Howard Douglas proceeds, page 50, to observe, that—

"My object, in giving the reader so much matter to wade through, is to enable him to try the case asserted for Mr Clerk.

"*First*, By the matter actually contained in the tract printed in 1782, and by what Mr Clerk has subsequently published.

"*Secondly*, By the actual tactical circumstances of the case.

"*Thirdly*, By the evidence of living witnesses.

"*Fourthly*, By the evidence of the code of signals then in use, and those actually made; and by reference to log-books, journals, and other authentic records.

"*Fifthly*, By epistolary and declaratory testimony rather than my father's, so that by not making him an evidence in his own case, I might explain and establish it on proof, which the other party could neither object to nor cavil at."

Sir Howard gives a fac-simile of a private letter from his father to his father's sister, which contains a pointed denial of his ever having derived any advantage, either directly or indirectly, from Mr Clerk or his writings. The same conclusion is also grounded on letters from several naval officers. This is a most important point, because it would reflect dishonour on Sir Charles Douglas, if, by Mr Clerk's writings, he had been instructed in that manœuvre, by which the decisive victory on the 12th of April 1782 was gained, and had declined to avow the obligations. This, Sir H. Douglas has effectually done, by *proving that the book by which it has been alleged they were taught, did not contain any such directions; and that those remarks upon the method of breaking the line practised on that day, were inserted in another edition of the book published in* 1790, *or eight years after the battle was fought and won.*

"The (Edinburgh) reviewer admits," (says Sir Howard Douglas, Naval Evolutions, page 2), "that I have proved beyond all possibility of doubt, by a general mass of evidence collected from the highest and most honourable sources, the facts of execution to have been as I have asserted in the statements bound up with the Naval Gunnery; that I have triumphantly vindicated my father's claim to the honour of being the immediate adviser of the grand operation by which the battle was gained, and but for his promptitude, energy, and decision, the enemy's line would not, in all probability, have been broken, nor the victory gained; that this distinguished officer and this great service were unduly overlooked in the distribution of honours on that occasion; and that it was fitting for the son, even at this distance of time, to reclaim for the father the honours that had been so long withheld."

From the proofs, therefore, which Sir Howard Douglas had formerly produced, the (Edinburgh) reviewer has been compelled to acknowledge that Sir Charles Douglas was undoubtedly the originator of the manœuvre which decided the victory; and, from evidence now before us in the tract under consideration, it is with equal certainty proved that Mr Clerk cannot lay any claim to the honour of being his instructor.

Though the Edinburgh reviewer has made ample acknowledgment of Sir Charles Douglas' right to the honour of being the immediate adviser of the grand operation by which the battle was gained, yet it has been alleged by the writer of an article in the London Quarterly Review, that to Sir George Rodney is alone due the honour of suggesting the manœuvre of breaking the line on that glorious day. The evidence of Sir Howard Douglas to disprove this insinuation is equally decisive. The letters in the Appendix from those distinguished officers, Sir Charles Dashwood, Sir Joseph Yorke, Sir Frederick Thesiger, Sir David Milne, Sir Gilbert Blane, &c., incontestibly prove that, had it not been for the urgent advice and strenuous exertions of Sir Charles Douglas, in opposition even to the views of his Admiral, it is certain advantage would not have been taken of the culpable negligence of the French officers in omitting to close their line.

In Appendix II., Letter I., Sir Charles Dashwood says,—

"I shall simply relate facts to which I was an eye-witness, and can vouch for their truth. Being one of the aide-de-camps to the commander-in-chief on that memorable day, it was my duty to attend both on him and the Captain of the fleet, as occasion might require. It so happened, that some time a ter the battle had commenced, and whilst we were warmly engaged, I was standing near Sir Charles Douglas, who was leaning on the hammocks (which in those days were stowed across the fore part of the quarter-deck), his head resting on one hand, and his eye occasionally glancing on the enemy's line, and apparently in deep meditation, as if some great event was passing his mind, suddenly raising his head, and turning quickly round, said, 'Dash! where's Sir George?' 'In the after-cabin, Sir,' I replied. He immediately went aft; I followed; and on meeting Sir George coming from the cabin, close to the wheel, he took off his cocked-hat with his right hand, holding his long spy-glass in his left, making a low and profound bow, said, 'Sir George, I give you joy of the victory.' 'Poh!' said the chief, as if half angry, 'the day is not half won yet.' 'Break the line, Sir George,' said your father, 'the day is your own, and I will insure you the victory.' 'No,' said the Admiral, 'I will not break my line.' After another request, and another refusal, Sir Charles desired the helm to be put a-port; Sir George ordered it to starboard. On your father ordering it again to port, the Admiral sternly said, 'Remember, Sir Charles, I am commander-in-chief. Starboard, Sir,' addressing the master, who, during this controversy, had placed the helm amidships. Both the admiral and captain then separated, the former going aft, the latter forward. In the course of a couple of minutes or so, each turned and again met nearly on the same spot, when Sir Charles quietly and coolly again addressed the chief: 'Only break the line, Sir George, and the day is your own.' The Admiral then said, in a quick and hurried way, 'Well, well, do as you like;' and immediately turned round and walked into the after cabin. The words, 'Port the helm!' were scarcely uttered, when Sir Charles ordered me down, with directions to commence firing on the larboard side. On my return to the quarter-deck, I found the Formidable passing between two French ships, nearly touching us. We were followed by the Namur and the rest of the ships astern; and from that moment the victory was decided in our favour. I am most clearly convinced, and my mind is most thoroughly satisfied, that the idea of breaking the line never entered into the imagination even of your gallant father, till the moment of his leaning on the hammocks, and looking towards the enemy's ships."

The testimony of the late Sir Joseph Sydney Yorke completely corroborates that of Sir Charles Dashwood; and Sir David Milne, not then in the same ship, testifies that the general belief in the fleet was, that the idea of breaking the enemy's line was attributed to Sir Charles Douglas.

Hence the following general conclusion may be confidently drawn, "That the idea of breaking the enemy's line was first suggested to Sir Charles Douglas by the opening he observed in it, who pressed it upon his Admiral almost beyond the degree of courtesy due from an inferior to his superior officer, from the important advantages that could not fail to result from it; that this manœuvre could not have been recommended either by Mr Clerk or his writings, because it was the offspring of the peculiar circumstances in which the two opposite fleets were placed; and moreover, though not *then* treated of by Mr Clerk, was by other tacticians known to be dangerous, unless under the peculiar advantages which had thus accidentally occurred."

"I have refuted," says he, "the assertions which reflect upon my father as an honourable man, and an accomplished officer. That is enough for me as his son. I shall now investigate the subject tactically, to correct many wrong notions which inexperienced officers might be led to form, from the unqualified manner in which Mr Clerk's theories have been lauded, in urging pretensions which some professional men proclaim to be *grand discoveries in the science of naval tactics.*"

He then examines the reasoning of the Edinburgh reviewer, and proves that he does not even understand the language employed in naval discussions, and from his ignorance of nautical phraseology, confounds two very different operations; and consequently, that no confidence can be placed in his deductions. The advocate does not even know the difference between the sea phrases *to bear up or away, and to haul up, or to haul the wind* *.

Sir H. Douglas, page 59, remarks:—

"Mr Clerk, in his theory of the cross attack from the leeward, (which was published for the first time in 1790, and forms no part of the previous tract of 1782), assumes that the lee fleet may penetrate a fleet standing athwart to windward, in any one point, and so cut it in twain; that the incision may either be made in the enemy's van, centre, or rear, and that whichever of these be chosen by the fleet bearing *up from the leeward*, as his advocate calls it, (but should have been *hauling up*), stemming close-hauled towards the broadside batteries of the enemy, that the windward fleet must be cut in twain at that one *point*, or otherwise the leader, getting foul of the lee ship, at that interval, will stop her course, and that of all her followers, (without stopping his own, which are precisely under similar circumstances,—for otherwise there is a gap, an enormous *gap*), throw all their sternmost ships into confusion, whilst *he* gets clear, maintains *his* order, and forces *them* to leeward.

* See Steel's Seamanship, Second Edition, London, 1807, pages 131 and 140.

Thus we perceive by his *plates*, and learn from his *text*, that all the attacking, and, as they ought to be, well battered ships, fetch unhurt through one and the same interval, to the weather beam of this easily defeated enemy ! Mr Clerk's notion is this; that whatever part of a windward fleet standing athwart, the ships of a lee line may have it in their power to fetch,—whether the rear, or the centre, or the van, they, by keeping their wind, will either force their way through one and the same interval, or otherwise, by getting foul, not only stop the course of all the enemy's ships, but likewise throw all those astern into complete confusion ; and in whichever case this may happen, that the enemy's sternmost ships must be intercepted and captured. This theory, as a practical maxim for future guidance, is deduced from the observations given by Mr Clerk on Admiral Byng's engagement in 1756, in the following words :—While matters were going on after this manner in the van, the Intrepid, one of the van ships, having lost her fore-top mast, was so taken aback, that her course was stopped. This, *of consequence*, produced a disorder and stoppage in the ship's next astern, some designing to go to leeward, and others endeavouring to go to windward, of the distressed ship."

From this " observation" we are referred to article 19, p. 32, Clerk's book, where we find this piece of *mismanagement—gross mismanagement*—drawn into a " *Demonstration*" for the guidance of the British Navy, in these words :

" It is evident, that should any ship be crippled, her way must of consequence be stopped, and occasion confusion amongst the ships astern, some moving to leeward, others endeavouring to get to windward, and those ahead (never looking behind them) running away from the rear. It is in vain that it had been laid down as an instruction, 'the stoppage of one ship need not necessarily produce a stoppage in every ship astern.' Mr Clerk *illustrates his theory* by the errors of the Intrepid ! The misconduct, not only in the handling of *that* ship, but in the management of her followers, who did not immediately pass her, and close up their intervals, should be condemned in the severest terms, and the heaviest censure pronounced upon such errors by every person engaged in tactical investigation. This theory is not only tactically erroneous, in the very first principles of the science, but it is highly dangerous to the country, that a book containing such doctrine should be so much cried up and advocated as this has been, without pointing out its great and manifold errors. This is proved by an investigation of Paul Hoste, Art. III. of his *Tactique Navale.*" Sir H. Douglas remarks, that " he (Mr Clerk) causes the enemy to remain apparently at rest ; makes no allowance for relative movement and position ; greatly accelerates his own speed ; extends prodigiously the enemy's line ; contracts his own, and assumes, that the contact of any two ships getting foul of each other will be partial to him, as all the other circumstances are assumed to be. Mr Clerk has here, therefore, not only committed a capital error in tactical principle, but supposes one of a still greater degree on the part of his adversary."

Again, page 62,—

" Mr Clerk's doctrine of cutting the line from the leeward, therefore, proceeds upon the assumption of the grossest misconduct on the part of his enemy, or comes practically to this,—a *melée*, in which Mr Clerk asserts, that, without sacrificing the activity, or compromising the safety, of any of his own ships, by running foul of the enemy's vessels, he must disable and detain them and their followers, but not his own, and so cripple the enemy's ships and ruin their fleet. Truly there is no science in this. Such a mode of fighting would be going back to the times of the ancients. Skirmishing with three decked ships as if they were galleys! Totally unqualified in practical knowledge, either of gunnery or seamanship, to treat this matter rightly, it is not surprising that Mr Clerk should have formed some strange and erroneous notions on the service, practice, capabilities, and comparative effects, of naval ordnance. So far was that commentator from having taught the British navy how to know and use their force, properly considered, he was so little skilled in what he undertook to explain and demonstrate, as to be incompetent to detect the serious errors that were committed by sail as well as by gun—in evolution and explication—in the very cases to which he refers.

"Mr Clerk likewise enumerates, as one of his demonstrations, that when the ships of a weather fleet are brought to at their position, the shot from the lee fleet, by the lying along of its ships, will be thrown up in the air, and have an effect at a much greater distance; whereas the shot from the windward fleet, from the lying along of its ships, will be thrown into the water, and the effect lost. This very extravagant conclusion, called a 'Demonstration,' appears to have been drawn from Admiral Byron's account of his engagement of the 6th of July 1779."

Sir Howard Douglas then enters into an explanation of these errors, and shews, as well he might, that they were attributable to a total ignorance of naval gunnery.

"Mr Clerk was in a great mistake in supposing that the French made it a *rule* to throw the whole effect of their shot into the rigging of their enemy. That practice was the effect of *random errors* in gunnery, just such as those upon which Mr Clerk proceeds."

Sir Howard Douglas, in page 75 of his Naval Evolutions, remarks:

"It is entirely owing to the injudicious attempts of the Professor (Playfair), and the (well known though anonymous) reviewer (in the Edinburgh Review), who have thought proper to urge Mr Clerk's performances out of all place, by representing them as evincing a superior degree of learning and skill *in nautical war*, to any such qualifications possessed by those professional men with whom Mr Clerk has been unwisely put in competition, and to the disparaging tendencies of the pleadings and conclusions of the reviewer, in particular, that these strictures on his client's work are owing. I may appeal to former writings, to show that I have forborne to notice the manifold errors and defects which are to be found in that work; and I deny not 'that it is a wonderful work for a landsman, who had never been at sea in his life, to have written.' But, when the contents of this book are cited by his advocates, thus to depreciate the skill of the eminent officers concerned, and doctrine such as the preceding is cried up as evidence of that superiority, I am obliged to show cause against the pretensions urged for the author as a learned teacher of naval tactics, though by no means disposed to refuse my tribute of respect for the ability and industry evinced by the acute but inexperienced commentator—the ingenious but erring amateur."

Instead of sketching the argumentation of Sir Howard Douglas, we have, by these quotations, rather chosen to make him speak for himself, and consequently there is little cause to fear that we have misrepresented his reasoning; and we terminate our present remarks with the following paragraph from p. 77.

"To the Editor of the Edinburgh Review I have peculiar, and, I trust, praiseworthy, motives for transmitting him a copy of this memoir. The writer tells us, page 3, that the reviewers, being Scotchmen, are disposed to maintain their original opinion, that their countryman Mr Clerk was the original proposer to the profession of the manœuvre of breaking the line;—that if it had not been for that learned gentleman, it never would have been known;—that Professor Playfair's record is true; and that, therefore, the victory gained on the great day in question is chiefly to be ascribed to Mr Clerk. Now I, being a Scotchman too, have no less disposition to *prove that* opinion to have been made up on erroneous and utterly untrue hypotheses; and determine, accordingly, to shew cause why *that* opinion cannot, consistently with truth and justice, be maintained. I call upon the editor of that journal, in particular, and upon the public press every where in the *land of my sires*, to hear me—to read me—to consider *my facts;* and then to say, whether an opinion formed *ex parte*, upon *hearsay*, *inference*, *manifest mistake*, and *groundless record*, is to prevail, to the prejudice of, I think, as good and true a Scot as ever lived. I love and honour my country; I laid my father's ashes in the dust there; and I do hope, with the blessing of God, and a just regard of my efforts by those who preside over the public journals, to gather his remains together, in an honorary sense, and deposit them in one of the niches of that temple which is destined to adorn the capital, and perpetuate the fame of the heroes and worthies of Caledonia."

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.

Dec. 10. 1832.

Manettia cordifolia.

M. *cordifolia;* glaberrima; caule suffruticoso, volubili, ramis teretibus; foliis cordatis, acuminatis, utrinque nitidis; stipulis amplexicaulibus, acuminatis; pedunculis axillaribus, unifloris, folio longioribus; calyce 4-lobo, lobulis minimis interjectis; corolla fauce nuda, dilatata.

Manettia cordifolia, *Mart.* Spec. Mat. Med. Bras. 1. 19. t. 7.—*De Cand.* Prodr. iv. 363.—*Bot. Mag.* 3202.

Manettia glabra, *Chamisso et Schlecht*, Linn. 1829, p. 169.—*De Cand.* Prodr. iv. 363.

Description.—Whole *plant* glabrous. *Stem* suffruticose, much branched, very slender, round, twining; *bark* grey and exfoliating, on the young shoots green, glabrous, and shining. *Leaves* (2 inches long, 1 inch broad but gradually smaller, and the uppermost about 4 lines long, 2 lines broad while the low and largest on a vigorous cultivated specimen are 4 inches long and nearly 2½ broad,) opposite, petioled, cordate, acuminate, glabrous on both sides, shining, pale, with prominent veins and obscure minute reticulations below, dark, and the veins slightly channelled above. *Stipules* small, subulate, and at length often reflexed in their upper half, bases broad and connate within the petioles, so as to form a small cup, which is occasionally toothed, round the branch. *Peduncles* elongated, solitary, glabrous, filiform, shining, and single-flowered, at the extremities of the branches, which are subsequently elongated, rendering the peduncle axillary. *Calyx* green, glabrous, 4-parted, with minute divided intervening teeth; segments acute, at length reflected, 1-nerved. *Corolla* (fully 1½ inch long, 3½ lines across the revolute limb) very handsome, shining on the outer surface, and glabrous every where, except a little above its base on the inside, where, for some distance, it is densely clothed with inverted white hairs; tube clavato-funnel-shaped, with four flat sides, nectariferous and only colourless at the base, every other part of the corolla vermilion-orange coloured, deepest on the inner side of the limb, green in the young buds, throat dilated and naked; limb 4-parted, segments deltoid, revolute. *Stamens* four, alternating with the segments of the corolla; filaments colourless, adhering to the tube throughout its whole length, the free portion slightly connivent, and rather shorter than the segments of the limb; anthers versatile, oblong, purple, inserted by the back, bursting along the front of the cells, which are distant in the middle, connivent at the extremities; pollen green. *Germen* inferior, green, compressed, bilocular, crowned by a white depressed disk, which rises above the insertion of the corolla. *Style* rather longer than the stamens, exserted, colourless, filiform. *Stigma* green, blunt, of two erect parallel lobes. *Ovules* numerous, erect, on erect free columnar receptacles, one rising into each loculament from near the base of the dissepiment. *Capsule* ovate, compressed, channelled on both sides, crowned by the persisting indurated calyx, bivalvular, bilocular, opening by a division of the dissepiment; valves boat-shaped, nerved, and each splitting into two teeth at the apex. *Seeds* brown, round, flattened, and surrounded by a membranous wing.

This truly beautiful plant, the bright vermilion of whose corolla surpasses immeasurably the colouring of the Botanical Magazine, was raised from seed sent by Mr Tweedie from Buenos Ayres, and first showed flower in the stove of Mr Neill's garden at Canonmills, in August last. Another and stronger specimen is just now (10th October) opening its first blossoms, and being covered with a profusion of buds in every stage, it promises to be exceedingly ornamental during many weeks *. My native specimens, obligingly communicated by Mr Tweedie, are from the woods of the Uruguay. The seeds were gathered in the province of Entre Rios, on the banks of the Arroya de la China, a stream which enters the Uruguay. The dilated naked throat of the corolla forms a remarkable exception to the generic character, as drawn by Jussieu in Memoires du Museum, 1820, p. 384, and the 4-sided tube of the corolla, with the connivent filaments, are at variance with the generic character given by De Candolle, l. c.

Milla uniflora.

M. *uniflora;* scapo unifloro; spatha bifida, inæquali; capsula clavata, apice depressa.

Description.—*Bulb* ovate, forming new ones at the base. *Leaves* (1 foot long, 2½ lines broad) all radical, glaucous, glabrous, linear, concave in

* This account I originally drew up for the Botanical Magazine at the date here mentioned, and it is published fol. 3202. of that work. I am now able to state, that the expectation of the protracted beauty of the species has been confirmed: it continued in flower to the end of November, and, even now, is covered with a profusion of buds.

their upper surface, keeled below, blunt. *Scape* (4–5 inches high) erect, glabrous, green, very slightly compressed. *Spathe* bidentate, segments connivent, rather unequal in length, and the division extending farther down on one side than the other. *Peduncle* generally longer than the spathe, nearly cylindrical, green. *Corolla* (1½ inch across when expanded) 6-cleft, marked from the base of the tube to the apex of the segments with six dark lines, which are purplish-green behind, lilac in front; tube clavate, naked; segments of the limb rather longer than the tube, spreading, ovate, acute, their sides involute at the apex, imbricated, the inner segments the narrowest. *Stamens* six, of unequal length, adhering to the tube to unequal heights, subcompressed; anthers yellow, oblong bifid at both ends, lobes acute; pollen yellow, granules minute. *Stigma* capitate, small, white, pubescent. *Style* included, grooved. *Germen* superior, rather shorter than the style, oblong, 6-furrowed, 3-locular. *Ovules* numerous, green, placenta central. *Capsule* clavate, depressed at the apex.

The bulbs of this very pretty plant, every part of which emits the smell of onions when bruised, were procured by Mr Neill from Mr Tweedie at Buenos Ayres, in June last, and flowered in the greenhouse at Canonmills. A few plants were also raised from seeds, communicated by the same valuable correspondent.

I have had some hesitation in considering it distinct from *Milla biflora* of Cavanilles; but as the plants, of which Mr Neill possesses a considerable number, are vigorous and healthy, have been in flower during a great part of the season, and have never shown the least tendency to divide the scape in a single instance, I have been led to consider them specifically different. Perhaps the difference of the station of this plant and that of Cavanilles, may add to the probabilities against their identity; but we know that there are species common to the Floras of Mexico and La Plata.

Nierembergia intermedia.

N. *intermedia;* erecta, glanduloso-pubescens; ramis patulis; foliis oblongo-spathulatis, sessilibus; corolla subregulari, infundibuliformi, fauce dilatata, calyce duplo longiori.

Description.—*Plant* herbaceous, perennial, the whole, excepting the inside of the corolla, minutely but densely glanduloso-pubescent. *Stem* (in a young plant about a foot high) erect, much branched, branches spreading, ascending. *Leaves* (1½ inch long, 4 lines broad) scattered, numerous, spreading or reflected, oblongo-spathulate, subavenous, with a distinct middle rib behind, somewhat keeled near the base, concave or flat above. *Peduncles* (1 inch long) solitary, filiform, from the side of the clefts in the branches. *Calyx* persisting, 5-parted, angular; segments spreading, foliaceous, linear, blunt. *Corolla* (9 lines long, and 9 lines across) funnel-shaped, twice the length of the calyx, rich purple, darker and dotted towards the throat, which is dilated, yellow, paler on the outside; limb nearly regular, 5-lobed, lobes blunt, the upper ones reflected rather more than the lower; tube inflated, clavate, about equal in length to the calyx. *Stamens* 5, of unequal length, the longest as long as the tube of the corolla; anthers short, oblong, lobes much divaricated, bent back, and approaching each other below, yellow; pollen-granules minute, round, yellow. *Seeds* brown, angled, muricated on the outer edge.

Seeds of this plant, which is exceedingly pretty, and very well deserving of cultivation, were received by Mr Neill from Mr Tweedie at Buenos Ayres in 1832, and the first specimen brought into flower in the stove at Canonmills in the end of September. It seemed to be about to flower very freely, but probably, on account of the season, all the buds dropped excepting one, which perfected its flower and seeds. It strikes very readily by cuttings, and will probably thrive well in a dry light greenhouse.

A better example than this plant cannot be wished by Mr David Don, in confirmation of his opinion expressed in the last Number of this Journal, and in Sweet's British Flower Garden, fol. 172., of the generic identity of *Nierembergia* and *Petunia.* The habit of this plant is wholly that of

Nierembergia, the flower in shape and structure precisely that of *Salpiglossis integrifolia* of Hooker, *Nierembergia phœnicea* of Don.

Scilla villosa.

S. *villosa ;* foliis lanceolatis, laxis, villosis ; racemis corymbosis ; bracteis, lanceolatis, pedunculos æquantibus.—*Sprengel.*

Scilla villosa, *Desfontaines,* Fl. Atlant. 1. 299. t. 85. f. 2.—*Pers.* Synops. 1. 365.—*Sprengel,* Syst. Veget. 2. 67.

Description.—*Bulb* ovate, coated, about the size of a small onion, truncated below, strong wrinkled nearly straight roots descending from within the edge, their branches spreading and villous. *Leaves* (3 inches long, half an inch broad) about four, all radical, spathulato-lanceolate, attenuated at the base, and there concave in front, nearly flat above, spreading, more or less ciliated with rather long but unequal spreading hairs, and more sparingly villous on the upper surface, glabrous below, and there purple in the lower half, involute at the apex, giving the appearance of a mucro. *Scape* (1½ inch long below the first pedicel) erect, shorter than the leaves, nearly round, glabrous, pale green. *Bracteæ* (7 lines long) single, lanceolate, attenuated at the apex, persisting. *Racemes* corymbose, few (5–7) flowered; pedicels erect, stout, resembling the scape, each springing from the axil of a bractea, embraced by it at the base, and equal to it in length in the native specimens, in the cultivated twice as long as it. *Corolla* (9 lines across) 6-petaled, spreading; petals ovate, attenuated at the base, each with a small tuft of crystalline tomentum at the apex, pale lilac, with a broad deep green stripe in the centre below. *Stamens* shorter than the petals, rising from their bases, and adhering to these by their backs for a little way; filaments lilac, tumid in the middle, slightly concave in front, and nectariferous ; anthers versatile ; pollen yellow. *Pistil* equal in length to the stamens, of a dull purplish-green ; stigma small, terminal, villous ; style short, conical, 6-furrowed ; germen ovate, 6-furrowed, the alternate furrows hairy, 3-locular, the dissepiments double, being formed by a duplicature of the inner membrane, opposite to the hairy lines on the germen, and alternate with the sutures ; ovules globular, several in each loculament, receptacle central.

Dried specimens of this pretty little plant, which, no doubt, will bear cultivation in a warm border in the open air, I received from my friend Dr Dickson in 1831, having been gathered by him in the neighbourhood of Tripoli. Among the specimens, some of the bulbs yet retained life. These were planted in the stove at the Botanic Garden, Edinburgh, and flowered there in November.

Sisyrinchium macrocephalum.

S. *macrocephalum ;* scapo simplici, ancipiti ; foliis omnibus radicalibus, ensiformibus ; fasciculis pedunculatis, congestis, lateralibus, multifloris, bractea brevioribus.

Description.—*Leaves* (2½ feet long) all radical, linear-swordshaped. *Scape* longer than the leaves, terminated by an acute erect bractea (5 inches long). *Flowers* in numerous fasciculi from the base of the bractea ; fasciculi supported on short flattened peduncles, and having many imbricated bracteæ similar to the primary one, but much smaller. *Pedicels* triquetrous, about as long as the secondary bracteæ. *Corolla* (1½ inch across when expanded) 6-parted, glabrous, deep yellow, segments imbricated, spreading, ovato-lanceolate, tipped with a slender point, almost aristate, nerved, the middle nerve larger than the others, greenish. *Stamens* less than half the length of the corolla ; filaments monadelphous, very short, diverging where free ; anthers spreading, oblong, bifid at the base ; stigmata minute ; style shorter than the stamens, trifid, segments spreading. *Germen* green, obovate, trigonous, trilocular. *Ovules* numerous, with a central receptacle.

Raised from seed received by Mr Neill from Mr Tweedie, Buenos Ayres. Flowered in the greenhouse during August and September, having frequently many flowers expanded at a time, and forming a very handsome addition to the known species.

Celestial Phenomena from January 1. *to April* 1. 1833, *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.*

JANUARY.

D.	H.	′	″	
1.	15	36	–	☌ ♀ γ ♑
1.	17	34	12	☌ ☽ μ Ceti.
2.	10	41	8	☌ ☽ ♂
3.	4	23	–	☌ ♀ δ ♑
3.	12	28	15	☌ ☽ 1 δ ♉
3.	12	57	8	☌ ☽ 2 δ ♉
3.	13	30	50	☌ ☽ 3 δ ♉
3.	17	7	52	Em. I. sat. ♃
4.	6	50	56	☌ ☽ m ♉
4.	18	3	43	☌ ☽ ζ ♉
5.	0	29	0	☌ ☽ 1 χ Orionis.
5.	8	7	50	☌ ☽ η ♊
5.	11	8	35	☌ ☽ μ ♊
5.	13	26	45	☌ ☽ ν ♊
6.	2	26	26	☌ ☽ ζ ♊
6.	7	38	44	○ Full Moon.
6.	8	18	13	☌ ☽ δ ♊
6.	19	14	40	Im. III. sat. ♃
7.	15	47	49	☌ ☽ δ ♋
10.	18	3	2	☌ ☽ ν ♍
10.	19	3	46	Em. I. sat. ♃
11.	2	42	37	☌ ☽ ♄
12.	23	23	30	☾ Last Quarter.
14.	12	22	0	☌ ☽ 2 ξ ♎
15.	7	2	4	☌ ☽ γ ♎
15.	11	8	18	☌ ☽ η ♎
15.	14	9	–	☿ greatest W. elong.
15.	15	46	55	☌ ☽ ϑ ♎
17.	8	58	23	☌ ☽ ρ Oph.
17.	19	28	36	☌ ☽ D Oph.
17.	20	53	–	☌ ♀ λ ♒
18.	9	38	6	☌ ☽ 1 μ ♐
18.	17	25	14	☽ very near ☿
19.	4	49	47	☌ ☽ 2 ν ♐
19.	6	6	28	☌ ☽ 2 ξ ♐
19.	9	23	31	☌ ☽ o ♐
19.	11	44	5	☌ ☽ π ♐
20.	5	17	18	☉ enters ♒
20.	18	20	20	Em. I. sat. ♃
20.	21	51	58	● New Moon.
22.	3	13	27	☌ ☽ ι ♑
22.	9	58	43	☌ ☽ ♅
22.	12	10	10	☌ ☽ γ ♑
22.	15	41	41	☌ ☽ δ ♑
22.	20	45	–	☌ ☽ φ ♒
23.	1	33	27	☌ ☽ ι ♒
24.	14	42	16	☌ ☽ 2 ψ ♒
24.	15	15	29	☌ ☽ 3 ψ ♒
24.	17	6	38	☌ ☽ ♀
25.	14	4	56	☌ ☽ r ♓
25.	15	52	56	☌ ☽ s ♓
26.	0	11	26	☌ ☽ ♃
26.	17	24	19	Em. I. sat. ♃
27.	18	20	31	☌ ☽ ν ♓
28.	10	16	30	☌ ☽ 1 ξ Ceti.
28.	17	47	5	☌ ☽ 2 ξ Ceti.
29.	0	45	10	☽ First Quarter.
29.	1	54	11	☌ ☽ μ Ceti.
30.	10	10	12	☌ ☽ ♂
30.	22	17	54	☌ ☽ 1 δ ♉
30.	22	47	48	☌ ☽ 2 δ ♉
30.	23	22	48	☌ ☽ 3 δ ♉
31.	16	46	30	☌ ☽ m ♉

FEBRUARY.

D.	H.	′	″	
1.	4	49	24	☌ ☽ ζ ♉
1.	11	24	53	☌ ☽ 1 χ Orionis.
1.	19	14	36	☌ ☽ η ♊
1.	22	19	13	☌ ☽ μ ♊
2.	13	52	47	☌ ☽ ζ ♊
2.	19	19	58	Em. I. sat. ♃
2.	19	48	51	☌ ☽ δ ♊
4.	1	31	34	☌ ♀ ♃
4.	3	21	27	☌ ☽ δ ♋
4.	18	33	52	○ Full Moon.
7.	3	51	31	☌ ☾ ν ♍
7.	10	6	–	☌ ☉ ♅
7.	11	57	22	☌ ☽ ♄
8.	0	12	–	☌ ♂ 1 A ♉
10.	19	10	21	☌ ☽ 2 ξ ♎
11.	13	16	46	☾ Last Quarter.

FEBRUARY—*continued.*

D.	H.	′	″		D.	H.	′	″	
11.	13	26	53	☌ ☽ γ ♎	21.	5	53	–	☌ ♀ 1 ζ ♓
11.	17	28	50	☌ ☽ η ♎	21.	18	3	52	Em. II. sat. ♃
11.	18	13	13	Em. III. sat. ♃	21.	19	59	11	☌ ☽ τ ♓
11.	22	2	1	☌ ☽ ϑ ♎	22.	5	29	17	☌ ☽ ♃
13.	14	53	9	☌ ☽ ρ Oph.	23.	14	47	10	☌ ☽ ♀
14.	1	22	11	☌ ☽ D Oph.	24.	0	17	0	☌ ☽ ν ♓
14.	15	42	46	☌ ☽ 1 μ ♐	24.	16	21	28	☌ ☽ 1 ξ Ceti.
15.	10	21	2	☌ ☽ 1 ν ♐	24.	23	57	44	☌ ☽ 2 ξ Ceti.
15.	10	47	17	☌ ☽ 2 ν ♐	25.	8	12	19	☌ ☽ μ Ceti.
15.	12	4	13	☌ ☽ 2 ξ ♐	26.	21	34	–	☌ ♀ π ♓
15.	15	18	36	☌ ☽ ο ♐	27.	5	40	36	☌ ☽ 1 δ ♉
15.	17	43	7	☌ ☽ π ♐	27.	6	11	26	☌ ☽ 2 δ ♉
17.	22	46	–	☌ ☿ ♅	27.	6	47	46	☌ ☽ 3 δ ♉
18.	9	41	–	☌ ☿ γ ♑	27.	8	7	33	☌ ☽ ε ♉
18.	12	26	–	☌ ♀ ε ♓	27.	13	14	10	☽ First Quarter.
18.	16	35	4	☌ ☽ ♅	27.	13	28	38	☌ ☽ ♂
18.	19	38	24	☉ enters ♓	27.	16	43	–	☌ ♂ τ ♉
19.	5	33	41	☽ near ☿	28.	0	46	6	☌ ☽ m ♉
19.	10	24	–	☌ ☿ δ ♑	28.	13	14	54	☌ ☽ ζ ♉
19.	17	22	4	● New Moon.	28.	20	4	54	☌ ☽ 1 χ Orionis.
20.	3	42	–	☌ ♂ 1 ν ♉					

MARCH.

D.	H.	′	″		D.	H.	′	″	
1.	4	12	3	☌ ☽ η ♊	18.	1	57	10	☌ ☽ ♅
1.	7	23	30	☌ ☽ μ ♊	18.	4	17	30	☌ ☽ δ ♑
1.	23	31	0	☌ ☽ ζ ♊	18.	14	10	36	☌ ☽ ι ♒
2.	5	39	17	☌ ☽ δ ♊	20	20	20	8	☉ enters ♈
3.	2	3	–	Sup. ☌ ☉ ☿	20.	20	14	–	☌ ☿ ε ♓
3.	14	8	24	☌ ☽ δ ♋	21.	10	55	16	● New Moon.
6.	4	45	46	○ Full Moon.	22.	0	20	17	☌ ☽ ♃
6.	15	6	43	☌ ☽ ν ♍	22.	17	30	8	☌ ☽ ☿
6.	16	54	–	♀ greatest E.	23.	6	8	33	☌ ☽ ν ♓
6.	19	14	39	☌ ☽ ♄ [elong.	23.	22	4	51	☌ ☽ 1 ξ Ceti.
10.	4	10	25	☌ ☽ 2 ξ ♎	24.	5	37	49	☌ ☽ 2 ξ Ceti.
10.	21	52	26	☌ ☽ γ ♎	24.	13	19	30	☌ ☽ μ Ceti.
11.	1	47	5	☌ ☽ η ♎	25.	2	16	24	☌ ☽ ♀
11.	6	13	10	☌ ☽ ϑ ♎	26.				♀ greatest elong.
12.	22	2	35	☌ ☽ ρ Oph.	26.	11	18	4	☌ ☽ 1 δ ♉
13.	5	40	40	☾ Last Quarter.	26.	11	48	57	☌ ☽ 2 δ ♉
13.	8	20	19	☌ ☽ D Oph.	26.	12	26	15	☌ ☽ 3 δ ♉
13.	22	17	58	☌ ☽ 1 μ ♐	26.	13	47	0	☌ ☽ ε ♉
14.	16	55	22	☌ ☽ 1 ν ♐	27.	19	17	43	☌ ☽ ζ ♉
14.	17	21	27	☌ ☽ 2 ν ♐	27.	21	54	3	☌ ☽ ♂
14.	18	37	47	☌ ☽ 2 ξ ♐	28.	2	15	55	☌ ☽ 1 χ Orionis.
14.	21	50	54	☌ ☽ ο ♐	28.	7	5	–	☿ greatest E.
15.	0	14	28	☌ ☽ π ♐	28.	10	34	6	☌ ☽ η ♊ [elong.
15.	12	1	17	☍ ☉ ♄	28.	13	49	8	☌ ☽ μ ♊
16.	12	11	4	☌ ☿ ♃	28.	22	37	34	☽ First Quarter.
17.	15	55	43	☌ ☽ ι ♑	29.	12	43	55	☌ ☽ δ ♊
18.	0	48	51	☌ ☽ γ ♑					

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

JANUARY.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′
1	10 57	20 11 S.	14 46	16 43 S.	20 28	20 7 N.	16 50	4 5 S.	5 14	2 48 N.	14 33	16 33 S.
5	10 38	20 27	14 49	15 3	20 15	20 17	16 37	3 50	4 59	2 49	14 18	16 29
10	10 29	21 12	14 52	13 49	19 58	20 31	16 20	3 30	4 39	2 51	13 59	16 24
15	10 27	22 1	14 55	10 29	19 44	20 49	16 4	3 8	4 20	2 53	13 41	16 19
20	10 31	22 38	14 56	8 1	19 29	21 9	15 47	2 46	3 59	2 57	13 22	16 14
25	10 40	22 53	14 59	5 30	19 16	21 30	15 31	2 22	3 39	3 1	13 2	16 9

FEBRUARY.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′
1	10 54	22 35 S.	15 1	1 52 S.	18 58	22 1 N.	15 9	1 48 S.	3 10	3 9 N.	12 37	16 2 S.
5	11 3	21 55	15 1	0 11 N.	18 48	22 20	14 56	1 29	2 54	3 14	12 20	15 57
10	11 17	20 38	15 2	2 48	18 36	22 43	14 40	1 3	2 34	3 22	12 4	15 52
15	11 29	18 48	15 2	5 23	18 26	23 6	14 24	0 36	2 13	3 29	11 46	15 46
20	11 44	16 22	15 1	7 54	18 17	23 29	14 9	0 9 S.	1 52	3 38	11 27	15 41
25	11 58	13 21	15 1	10 20	18 6	23 50	13 53	0 19 N.	1 31	3 47	11 8	15 36

MARCH.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′
1	12 13	9 48 S.	15 1	12 13 N.	17 59	24 5 N.	13 41	0 40 N.	1 15	3 56 N.	10 54	15 32 S.
5	12 21	6 32	14 59	14 2	17 52	24 20	13 33	1 3	0 58	4 3	10 39	15 28
10	12 37	2 5 S.	14 58	16 10	17 43	24 36	13 16	1 31	0 36	4 13	10 21	15 23
15	12 52	2 35 N.	14 57	18 10	17 35	24 50	13 0	2 0	0 15	4 23	10 2	15 18
20	13 4	7 4	14 55	20 1	17 26	25 1	12 43	2 28	23 54	4 32	9 43	15 13
25	13 11	10 50	14 52	21 38	17 17	25 9	12 27	2 57	23 33	4 42	9 23	15 9

On the 6th of JANUARY, the Moon will be eclipsed, *partly visible:*

		D.	H.	′	″
The Eclipse begins,	January	6.	6	35	48,4
Middle, ...			7	46	21,0
Moon's upper limb set, ...			8	30	58
End of the eclipse, ...			8	56	53,6

Digits eclipsed, 5 dig. 42′ 49″,5 on the north part of the Moon's disc.

SCIENTIFIC INTELLIGENCE.

METEOROLOGY.

1. *Extract of Letter from Mr James Mackintosh, Principal Lightkeeper, Corsewall, to R. Stevenson, Esq., containing notice of a Water-Spout.*—On the 5th October 1832, a line of dark clouds had formed on the Irish shore about noon, which shore they gradually coasted till opposite Cantyre, to which they crossed; from thence they passed to Arran, and then direct to Lochryan (where Corsewell is situate). They reached Lochryan at 5 P. M. At that time I observed a thick dark column as if suspended from the darkest part of the cloud, its lower end being detached a small space from the water below. The column revolved from east to west, and the water immediately below was in terrible commotion, while all around was smooth and calm. The column passed near to two smacks which were lying off Ballantrae. Before it reached the entrance to the loch, the column was either expended or absorbed by the cloud above; and as it rose, its motion increased in violence. From the time the column was first observed till its disappearance fifteen minutes elapsed. Fahrenheit's thermometer 51°; barometer 28·90.

2. *Molybdena and Copper in Meteoric Iron.*—Professor Stromeyer has discovered in iron in a meteoric stone from the Caspian, besides nickel and cobalt, also molybdena and copper.

3. *Barbadoes Hurricane of* 1831.—In the hurricane that swept across the Island of Barbadoes between sunset of the 10th and sunrise of the 11th of August 1831, property to the amount of £2,311,729 was destroyed; the number of killed and who died from injuries received, was 2500; and at least 5000 persons were wounded.

ZOOLOGY.

4. *Comparative Temperature of Whites and Negroes.*—In a manuscript memoir on his voyage to Central Africa, presented to the Academy of Sciences by M. Douville, he has mentioned some experiments on the difference which exists between the temperature of these two races, according to age, sex, &c. These experiments, although in some points imperfect, are, in many, highly interesting. The researches were made in Africa. M. Douville ascertained the temperature of a number of persons at 7 o'clock A. M., before they had been exposed to the sun. Some of the results follow:

1. A White, . .	aged 12 years,	= $29\frac{1}{4}$° Reaumur.
2. A Negro, . .	... 12 ...	= $31\frac{1}{2}$
3. A White, . . .	... 20 ...	= 29
4. A Negro, . .	... 20 ...	= 31
5. A White Woman, .	... 14 ...	= $29\frac{3}{4}$
6. A Negress, . .	... 14 ...	= $32\frac{1}{4}$

Whence results, that, *cæteris paribus*, the Negro possesses more animal heat than the white. M. Douville considers that there is a relation also between the development of heat and of the intellect. Thus the temperature of

1. A stupid, slothful Negro,	aged 18 years,	= $29\frac{11}{12}$° Reaumur.
2. A lazy Negro, . .	... 18 ...	= $29\frac{8}{12}$
3. An intelligent Negro,	... 18 ...	= $29\frac{4}{12}$
4. An active and intelligent Negro,	... 18 ...	= $29\frac{1}{12}$

As the passions of the Negro cool with age, he loses a great deal of this excessive heat. He grows old very soon, and at thirty is as aged as a European at fifty-five or sixty years. It is rare to meet a Negro older than forty years; but still the old Negro has a higher temperature than the white in his prime of life. It results from the researches of M. Douville, that the temperature of the Negro is, *cæteris paribus*, much superior to that of the white; that the heat of Negresses is greater than that of Negroes up to the fifteenth year of their age, but after that period less, but still greater than that of whites; that the Negroes diminish in temperature as they grow old; and, finally, that the old Negroes have a still higher temperature than the whites.

5. *Stature of the Human Race.*—Contrary to what occurs among domestic animals, variations of stature in the human race are included in much narrower limits than individual variations. The size of women is less variable than that of men. They are much smaller than men among people of large stature, while the difference in size between the sexes is very small among people of low stature. The people who are most remarkable for their great height, generally inhabit the southern hemisphere, and, as has long been known, those who are distinguished for lowness of stature almost all reside in the northern hemisphere. Among the people of the greatest height some live on the southern part of the American continent, others in various archipelagos of the Southern Ocean; and it may even be remarked that they thus form in the southern hemisphere two series, one continental, the other insular, both irregular and often interrupted, but commencing in each at eight or ten degrees of south latitude, and terminating at about fifty degrees. There exist, however, in the southern hemisphere, people whose height is below the mean, and reciprocally in the northern, those whose height surpasses the mean. Now, in comparing the geographical position of these people with those who are extremely tall or extremely short, we arrive at the result apparently paradoxical, and yet in part of easy explanation, that the short race live almost every where near the tallest nations, and reciprocally, the tallest people near those nations who are the most remarkable for their low stature. The diversity of stature in the human race may be explained (but in part only) by the influence of climate, of dietetic regimen and mode of life. It is at least extremely probable that the size of the race, notwithstanding some local variations, has not sensibly diminished; and this, not only from the concurrence of so many kinds of proofs as are derivable from historical evidence from the earliest known periods, but from considerations of science, in the absence of all monuments, it may be inferred that there has been no material change since the origin of mankind.—*Isidore Geoffroy Saint Hilaire, Rev. Encyc. Jan.*

6. *Gelatine of Bones.*—A memoir presented to the French Academy, by Mr Donné, having thrown some doubt upon the

wholesomeness of gelatine, M. Darcet made the following summary. Butchers' meat contains, per 100 lbs., at a medium—

Dry meat,	24
Water,	64
Bones,	12
Total,	100

Bones contain, per hundred,—

Earthy matter,	60
Gelatine,	30
Fat,	10
Total,	100

Thus, the 15 parts of bones in butchers' meat may furnish 6 parts of pure animal substance, and therefore 100 lbs. of meat, which commonly yield but 24 lbs. of alimentary substance, may furnish 30 lbs., if care be taken to extract the whole. It is obvious, therefore, that four head of cattle may supply as much nutriment as is now obtained from five. This is an enormous waste; and to prove the wholesomeness of gelatine, M. Darcet states, that a committee of the faculty of medicine, composed of Leroux, Dubois, Pelesten, Dumeril, and Vanquelin, distributed jelly to forty patients, and reported, 1*st*, That it was not only a great improvement as an article of diet, but economical, and that to an extent which ought not to be overlooked; 2*d*, That soup made with gelatine was at least as agreeable as the ordinary soup of hospitals; 3*d*, That gelatine is not only nourishing and easy of digestion, but very salutary, and is attended with no unpleasant effects on the animal economy. In the hospital of St Louis, there is an apparatus which furnishes 900 rations of broth per day. It has been in operation twenty months, and has supplied 550,800 rations of gelatinous solution, and various reports made to the administration testify to its value. At the Hotel Dieu 443,650 rations have been supplied, with the same result. These facts M. Darcet thinks ought, at least, to induce the academy to suspend its judgment, before it harbours a sentiment unfavourable to the wholesomeness and economy of gelatine.—*Rev. Encyc. Juin* 1831.

7. *Faraday on the Planariæ.*—From Dr Johnson's experi-

ments it appears, that, if an incision be made longitudinally into the head of the animal, so as to separate its eyes from each other, if the cut has not been carried very far down, it will heal in the ordinary manner; but, if the head be absolutely cleft in twain, then, according to the extent of the fissure, there will be a mass of new matter formed by each half of the head, which will either join the two halves together, forming a head of extraordinary size, and bearing in it one or two additional eyes; or each old half, thus cleft, will form the new matter into another half, with an eye; and so the animals have two complete and entire heads. If the fissure be carried farther down through the body of the animal, then not only will there be two heads but two bodies also formed, joined together only by the tail; and when this is the case, so little unanimity exists between these Siamoid twin-planariæ, that they never pull or swim the same way; and so violent are their efforts, that they frequently, in the course of two or three days, tear the only remaining bond or union, their tail, in sunder, and then two distinct and perfect animals result. If, in common planariæ, the head be cut entirely off, a new head will be formed; and, if their lower extremity be removed, it will produce a new tail. In a planaria, which, by the operation above described, had been invested with two heads, these "nova capita" were successively severed for three several generations, and were immediately and perfectly renewed, and subsequently the animal was cut through just below the artificial bifurcation, and then only a single head was produced; so that in this more than simple "capital" operation, a single headed animal became a biceps, and, after having the use of six heads in succession, was subsequently reduced to the possession of a single one. When one of these animals is cut in half, the head or anterior extremity swims away as if nothing had happened, and speedily retails itself; but the tail swims to the bottom, and remains torpid for two or three days, by which time it has formed for itself a head. If a planaria be cut into three pieces, the head will form a new body and tail, the tail a new body and head, and the middle section or body will produce both head and tail. If a quarter be removed by making a longitudinal section through the head, and half down the body, and then a semi-transverse cut to remove the upper quarter, not only will the three remaining quarters speedily reproduce a new fourth, but also the separate fourth will form to itself three new quarters. Indeed a planaria has been cut into as many as ten pieces, and each piece has become an entire and perfect animal. In fact, this mode of propagation, which physiologists artificially institute, seems to be frequently resorted to by the animal itself. The Planaria felina has been seen to throw off pieces of its body to form new animals; and these are not diseased, but healthy parts; and not only parts of its tail, but often offsets from its sides, &c. Indeed, the Planaria felina and P. arethusa have been never known to lay eggs; whilst the torva, lactea, &c. lay them in abundance, both the original animals and those artificially produced. It would seem that those species which inhabit springs and running waters propagate only by division; but those which dwell in ponds and ditches, where the water is occasionally exhausted, are oviparous, as well as viviparous. The above facts are physiologically curious, as they shew a still closer affinity than had previously been supposed to exist between the propagation of plants and animals by cuttings as well as seeds, for they have shewn that this mode of propagation can be carried to an almost equal extent in the one as in the other,—an extent to which the experiments of Trembley and others on polypi, star-fish, &c.) did not reach. —*Medical Gazette*, *Feb.* 1832.

8. *Presence of Entozoa in the Eyes of Animals.*—Hitherto, worms have been seldom, and in small numbers, found in the eyes of animals. M. Nordman has, however, met with them in all the eyes of fishes, reptiles, and birds. In the summer of 1829, he met with an immense number in most fishes. It is particularly in the vitreous humour, near the companula Halleri, and even in the crystalline lens, that he has observed them in groups of from 60 to 100 individuals. They are generally of a new genus of the Nematodes; he has also met with two new distomas, contained, as he say, in hydatids; and finally, very rarely a species of capularis.—*Dublin Medical Journal.*

9. *On the Formation of Pearls.*—Dr Baer of Koenigsberg rejects the old hypothesis, lately revived by Sir Everard Home,

which represents pearls as originating in abortive ova. The following are the results of Dr Baer's investigations: 1. In the fresh water mussels of Germany, though true pearls are rare, yet in most of the species which he has examined, he has occasionally succeeded in discovering them. 2. He has never met with them either in the ovaries, liver, kidney, or any of the internal organs. 3. The pearls were always situated either in or under the skin of the back, where it is close to the shell. 4. In the same part of the integuments, small coagulated isolated masses are often observable, exhibiting, however, no traces of organization. He conceives, that the pearls are the result of an ulterior formative process taking place in these isolated amorphous masses, and, although comparatively few of them eventually undergo this transformation, cannot be fairly urged as any objection to the truth of his hypothesis. He suggests, that those only may ultimately become enveloped with a layer of calcareous matter, which are nearest to the *external surface* of the integuments, the natural organization of which adapts it for such a secretion. This view of their formation is still farther supported by the fact of pearls having been found by other naturalists, not merely in the above described situation, but also in free or unattached portions of the integuments, or in mantle flaps. The observations of Reaumur in the Memoirs of the Academy of Paris (1717), as well as those of L. D. Herman, who spent many years in the investigation of this subject, tend to corroborate the opinion of Dr Baer. Even the drawing given by Home vouches for the correctness of the German physiologist, as the pearls in it are evidently placed in the integuments, namely, in that part of them which is opposite to the heart, and to which the ovary never extends. It is probable that, in some instances, the little soft masses already alluded to became coated externally with calcareous matter, thus accounting for the cavity observable in many pearls; whilst in others, on the contrary, they become infiltrated and saturated with the same material, and thus form solid pearls. That pearls are merely morbid concretions may, indeed, be considered as long-since satisfactorily made out; the peculiar merit of Professor Baer consists in directing attention to the soft coagulum which precedes their formation. The thicker the layer of mother-of-pearl on the inner surface of the shell, the more capable, he conceives, is the individual of converting these coagula into pearls. There is, he admits, another variety, originating in the presence of foreign bodies, such as grains of sand, &c. between the shell and the integuments, which become enveloped in a layer of pearly matter; and a third species, as is well known, may be generated by boring into the shell, or, indeed, originates sometimes without any external injury, merely in a diseased secretion of the mantle.—*Dublin Medical Report*, No. iv. p. 132.

10. *On the Reproduction of Nerves, by Tiedemann.*—It is a well known fact, that nerves, after having been cut through, have the power of uniting and growing together again. The phenomena observed in this process are the following: In the first place, the ends of the divided nerve recede from each other, so as to leave an interval of from about two to six lines, or more, between them. This is more striking in great than in small nerves. It does not depend on their elasticity, as some have imagined, but on the organic contractibility of tonicity of the neurilema, and of the surrounding and connecting cellular tissue. The proof of this is, that the same phenomenon does not occur in the dead body on dividing the nerve. In consequence of the irritation produced by the division, inflammation soon sets in, and the nerves assume a red colour, and become thickened, generally for the space of from half an inch to an inch, from the point of section. These appearances are the more remarkable in the end connected with the nervous system, than in the other. Coagulable lymph becomes deposited around them, and minute vessels appear in it. In consequence of the inflammation and the effusion of lymph into the cellular tissue around the general sheath and between the partial sheaths, a swelling or knot is produced of the ends of the nerves, that on the upper end being the largest; similar bulbous swellings are found on the ends of nerves divided by the amputation of a limb. After a few days the separated ends become connected by the effused plastic lymph, which gradually assumes a firmer texture, and shews less blood in its vessels. The bulbs gradually approach each other, and at last unite; and thus the connection between the parts of the divided

nerve is restored. On examining the swelling some time afterwards, it is found to be of a bright or greyish-red colour externally, and white in the centre; and medullary fibres are seen passing through it, and completely connecting the nerves. The knot remains for a long time after the cure has been completed. It has been found 50, 60, 90, 100, 110, and even 185 days after the division of the nerve. The author observed it in dogs two years after; and in the human subject, six or eight years after the amputation of the arm.—It is a question which has given rise to much controversy, whether the substance connecting the divided extremities of the nerves has the true nervous texture, and be capable of conveying sensation to the brain, and volition from it. Arnemann, Michaelis, Meyer, Cruickshank, and Haighton, insist that the nervous substance is really regenerated, and that the nerve becomes capable of again performing its functions. Prevost also made some experiments on cats, which led to the same result; and Swan came to the same conclusion from his experiments on rabbits and dogs. The preceding experiments certainly go to prove, that a true regeneration of the nervous issue takes place; but none of them are very satisfactory as to the restoration of the powers of sensation and motion to the parts whose nerves had been divided. The author of this paper consequently determined to make some more decisive experiments on the subject; one of the most satisfactory of which was the following. On the 16th August 1827, he laid bare the axillary plexus of a dog, parted the several nerves, and cut out of each a piece of from 10 to 12 lines in length. The animal immediately lost all power of feeling and motion in the corresponding limb. The wound healed in three weeks, the limb continuing in the same paralyzed state, and appearing evidently wasted, in comparison with the other fore leg. When the dog walked or ran, it went on three legs, and raised the fourth by means of the muscles of the shoulder. In May 1828, that is, eight months after, the author observed that the animal began to use the injured limb again, and that when pinched or pricked with a needle in the paw, it showed some signs of feeling. During that and the following year, the powers of sensation and motion gradually returned, till at last they seemed as perfect as they had been previously. In order to examine the condition of the nerves, the dog was killed on the 2d June 1829, twenty-one months after the operation. They were then found to have oval swellings or knots at the points where the pieces had been cut out; those above were larger than those below. Between these swellings, and connecting them, were portions which had been evidently reproduced, and consisted of bundles of white nervous filaments: they were, however, thinner than the rest of the nerve. When laid upon a plate of glass, and moistened with nitric acid, they were not dissolved, which proves that they contained the true nervous substance. This experiment affords a convincing proof that nerves are capable of being regenerated, at least in the lower animals. With respect to the human subject, there are several observations which prove it in an equally convincing manner. Some of these are to be found in Swan, &c. Again, several cases have been recorded in Medical Periodicals, in which portions of a finger that had been chopped off by accident, and united again, gradually recovering the power of feeling and motion after the healing of the wound. Lastly, the well known fact that those who have had a nerve divided, or even a piece taken out in cases of neuralgia, are often attacked again by their old tormentor after some time, can only be explained by supposing the reunion and regeneration of the nervous tissue. A remarkable case of this description is to be found in Abernethy's Surgical Works.—*Dublin Medical Journal*, No. iv. p. 129.

GEOLOGY.

11. *Vienna—Meeting of Naturalists in September* 1832.—You are aware that no meeting took place last year, owing to the prevalence of the cholera, and that the one just finished at Vienna was the result of an invitation, given two years since in Hamburgh, by Baron Jacquin and Littrow, by the authority of the Emperor of Austria. The unexpected return of the cholera to the Austrian capital has been the means of preventing many distinguished persons from attending at this assembly, but nevertheless it has turned out the most numerous of the ten meetings which have taken place in Germany. At the *first* meeting, it was announced that 350 *members* and upwards of 300 *guests* had been

enrolled. The absence of several leaders in science, whose presence had been expected, gave much disappointment. Humboldt did not come, owing, I believe, to indisposition. Treviranus sent his apology; and Oken staid away, owing, some say, to politics, others to fear of the cholera. Though most of the German States had their representatives in this congress of the learned, and though individuals were present from almost all the countries of Europe, and even from North and South America, and the Cape of Good Hope, yet by far the largest proportion of members were derived from the Austrian dominions. I shall mention some of the names best known to me, and chiefly those of naturalists: Count Sternberg, Von Buch, and the two Roses (Henry and Gustav.), from Berlin; Boué, from Paris; Mohs, Jacquin, Littrow the astronomer, Riepl, Zippe from Prag; Partsch of Vienna; Harles of Bonn; Otto, Goppert, and Glocker, from Breslaw; Burdach from Konigsberg; Froriep from Weimar; Sacco of Milan, &c.—*Tuesday* the 18th was the first day of meeting, and, at an early hour, the grand hall of the University presented a scene of great bustle and animation. Many distinguished visitors were present. A few rows before me were Metternich, and several of the ministers; and near them Marshal Marmont and the ex-minister Monthel, (the two last inscribed their names as members). Many Austrian and Hungarian noblemen were also amongst the auditors. Baron Jacquin and Littrow occupied the two presidents' chairs; the former delivered an introductory address, and the latter read the regulations of the meeting. A memoir was then read, by Hofrath Burdach, on the Motion of the Heart; 2d, A dissertation on Cholera, by Professor Wawnuch of Vienna; and, lastly, a paper on Physiological Botany, by Professor Göppert of Breslaw. The meeting then divided into five sections, each of which retired to an apartment, in order to elect a president and secretary. The following, I believe, were the individuals chosen. Of the Botanical section, Professor Göppert, president; of the Physical and Chemical, Professor Henry Rose, president; of the Medical, Professor Harles of Bonn; of the Geological, Mineralogical, and Geographical section, Baron Von Buch and Professor Mohs, to act alternately as presidents; and of the department of Zoology and Comparative Anatomy, Hofrath Burdach, president. It was only possible to attend regularly the meetings of one section, and I joined that of geology and mineralogy, so that I can only give you an account of what was transacted in my department, and that but in a very imperfect manner.—*Wednesday*, 19*th September*. Von Rosthorn of Wolfsberg, Carinthia, exhibited and explained, 1*st*, A geological map he has lately finished of the south-east parts of the Alps, in Carinthia, Carniola, and Stiria; 2*d*, An interesting section of the strata between Krainburg and Vochlabruick; and, 3*d*, Panoramic and geological views of the Salzburg Alps, taken from a mountain near to Gastein; also several other sections. M. Boué read an account of the origin, progress, and present state of the Geological Society of France, and proposed that an attempt should be made to hold a general meeting of the members of that institution and the naturalists of Germany. Baron Von Buch exhibited his new and splendid map of the island of Teneriffe.—*Thursday*, 20*th September*. Dr Reichenbach exhibited his geological map of a district in Moravia to the north of Brunn, and chiefly to the east of the road leading from that town to Prague. The formations he mentioned as occurring are sienite, old red sandstone, coal formation, mountain limestone, quadersandstone, and Leitha kalk. Professor Zippe read a paper on, I believe, some peculiar forms of scapolite and idocrase. M. Partsch exhibited lithographic prints of the rarer fossil shells found near Vienna; also the sections and maps of the Alps made by Mr Murchison. The members were then afforded an opportunity of examining the elaborate and extensive geological maps and sections of the Carpathians made by the late Lill Von Lilienbach, and now belonging to government.—*Friday*, 21*st September*. The various sections held a common meeting, to witness the experiments by the Chevalier Aldini on the incombustibility of asbestus cloth, and the practical purposes to which such cloth could be applied. The geological section then joined the botanical, in order to see some vegetable impressions exhibited by Count Sternberg, and also some of the plates which are to form part of the supplement to his great work, which will appear next year. The geologists afterwards adjourned to the Imperial Topographical Bureau, where all the great maps now in progress of the different parts of the empire were displayed.—On *Saturday 22d September*, a great meeting was held, at which it was determined that the next meeting shall be held at Breslaw. Bonn and Pyrmont were also proposed, but Breslaw was carried by an immense majority. Several medical and physiological papers were read, by Professor Willbrand, Professor Czermak, &c. &c.; and an account of the geology of some parts of Silesia, by Professor Glocker.—*Monday, 23d September.* Geological section. A paper was read by Boué on the types of European formations, accompanied by remarks, tending, I believe, to prove that it is unnecessary to separate the transition from the primitive formation. Waldauf von Waldenstein gave a general outline of the investigations made during the last ten years on the geology of the Austrian States, and particularly mentioned Buch, Boué, Partsch, Lill Von Lilienbach, Murchison, Count Sternberg, Rosthorn, Mohs, Zippe, Riepl, Anker, Prevost, Breunner, &c. &c. The same gentleman then exhibited various sections, lately made by Count Breunner, of the formations of the Ziller Thal in the Tyrol. Dr Schreibers read a paper on meteoric iron, and Prof. Scherer an account of a meteoric stone which fell in 1826, and proposed a new theory on the origin of meteorites in general. M. Partsch exhibited his splendid and detailed geological maps of Austria, Transylvania, &c., also a panoramic geological view of the environs of Vienna. Professor Zippe explained his geological map of Bohemia and part of Moravia. Professor Riepl, his map of the eastern part of the Alps. Professor Zeune read a notice on storms in the China seas. An interesting account of the Labyrinth of Crete, founded on personal observation, was read; rocks, &c. from Egypt, were exhibited. Professor Glocker read an account of the rarer minerals found in Silesia and Moravia. Bonnsdorf read a notice on the decomposition of a variety of granite in Finland.—*On Wednesday 26th*, the last general sitting took place, and formed the conclusion of the Versammlung of 1832. Reports of the proceedings in the different sections were read by the respective secretaries; some short papers; and a farewell address by Littrow. A supplementary meeting was held by the geological section on *Thursday 27th*, when a paper was transmitted by Professor Anker of Gratz, on remains of the Anthracotherium found in brown coal at Schoenegg. Plates were exhibited by M. Partsch, of interesting remains of the Dinotherium and Anthracotherium found in Austria. Professor Gustav. Rose read a paper on the uralite of Fassa Thal. Professor Baumgartner exhibited a modification of Wollaston's goniometer, proposed by Professor Mohs. Proposals were circulated in the meeting for the sale of mineral shells, plants, and fossils, belonging to Christópheris of Milan.—Having now given a very brief account of the proceedings of our section, I must endeavour to convey to you an idea of the lighter occupations and amusements of the members of the meeting. Nothing could have been more hospitable and splendid than the reception given to the learned assemblage. It was formerly thought that a sort of barrier existed on the frontier of Austria to the admission of knowledge from other parts of Europe, and that such a meeting would barely be tolerated by government; but I am sure all foreigners who were present, must have left Vienna with very different feelings. The Emperor and his Ministers bestowed the most decided marks of attention on them all, and entertained them in the most sumptuous style. The members dined together every day in a great hall, and the ladies of foreigners were allowed to attend. On Sunday the 23d, the town of Baden gave a great dinner to the whole party of strangers, amounting to about 240, who were all conveyed in about fifty Eilwagens. On the following Tuesday the Emperor gave a truly imperial entertainment to 500 individuals, at his palace of Lachsenburg. During the forenoon we were driven through the beautiful pleasure grounds in sixty imperial carriages, and we were carried to and from Vienna at the expense of the Emperor. The day I left Vienna, I was at a superb dinner given to about forty of the foreigners by the Minister of the Interior; and the day after I left, Metternich gave a grand entertainment. During the week of the meeting, Prince Metternich gave a soirée to all the members.—*P.S.* I should mention that the Emperor was prevented by indisposition from coming to Lachsenburg the day we were there.

12. *Relative Position of Granular Rocks.*—Serpentine, diorite, augite rocks, auriferous porphyry, augitic porphyry, and granite of Predazzo, traverse primitive slates, transition rocks, and secondary and tertiary deposites; and the granite of Baveno, and of Mettelwald, in the *Tyrol*, and the sienite of Skye, traverse lias limestone.

13. *Silver Mines of Kongsberg.*—Within a few years, the working of the former famous silver mines of Kongsberg in Norway have been resumed, and with great profit: thus, during the month of April of last year (1831), 865 marks and 16 loth of silver were obtained; and, in the first week of May of the same year, 245 marks $10\frac{1}{4}$ loth, of which the Armengrube alone afforded 219 marks 12 loth.

MINERALOGY.

14. *Analyses of Limestones of Barjarg and Closeburn, in Dumfriesshire*; by WILLIAM COPLAND, Esq.—At Barjarg Quarry the limestone contains about 56 per cent. of carbonate of lime, and 35 per cent. of carbonate of magnesia. At Closeburn Quarry, the upper bed of limestone is nearly identical with that of Barjarg; but there is a lower bed, which is very different in its composition, as it contains from 80 to 90 per cent. of carbonate of lime, but *no magnesia*; at least I was not able to detect any in any of the specimens which I analyzed.

15. *Analyses of Chabasites, by Dr Ern. Hoffmann.—Chabasite* from Riebendörfel, near to Aussig, in Bohemia. Specific gravity at + 7°.7 R. = 2.127. Silica, 48.18. Alumina, 19.27. Lime, 9.65. Natron, 1.54. Potash, 0.21. Water, 21.10: = 99.95.—*Chabasite* from the valley of Fassa. Specific gravity at + 8°.3 R. = 2.112. Silica, 48.63. Alumina, 19.52. Lime, 10.22. Natron, 0.56. Potash, 0.28. Water, 20.70: = 99.91.—*Chabasite* from Parsborough. Specific gravity at + 7° 6 R. = 2.075. Silica, 51.46. Alumina, 17.65. Lime, 8.91. Natron, 1.09. Potash, 0.17. Oxide of Iron, 0.85. Water, 19.66: = 99.79.

16. *Analyses of Arsenical Pyrites, by Dr Hoffmann.—Arsenical Pyrites from Reichenstein*, in Silesia—is the arsenikalkies of Weiss; axotomous arsenical pyrites of Mohs. Sulphur, 1.94. Arsenic, 65.99. Iron, 28.06. Serpentine, 2.17:

= 98.16.—*Arsenical Pyrites from Sladrning.* Sulphur, 5.20. Arsenic, 60.41. Iron, 13.49. Nickel, 13.37. Cobalt, 5.10 = 97.57.

17. *Harmotome from Strontian.*—The figures of the crystals of harmotome from Strontian, referred to in Mr Connell's paper on the composition of that mineral, in the Number of this Journal for July 1832, having been accidentally omitted, they are given in the present Number, Plate II. Fig. 7. represents the ordinary crystal of the mineral from the above locality; Fig. 5. the modification of Fig. 7., which was the subject of analysis; and Fig. 6. the intermediate form. The three forms are particularly described in the paper referred to.

18. *Fertilizing Property of Gypsum or Sulphate of Lime.*—In order to determine the manner in which gypsum contributes to vegetable growth, M. Peschier of Geneva, performed several comparative experiments. Two theories have been suggested by chemists,—one, that the gypsum acts simply as a stimulus to the organs of the plant,—the other, that it gives up to the plant its water of crystallization. M. Peschier filled two vessels with siliceous sand, slightly moistened, and sowed in each of them a few seeds of water-cresses, and watered one of them with pure water, and the other with a solution of the sulphate of lime. The plants, when a few inches high, were burned, and equal quantities of their ashes were analyzed. In those watered with the solution of sulphate of lime, there was found a much more considerable quantity of sulphate of potash than in the other. In a second experiment, he found that the proportion of sulphate of potash was increased when the plants watered with the solution of sulphate of lime were subjected to the gypsum of a galvanic current. M. Peschier thence infers that the plaster undergoes a decomposition by the act of vegetation, and he thinks he has observed that crude gypsum is more efficacious than that which has been calcined.—*Rev. Encyc. Nov.* 1831.

BOTANY.

19. *Secretion of Water by certain Plants.*—Professor L. C. Treviranus of Breslau has lately given his attention to the sub-

ject of the watery secretion of the leaves of plants. The Nepenthes, Sarracenia, and Cephalotus have long afforded the most striking examples of this function. Rumple's observation, that the water of the tankard-shaped leaves of the N. distillatoria is always pure, militates against the supposition that it comes from without. He also remarked, that when the lid of the N. Phyllamphora is open, the water is diminished one-half by solar evaporation, which, however, is restored at night. The structure of the goblet-like leaf, as observed by Treviranus, is like an actual secreting organ, and adds a strong reason for thinking that the plant supplies the water. He finds the parietes of the leaf of N. distillatoria traversed by a multitude of proportionably large anastomosing veins, which contain many true spiral vessels. The upper half of its inner surface is covered with a blue rind, as parts are often which are to be protected from the action of water; the under half is, on the contrary, shining and full of gland-like eminences, directed downwards, and having a hole almost visible with the naked eye, which is uncovered with the cuticle, which the remainder possesses. Through these, he thinks, is the water secreted, and it reaches generally to their level in the middle of the leaf. It is remarkable, that the inner or under surface of the lid, exhibits a similar structure, but whether it also secretes water, future observations must discover. Sir J. Smith's remarks on the construction of the lid of the Sarraccenia flava and adunca, are sufficient to invalidate Linnæus' opinion, that the leaves of this genus, as well as the Nympheæ, were intended as natural reservoirs for rain-water. In the Sarracenia, there is no particular apparatus as in the Nepenthes, for the secretion. Macbride's observations demonstrated on the edge of the Sarracenia adunca, a sweet substance that allures insects, which, creeping into the funnel of the leaf, arrive at the water, and being hindered from returning by the hairs directed downwards, are drowned. It is reserved for future investigation to discover what gives the sweet taste to the Nepenthes and Cephalotus, which is mentioned, and how the insects are killed, as nothing appears to hinder their creeping out again. Treviranus has examined particularly the watery secretion of the Amonium Zerumbet, which was not noticed by any botanist, except cursorily by Murray. The spikes stand on a stalk a foot and a half long, rising from the root, and are the size of a hen-egg, or sometimes as large as a goose-egg ; they consist of a number of broad deep scabs which lie over one another, imbricated, and enclosing a space between them. The scales are of a leathery consistence, each of them enclosing a small colourless flower, of a more cuticular nature. At the commencement of the flowering, the spikes are full of clear water, which is nearly without smell or taste. By gentle pressure, it comes from between the scales, and if it be emptied in the evening it becomes in great part renewed by morning. The lower half of the scale, which contains no flower, is found as full of water as the rest. Treviranus, therefore, considers the inner inferior part, where the scales are connected with the stalk, the place where the water proceeds from. The water lasted during the whole flower time, that is, three weeks, but as it advanced it did not preserve its original pureness ; it became somewhat ropy, and got the smell of the bruised leaves of the plant, without, however, losing its transparency in the least. Dr Goppert subjected a portion of it to chemical analysis, from which it results, that the fluid between the scales of the spikes of the Amomum Zerumbet consists of pure water, containing a small quantity of vegetable fibrine and mucus ; the quantity of which last is different at different periods of the flowering time. He has also observed a tasteless water in the corolla of Moranta gibba.—*Dublin Medical Journal, from Treviranus' and Tiedemann's Journal.*

HYDROGRAPHY.

20. *Specific Gravity of Ice.*—Osann has determined the specific gravity of ice at 0°, and found it, after a mean of ten weighings, of which the lowest was 0.9198, and 0.9352 the highest, to be 0.9268.

ARTS.

21. *French Ultramarine.*—The price of the artificial ultramarine, the process for manufacturing which has been discovered by M. Guimet of Paris, has been so reduced as to make it an object with painters and colourmen, in point of economy, to

substitute this article in the room of cobalt in the bluing of paper, thread, and stuff in which this material is employed. The discoverer has purchased a situation three leagues from Lyons, in which he is about to establish a manufactory, on a scale sufficiently large to supply the demands of commerce. M. Guimet has proved, by trial, that a pound of his ultramarine, of the second quality, and which can be afforded at twenty francs, will blue as much paper as ten pounds of cobalt, which, at wholesale, costs twenty-six francs; and an important advantage of the former is, that, on account of its lightness, it spreads more uniformly over the paper. Since his success in his application of the new colour, he has tried it in dyeing, and has obtained, upon linen, cotton, and silk, a degree of success which encourages the hope of an ultimate and decided superiority over indigo. In his printed circular, M. Guimet offers his ultramarine for bluing paper at sixteen francs.—*Report of M. Merimée to the Societé d'Encouragement; Bull. d'Encour. April* 1831.

STATISTICS.

22. *Ancient Price of Labour.*—In the year 1352, 25th Edward III, wages paid to haymakers was but 1d. a-day. A mower of meadows 3d. per day, or 5d. an acre. Reapers of corn, in the first week of August 2d.; in the second, 4d., per day, and so on, till the end of August, without meat, drink, or other allowance, finding their own tools. For thrashing a quarter of wheat or rye, 2½d.; a quarter of barley, beans, peas and oats, 1½d. A master carpenter, 3d. a-day, other carpenters 2d. per day. A master mason 4d. per day, other masons 3d. a-day; and their servants 1½d per day. Tilers, 3d., and their knaves 1½d. Thatchers 3d. per day; their knaves 1½d. Plasterers, and other workers of mud walls, and their knaves, in the like manner, without meat or drink, and this from Easter to Michaelmas; and from that time less, according to the direction of the justices —By the 34th of Edward III, 1361, chief masters of carpenters and masons, 4d. a-day, and the others 3d. or 2d. as they were worth.—By the 13th Richard II, 1389, the wages of a bailiff of husbandry, 13s. 4d. per year, and his clothing once a year at most; the master hind, 10s.; the carter, 10s.; shepherd, 10s.;

oxherd, 6s. 8d.; cowherd, 6s. 8d.; swineherd, 6s.; a woman labourer, 6s.; a day labourer, 6s.; a driver of plough, 7s. From this time up to the time of 23d Henry IV, the price of labour was fixed by the justices by proclamation.—In 1445, 23d Henry IV, the wages of a bailiff of husbandry was 23s. 4d. per annum, and clothing of the price of 5s., with meat and drink; chief hind, carter, or shepherd, 20s.; clothing 4s.; common servant of husbandry, 15s.; clothing 3s. 4d.; a woman servant 10s.; clothing 4s.; infant under fourteen years, 6s.; clothing 3s. Freemason or master carpenter, 4d. per day; without meat or drink, 5¾d. Master tiler or slater, mason, or mean carpenter, and other artificers concerned in building, 3d. a-day, without meat and drink 4½d.; every other labourer, 2d. a-day, without meat or drink 3½d. a-day; after Michaelmas to abate in proportion. In time of harvest, a mower 4d. a-day; without meat and drink, 6d.; reaper or carter, 3d. a-day, without meat and drink, 5d.; woman labourer, and other labourers, 2d. a-day, without meat and drink, 4½d. per day. By the 11th Henry VII, 1496, there was a like rate of wages, only with a little advance; as, for instance, a freemason, master carpenter, rough mason, bricklayer, master tiler, plumber, glazier, carver, joiner, was allowed from Easter to Michaelmas to take 4d. a-day, without meat and drink 6d.; from Michaelmas to Easter to abate 1d. A master having under him six men, was allowed 1d. a day extra.—By the 6th of Henry VIII, 1515, the wages of shipwrights were fixed as follows: A master ship carpenter taking the charge of the work, having men under him, 5d. a-day in the summer season, with meat and drink; other ship carpenter, called a hewer, 4d.; an able clincher, 3d.; holder 2d.; master calker, 4d.; a mean calker, 3d.; a day labourer by the tide, 4d.

23. *Butter.*—Butter is extensively used in this and most northern countries; that of England and Holland are reckoned the best. In London, the butter of Epping and Cambridge is in the highest repute: the cows which produce the former feed during summer in the shrubby pastures of Epping Forest; and the leaves of the trees, and numerous wild plants which there abound, are supposed to improve the flavour of the butter. It is brought to market in large rolls from one to two feet long, weighing one pound each. The Cambridgeshire butter is produced from cows

that feed during part of the year on chalky uplands, and the other on rich meadows or fens: it is made up in long rolls like Epping butter, and generally salted or cured before being brought to market; the London dealers, having washed it and wrought the salt out of it, frequently sell it for Epping butter. The butter of Suffolk and Yorkshire is often sold for that of Cambridgeshire, to which it is little inferior. Somersetshire butter is thought to equal that of Epping: it is brought to market in dishes containing half a pound each; out of which it is taken, washed, and put into different forms, by the dealers of Bath and Bristol. Gloucestershire and Oxfordshire butter is very good: it is made up in half pound packs or prints, packed up in square baskets, and sent to the London market by waggon. The butter of the mountains of Wales and Scotland, and the moors, commons, and heaths of England, is of excellent quality when properly managed; and, though not equal in quantity, is superior to that produced by the richest meadows. Considerable quantities of butter are made in Ireland, and it forms a prominent article in the exports of that country; it is inferior to that of England. Some of the best Irish butter brought to London, after being washed and repacked, is sold as Dorsetshire and Cambridgeshire butter. The salt butter of Holland is superior to that of any other country; large quantities of it are annually exported. It forms about three-fourths of all the foreign butter we import. The production and consumption of butter in Great Britain is very great. The consumption in London may be averaged at about one-half pound per week for each individual, being at the rate of 26 lb. a year; and supposing the population to amount to 1,450,000, the total annual consumption would be 37,700,000 lb., or 16,830 tons; but to this may be added 4000 tons for the butter required for the victualling of ships and other purposes, making the total consumption in round numbers 21,000 tons, or 47,040,000 lb., which, at 10d. per lb., would be worth L. 1,960,000. The average produce per cow of the butter dairies is estimated by Mr Marshall at 168 lb. a year; so that, supposing we are nearly right in the above estimates, about 280,000 cows will be required to produce an adequate supply of butter for the London market. But the consumption of butter in London has sometimes been estimated at 50,000 tons; which would require for its supply upwards of 666,000 cows.—*Saturday Magazine, No.* 9.

24. *Irish Trade with England.*—Some idea of the extent and importance of the trade between Ireland and England may be formed from the following list of articles imported into England during the year 1831.

Horses,	155		at	£20	0	0	each	£3,100	0	0
Cows,	6,821		—	8	0	0	—	54,568	0	0
Calves,	285		—	1	0	0	—	285	0	0
Sheep,	13,218		—	1	0	0	—	13,218	0	0
Lambs,	1,314		—	0	6	8	—	438	0	0
Pigs,	89,700		—	0	10	0	—	44,850	0	0
Mules,	243		—	10	0	0	—	2,430	0	0
Bacon,	15,090	bales,	—	2	10	0	—	37,725	0	0
Pork,	17,746	barrels,	—	3	0	0	—	53,238	0	0
Beef,	9,445	tierces,	—	5	10	0	—	51,947	10	0
Hams and Tongues,	970	hhds.,	—	3	0	0	—	2,910	0	0
Lard,	8,452	firkins,	—	2	10	0	—	21,130	0	0
Butter,	504,047	firkins,	—	3	0	0	—	1,512,141	0	0
Eggs,	3,508	crates,	—	2	0	0	—	7,016	0	0
Wheat,	377,060	quarters,	—	2	10	0	—	942,650	0	0
Barley,	313,458	—	—	1	10	0	—	470,187	0	0
Oats,	460,786	—	—	1	0	0	—	460,786	0	0
Rye,	560	—	—	1	10	0	—	840	0	0
Peas,	2,736	—	—	1	10	0	—	4,104	0	0
Beans,	10,456	—	—	1	10	0	—	15,684	0	0
Malt,	8,650	—	—	2	10	0	—	21,625	0	0
Flour,	113,194	sacks,	—	2	10	0	—	282,985	0	0
Meal,	250,860	loads,	—	1	10	0	—	376,290	0	0
			Total value,					£4,380,147	10	0

Quarterly Journal of Agriculture.

NEW PUBLICATIONS.

1. *Outlines of Physiology and Pathology.* By W. P. Alison, M.D. F. R. S. E. Professor of Medicine in the University of Edinburgh. 1833.

This valuable volume contains, in a small space, the most luminous, accurate, and satisfactory view of the present state of physiological and pathological science we have met with. The Continental works on these subjects are characterized by the styles of arrangement and reasoning of the schools from which they emanate; in like manner, Dr Alison's excellent work every where displays that sound judgment and consideration which so generally distinguish the cultivators of science in Britain.

2. *Essay on the Natural History, Origin, Composition, and Medicinal Effects, of Mineral and Thermal Springs.* By MEREDITH GARDNER, M. D. 12mo. 1832.

We have no complete work on the natural history and chemical and medical nature of springs in our language. This blank in our literature is ably filled up by Dr Gairdner's treatise, which will bear a comparison with the best foreign treatises on this beautiful and important branch of science. We, therefore, have no hesitation in recommending it to our readers as a work of great merit, and which we are confident will, as soon as known, find a place in every medical library,—be treasured up by our numerous geologists—and become a chief authority and indispensable companion in every watering-place throughout the kingdom. The following table of contents of the volume will shew the arrangement and subjects discussed by Dr Gairdner.

3. *The Mosaical and Mineral Geologies illustrated and compared.* By W. M. Higgins, F. G. S. &c. London 1832. 8vo.

This amusing and interesting little volume contains, 1. Outline of Practical Geology; 2. Outline of Theoretical Geology; 3. Comparison of the Mosaical and Mineral Geologies. The first chapter of Genesis, which contains all that has been revealed concerning the Creation, may be, according to our author, divided into three periods: first, there is a statement that the heavens and the earth were created; there is then a description of the earth previous to the *days of creation;* and afterwards a somewhat detailed account of the order in which the Almighty furnished the world during the six days. Our author first shews that the earth, and the heavenly bodies by which it is immediately surrounded, were in existence before the *days of creation.* After the creation of the earth, through the action of the elements, the previously existing primitive rocks were partially broken down, and afforded materials for the transition and secondary formations. These formations are maintained to have taken place during that period which intervened between the creation of the world and the commencement of *the days.* At the commencement of the days, the "*earth was invisible, and unfurnished, and darkness was upon the face of the deep.*" There is here, says our author, an evident distinction between the earth and the deep; they were both invisible, and the former was unfurnished. By this statement, we may either understand that darkness was upon both, and that all which existed upon the land had been destroyed; or that the earth was covered with water. The latter is probably the meaning; for we find that, on the third day, God gathered the waters together into one place, and caused the dry land to appear. The cause of this universal deluge and darkness is not stated by Moses; but, according to the view which has been taken of the state of the earth preceding this period, it must have suffered a most important revolution. Land and water had existed during the deposition of rocks, and, in order to the accomplishment of the universal deluge, a sinking or elevation of strata seems to be necessary, or the interference of that Power which, in after ages, again encompassed the earth with floods; and the same Power which brought the waters over the globe, covered it with darkness, which was in all probability transient; as we know that the sun and planetary bodies, which act so important a part in conveying light to the world, were certainly created. Much has been written concerning the word IOM, translated in this place *day*. The word has various acceptations in Scripture; as used by Moses, in describing the *second creation*, the word evidently refers, says our author, to a single revolution of the earth on its axis. The earth being in darkness at the commencement of the days, God first calls or recalls the light; for there is nothing in the Mosaical statement that precludes the idea that light in the same form as it was now exhibited had existed before; but, on the other hand, every thing to strengthen the opinion. On the *second day*, God created the firmament, and divided the waters which were under the firmament from those which were above. On the *third day*, the waters under the heavens, which had hitherto covered the whole earth, were gathered together into one place, and the dry land appeared. On the same day the earth was decked with its living green, and it brought forth the herb and the tree, each yielding fruit after its kind. In order to the gathering of the waters together, some great convulsion must have transpired. We are led to suppose, from passages in Scripture and natural phenomena, that there was a sudden upheaving of a considerable portion of the solid crust of the earth. Let us suppose for a moment that some of the immense chains were elevated, or the whole continents of which they form a part. The mighty waters, which so calmly flowed over the surface, would be thrown into inconceivable agitation, and roll their disturbed waves from shore to shore, until they had found that bound which they should not pass; and of such a convulsion there are abundant proofs in the state of the earth's crust. To this cause we may assign many of those *tertiary deposits* which have hitherto been supposed to have existed before the *days of creation.* On the *fourth day*, the heavenly bodies were set apart for a distinct and separate purpose, and not then created, as some maintain. The earth being thus prepared as the habitation of animated creatures, God creates, on the *fifth day*, all that moveth in the waters and in the air. On the *sixth day*, he completes his work by the creation of all living beings that inhabit the earth, "cattle, and creeping things, and beasts of the earth." Lastly, man was created.

4. *The Microscopic Cabinet, or Select Animated Objects; with a Description of the Jewel and Doublet Microscope, Test Objects, &c.: to which are subjoined Memoirs on the Verification of Microscopic Phenomena, and an exact Method of appreciating the quality of Microscopes and Engiscopes.* By C. R. Goring, M. D. Illustrated, from original drawings, by thirteen coloured plates, and numerous engravings on wood, by Andrew Pritchard. 8vo. Pp. 246. London 1832.

As the use of the microscope is daily leading to most important discoveries,—witness those of Ehrenberg and Strauss,—a work descriptive of this instrument in its various forms, and the modes of using it, cannot but be prized by those who take an interest in the beautiful objects it reveals to our senses. The volume of Goring and Pritchard, the title of which is here given, fully fulfils these conditions, and besides contains many original and curious observations. The plates are well engraved, and evidently from accurate drawings.

5. *Outlines of Medical Botany*, &c. &c. By Hugo Reid, Esq. President of the Physical Society of Edinburgh. 8vo. Pp. 390. Edin. 1832.

This work contains a concise view of vegetable anatomy and physiology; and also, under the head Systematic Botany, a view of the Natural and Linnean systems of classification. The natural system, that now most in request, is fully sketched. This volume is intended as an elementary work on Botany, for the use of students of medicine, for which purpose it is well adapted, and we doubt not will be extensively used by those for whose use it has been published.

6. *Memoir on the Pearly Nautilus* (Nautilus Pompilius, *Lin.*), *with Illustrations of its External Form and Internal Structure.* Drawn up by RICHARD OWEN, Member of the Royal College of Surgeons of London, and Assistant Conservator of the Museum of the College. With Plates. Published by direction of the Council. 4to. Pp. 68. London 1832.

This interesting memoir, which will be received by zoologists and comparative anatomists as an important addition to our knowledge of the internal structure of cephalopadous mollusca, is highly creditable to the skill and dexterity of Mr Owen as a comparative anatomist. The dissections are illustrated by a very beautiful series of engravings from Mr Owen's elegant drawings. The specimen of this rare animal, anatomized by our author, was taken in Marekini Bay, in the island of Erromanga, one of the New Hebrides, in 1829, by Mr Bennet, F. L. S., and of the Royal College of Surgeons in London, and by him presented to the magnificent Museum of Comparative Anatomy of the Royal College of Surgeons of London.

List of Patents granted in Scotland from 18*th September* 1832.

1832.

Sept. 18. To Pierre Nicolas Hainsselin, of Duke Street, St James's, in the county of Middlesex, architect and engineer, for an invention of "a machine or motive power for giving motion to machinery of different descriptions, to be called Hainsselin's Motive Power."

21. To George Jones, of Wolverhampton, in the county of Stafford, ironmaster; James Foster, of Stourbridge, in the county of Worcester, ironmaster; and John Barker, and John Jones, both of Wolverhampton aforesaid, ironmasters, for an invention of "a certain improvement in the process now in use for producing or making malleable iron."

To Richard Whytock of the city of Edinburgh, manufacturer, for an invention of "an improved method or manufacture which facilitates the production of regular figures or patterns on different fabrics, particularly velvets, velvet-pile, and Brussels, Wilton, and Turkey carpets, with a saving of material."

Oct. 5. To Baron Charles Wetterstedt, of the Commercial Road, in the county of Middlesex, for an invention of "a composition or combination of materials for sheathing, painting, or preserving ships' bottoms, and for other purposes."

23. To John Hornby Maw, of Aldermanbury, in the city of London, surgical instrument-maker, for an invention of "an improved apparatus for injecting enemata."

Nov. 2. Angier March Perkins, of Harper Street, in the county of Middlesex, civil-engineer, for an invention of "certain improvements in the apparatus or method of heating the air in buildings, heating and evaporating fluids, and heating metals."

To John Brown of Heaton Norris, in the county of Lancaster, cotton manufacturer, and Thomas Heys of Heaton Norris aforesaid, book-keeper, for an invention of "an improvement in the machinery used for spinning cotton, silk, flax, and other fibrous substances, commonly called Throstles."

7. John Nash, of Market Rasen, in the county of Lincoln, brick manufacturer, for an invention of "certain improvements in the machinery and process, used in the manufacture of bricks, tiles, bread, biscuits, and various other articles of commerce, made from plastic materials."

6. To George Lowe, of Brick Lane, Old Street, in the county of Middlesex, civil-engineer, for an invention "for increasing the illuminating power of such coal-gas as is usually produced in gas-works; also for converting the refuse products from the manufacture of coal-gas into an article of commerce, not heretofore produced therefrom, and also for a new mode of conducting the process of condensation in the manufacture of gas for illumination."

NEW ARMY REGULATION IN REGARD TO NATURAL HISTORY AND BOTANY.

We understand, by a communication just transmitted to the Medical Professors in the University, that candidates for the Medical Department of the Army are required, before examination, to produce certificates of having attended a three months' course of Lectures on Natural History, and another, of equal extent, on Botany, at established schools of eminence.

THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

Death of Cuvier.

THE learned of Europe have sustained a great and irreparable loss. GEORGE CUVIER expired on the 13th May 1832, after four days of suffering, from an attack of paralysis in the throat, which very soon reached his lungs. He was only sixty-three years of age, being born in the month of February of the year 1767, which has produced so many remarkable men,—Napoleon, Chateaubriand, Walter Scott.

His native city, Montbelliard, since reunited to France, was then a principality of Switzerland, and dependent on the Duke of Wurtemberg. His first studies were at the school of Stuttgardt, and he commenced his career by entering as sub-lieutenant in the Swiss regiment of Chateaubriand. The disbanding of this corps gave him his liberty, and he passed the most troublesome period of the Revolution occupied with his education, at a country house in Normandy, not far from the sea. It was there, as his first essay, he made those great anatomical discoveries on the Mollusca, which occasioned a total change in the zoological classification which had been unanimously admitted since the time of Aristotle. This work, published in 1795, fixed upon him the attention of all the learned in Europe. M. Geoffroy St Hilaire had the honour of first perceiving the importance of the discoveries, and contributing to the advancement of their author. He was almost immediately chosen a member of the class of sciences of the Institute, and to succeed the old Mertrud, in the chair of Comparative Anatomy in the Garden of Plants at Paris: his lectures were already become remarkable for their eloquence and clearness, and attracted crowds of students. Cuvier appeared at this period threatened with consumption, and he has often said since, that his exercise as a professor gave activity to his lungs, and restored him to health. Named Professor of Natural History to the Central School of the Pantheon, he threw a lustre over this place by the publication of his *Tableau du Règne Animal*, which, notwithstanding its elementary appearance, has served as a basis to all subsequent works on zoological classification.

He published soon after, his Lectures on Comparative Anatomy (5 vols. 8vo.), which were afterwards pronounced by the Institute to have merited the great decennial prize for the work which had most advanced the knowledge of natural science. This work, abridged from his lectures, was arranged under his own eyes, the first two volumes by his friend M. Duméril, and the last three by his relative M. Duvernoy. At this same time he published a series of memoirs upon the Anatomy of the Mollusca. Afterwards he devoted much of his attention to the detailed examination of the fossil debris of the bones of mammifera: he took particular notice of a number of fossils in the environs of Paris, and was assisted in the geological part of his labours by his friend M. Alexander Brongniart. The sagacity and skill which he applied to the determination of these fossil bones, gave rise to a science altogether new, which considerably assisted geology, and conferred a more philosophic character upon it. A number of excellent works and memoirs published since by various naturalists, have shewn the prodigious influence which the labours of Cuvier have had on the study of geology, upon that of the animal kingdom, and even upon that of vegetable fossils. M. Cuvier, although he did not publish any great work for a long period, continued to lay before the public his particular researches, which alone would have been sufficient to render any other man illustrious. Such are his beautiful dissertations on the voices of birds, on crocodiles, and many different points of zoology. Such, also, are his descriptions of living animals in the menagerie, &c. Every where, even in the most minute details, we observed that clear, luminous, methodical spirit, and sagacity, which characterised him.

He perceived the necessity of collecting the whole of his ideas, and presented to the public, in 1817, a general table of Zoological Classification. This work, entitled "*Le Règne Animale distribué d'apres son Organization*," 4 vols. 8vo, soon became the foundation of all zoological studies; in most of the schools, the lectures, the collections, the works of research, were more or less elucidated and illustrated by an appeal to this great work. M. Cuvier was assisted by his friend M. Latreille, in the part of his work connected with the class of insects, which is in itself more numerous than all the rest of the animal kingdom, and would require the whole life of a laborious man. But he had persuaded this skilful entomologist to deviate in some points from his usual system, that his labours might agree with the other parts of the work.

The redaction of the *Règne Animal* shewed M. Cuvier how far behind the study of fishes was to the rest of zoology, and made him feel the accumulated difficulties of this branch of science, from the obscurity of the anatomy of these animals, and the impossibility of knowing with precision the laws from the comparison of their organs, as well as by the want of good collections, and perhaps also by the too artificial spirit which had hitherto prevailed in the study of Ichthyology. He exerted himself to collect, in the museum of Paris, skeletons of fishes from all parts of the world, and had such success in his search for the materials of his work, that the number of fishes in the museum, which had scarcely amounted to a thousand kinds, were now, in a few years, raised to about six thousand. He anatomised a great number with unusual care, and associated with himself in the study of their details, a man of merit, M. Valenciennes, and became thus, in a period which must be called short, if judged by the immensity of its results, enabled to arrange the elements of his great history of fishes, of which the first volumes have appeared, and the public hope for the remainder from his laborious coadjutor. The recent embarrassments of the book-trade had a little delayed its progress, and as the part written was already prepared for the printer, he employed himself in revising his "Lectures on Comparative Anatomy," in order to publish a second edition, which had long been eagerly desired.

"This will be" (he wrote the 26th April last to the compiler of this note) "a work almost entirely new, because our immense collections, and the works executed by other anatomists since the first publication, have furnished me with many new facts; but I see with pleasure, that the system requires little change, and that it continues preferable (at least in my opinion) to those which have been adopted since by some learned men. Nevertheless," adds he, "I by no means renounce my great Comparative Anatomy (if I live), for which I have already a thousand drawings." This project, which was always present to his imagination, and for which he had laboured forty years, seemed to him necessary for the completion of all his works; but the melancholy doubt expressed in this letter (if I live) has been too soon verified! The homage most worthy to be paid to the glory of Cuvier, will be the publication of these drawings and his great Comparative Anatomy. Thus this man, whom the entire of Europe admires for his surprising fertility of genius, left unpublished works so immense, they might be supposed the labour of a whole lifetime.

Did this attention, so laboriously directed to Natural History, exclude in him all other studies?—Certainly not! Read the eloges he delivered, as perpetual Secretary to the Academy of Sciences, and in which he reviews so many men, and so many different subjects!

Thus, for example, his eloge of Adanson proves, that only a naturalist of the first order could have written it; while those of Bonnet, or of Priestley, shew that he was well informed in all branches of human knowledge. Everywhere in these classical memoirs we find interspersed the most profound reflections on the progress of science, and the most striking allusions to human nature, and the social state of the period. But, above all, there shines forth that love of truth, that feeling of the dig-

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nity of intellectual studies, which was one of his most vivid impressions. It is to this elevated sentiment that we may refer the impartiality of his eulogies, of his explanations, and of his opinions on literature and science, the distance which he always kept from every intrigue whatever, and the zeal which he carried to all the duties confided to him, the ardour with which he encouraged and protected young men of promising talents, and the noble disinterestedness with which he spared no expense for the development of his works of science.

His varied talents are best proved by the influence he had on Natural History. It may almost be said he had created, so much had he improved, the Cabinet of Comparative Anatomy, certainly one of the most admirable departments of the Museum of Natural History at Paris, which attracts the admiration of all Europe. Placed frequently by the choice of his colleagues at the head of this establishment, he powerfully contributed to its progress, and carried into its general details that activity and that order which distinguished him. Called to co-operate in the direction of the public instruction, at first as Inspector of the University, since as Member of the Council for Public Instruction, as Chancellor, as Superior of different Faculties,—everywhere he made himself remarkable for the same qualities. His remarks on the primary instruction of Holland, is a monument of his solicitude for popular instruction; and all those who have watched the effect of his arrangements in the higher studies, know how much he befriended their progress, and how much of evil he corrected. This last kind of service, less known than the others, proves the elevated mind which disdains the applause of the moment for the real benefit of the future.

He advanced gradually in the field of civil administration, as Master of Requests, Councillor of State, President of the Section of the Interior, Director of Protestant Worship, and at last Peer of France, thus making the round of the administrative functions, with exception of Censor, which he nobly refused when they wished to bestow it. He maintained in all these situations that superiority which no person could contest with him. He was so well acquainted with the laws, the regulations, and the least official acts, that his colleagues left the whole of the administration to him, and were every day more and more surprised with his prodigious talents.

His range of knowledge was surpassingly great. He had all his life read much,—seen much,—and had never forgotten any thing. A powerful memory, sustained and directed by sound judgment and singular sagacity, was the principal foundation of his immense works and his success. This memory was particularly remarkable in what related to forms, considered in the widest sense of that word; the figure of an animal, seen in reality or in drawing, never left his mind, and served him as a point of comparison for all similar objects. The sight of a map, of the plan of a city, seemed sufficient to give him an almost intuitive knowledge of the place; and among all his talents, that memory which may be called *graphic*, seemed most apparent: he was consequently an able draughtsman, seizing likenesses with rapidity and correctness, and had the art of imitating with his pencil the appearance of the tissue of organs, in a manner peculiarly his own, and his anatomical drawings were admirable.

In the midst of a life so occupied, he was far from neglecting the ornaments of society: his conversation sometimes grave and solemn,—sometimes piquant and lively, always correct, circumspect and original—made him the ornament of the saloon, and fascinating to his acquaintances. He was a warm, sincere, and faithful friend. He engaged the minds and hearts of those who surrounded him, and the ability with which he directed the efforts of others towards his own views, was not one of the least causes of his success. His steadiness in friendship, his gratitude to those who had contributed to the prosperity of his youth, his moderation in all discussions, the devotion which he knew how to inspire in those about him, are evidences of the qualities of his heart, and explain that extensive moral influence which he exercised.

He was surrounded by friends worthy him: his wife, his daughter-in-law, angels of goodness, of grace, and resignation, under dreadful misfortunes, could not but bestow happiness: his brother, a distinguished man, and who would have been more so had he not been placed beside a giant, was a true and steady friend to him. His domestic life, which should have been so happy, was cruelly troubled; three sons, in infancy, preceded him to the tomb; and his daughter, a model of grace and virtue, was carried off at the moment when a happy marriage had received his blessing. Of four children, which his wife had by her first marriage, and which he had adopted, two were arrested by death at the age when all risks seemed to have ceased, and when hope had become reality. Oh! how powerful a balm must be the love of labour, the love of truth, and of the public welfare, to give support under so many afflictions. How many might I name who have been dear to him, and who have warmly returned that sentiment! If I dared to limit the circle of his friends by the ties of nature, how many would dispute that rank? This homage, paid to the moral qualities of Cuvier, will, I know, appear suspicious. He, who hurriedly thus describes him, was his friend thirty-four years, and honoured him still more for his heart than for his celebrity. And while, he writes in mourning, it is consoling to have expressed, although no doubt imperfectly, yet with truth, that he was one of the most eminent men that ever Europe lost.

De Candolle.

Vegetable Physiology in Relation to Rotation of Crops. By M. Macaire.

In a Memoir inserted in the Transactions of the *Societé de Physique et d'Histoire Naturelle* of Geneva, M. Macaire has stated some physiological facts, worthy of being generally known.

A judicious rotation of crops is known to be a matter of great importance. One kind of vegetable (A) will grow and flourish well in a soil from which another kind of vegetable (B) has just been gathered; while an attempt to raise another crop of the first vegetable (A), or a crop of the third vegetable (C) immediately after the first (A) in the same soil, will be attended with little or no success. The discovery of this fact, which is almost as ancient as agriculture itself, is supposed to have led to the practice of fallowing. A piece of fallow ground will, almost to a certainty, be covered with a crop of weeds. These being plants of a different nature, do not unfit the soil, but prepare it for a succession of the same crop as that which preceded them. But science or experience has taught the enlightened farmer to substitute useful plants in the room of weeds, and thus to keep his ground in profitable activity.

Various reasonings have been employed to account for the necessity of this rotation. 1*st*, That different plants absorb different juices from the same soil, and that a piece of ground exhausted by culture may still be rich for another class of vegetables. But it is known to physiologists, that plants absorb all the soluble substances that the soil contains, whether injurious to their growth or not. 2*d*, That the roots of different plants being of different lengths, extend into different layers of the soil, and thus derive from it appropriate nourishment. But the roots of all plants, at the period of germination, must be in the same stratum, and, of course, be equally dependent upon it; and, besides, the culture of the farmer turns up and mixes the various layers of the soil together, so as to render them, in all probability, homogeneous. It is known also, that plants of the same family, such as clover (trefoil) and lucerne, do not prosper in succession, although their roots are of very different lengths. The true explanation of the necessity of rotation appears to be founded on the fact stated by Brugmans, and more fully exposed by De Candolle, that a portion of the juices which are absorbed by the roots of plants, are, after the salutiferous portions have been extracted by the vessels of the plant, again thrown out by exudation from the roots, and deposited in the soil. It is probable the existence of this exuded matter, which may be regarded, in some measure, as the excrement of the preceding crop of vegetables, that proves injurious to a succeeding vegetation. It has been compared to an attempt to feed animals upon their own excrements. The particles which have been deleterious to one tribe of plants cannot but prove injurious to plants of the same kind, and probably to those of some other species, while they may furnish nutriment to another order of vegetables.

The author endeavoured to subject these theoretic views to the test of experiment. After various attempts to raise plants in pure siliceous sand, pounded glass, washed sponge, white linen, &c., he decided upon pure rain water. After cleansing and washing the roots thoroughly, he placed them in vials with a certain quantity of pure water. After they had put forth leaves, expanded their flowers, and flourished for some time, he ascertained, by the evaporation of the water, and the use of chemical reagents, that the water contained matter which had exuded from the roots. He satisfied himself that this is the fact with respect to nearly all the phanerogamous plants.

Several plants of *Chondrilla muralis*, perfectly clean, were placed with their roots in pure water. At the end of a week, the water was yellowish, and emitted an odour like opium, and had a bitter taste. Subacetate and acetate of lead produced a brownish flocculent precipitate, and a solution of gelatine disturbed its transparency. As a proof that this matter was the result of excretion from the roots, it was found that neither pieces of the root nor of the stem, when macerated in the water during the same time, occasioned either taste, smell, or precipitate.

To determine at what period, whether during night or day, this discharge from the roots takes place, a plant of common bean (*Phaseolus vulgaris*) was carefully cleaned, placed in rain-water, and kept a week during the day-time in one vessel, and during the night in another, being well wiped at each transfer. In both the fluids there were evident marks of excretion from the roots, but that in which the roots were immersed during the night contained a very notable excess of the transpired matter. Numerous other experiments gave the same result. As it is well known that the light of day causes the roots to absorb their juices, it is natural to suppose that during the night absorption ceases and excretion takes place.

To prove that plants employ (if we may so speak) the excretory power of their roots, in order to get rid of hurtful substances which they may have imbibed, the following experiments were made. Some plants of the *Mercurialis annua* were well washed in distilled water, and placed so that one portion of their roots dipped into a weak solution of acetate of lead, and another branch of the same root into pure water. Having vegetated in this manner very well for several days, the water was tested by hydrosulphuret of ammonia, which proved, by the black precipitate which it formed, that a notable portion of the lead had been absorbed and deposited by the branch which dipped into the pure water. Groundsel, cabbage, and other plants, gave the same result. Some plants grew very well for two days in acetate of lead. They were then withdrawn, their roots well washed with distilled water, carefully wiped, again washed in distilled water (which, being afterwards tested, was found to contain no lead), and then placed to vegetate in rain water. In the course of two days, this water was found to contain a small quantity of acetate of lead.

The same experiments were made with lime-water, which, being less injurious to plants, is preferable to lead. The roots, being partly placed in lime-water, and partly in pure water, the plants lived well, and the pure water soon shewed the presence of lime by oxalate of ammonia, and plants which had grown in lime, and then transferred with every precaution to pure water, soon disgorged into it a portion of lime.

Similar trials were made with a weak solution of marine salt, and with a like result. Learning from M. De Candolle that marine plants, when transported in a healthy situation, frequently grow well at a distance from the sea, and that, in such cases, the soil in which they grow contains more salt than the surrounding soil, the author endeavoured to imitate nature by taking a few common plants, placing their roots in rain-water, and wetting their leaves with a solution of marine salt. None of the salt was discoverable in the water; and it may therefore be inferred either that solutions of salt cannot imitate the delicate process of nature, or perhaps more probably that soda plants alone have the power of absorbing, by their leaves, marine salt, and rejecting a portion of it by their roots.

There can be no doubt, then, that plants have the power of rejecting, by their roots, soluble salts, which are injurious to vegetation. The author gives a few interesting details of experiments on some particular families of plants.

Leguminous Plants.—The only plants which he tried of this family were peas and beans. They live and grow well in pure water. After some time, the liquid, being examined, has no sensible taste. Its smell is faintly herbaceous. It is quite clear, and almost colourless, in the case of kidney-beans (haricots), more yellow in peas and common beans (feves.) The fluid, when examined by chemical tests, evaporation, &c. is found to contain a matter very analogous to gum, and a little carbonate of lime.

It was found that when the water in which these plants had lived was pretty well charged with this excrementitious matter, fresh plants of the same species soon withered in it, and did not live well. To ascertain whether this was for want of carbonic acid in the fluid (which plants derive from the earth as well as from the air), or from the presence of excreted matter, which they repudiated, the author put into the fluid some plants of another family, and especially wheat. This lived well, the yellow colour of the fluid became less intense, the residuum less considerable, and it was evident that the new plant absorbed a portion of the matter discharged by the first. It was a kind of rotation experiment, performed in a bottle, and the result tends to confirm the theory of De Candolle. It is not impossible that, by experiments of this kind, results may be obtained of practical importance to agriculture. The author would infer that wheat may follow with great advantage a crop of beans.

Gramineous Plants.—Wheat, rye, and barley were examined. They do not grow well in rain-water, probably from the notable quantity of mineral substances, especially silex, which they contain, and which they cannot derive from pure water. The water in which they have vegetated is clear, transparent, without colour, smell, or taste. It contains some salts, alkaline, and earthy muriates and carbonates, and only a very small portion of gummy matter. He thinks these plants reject scarcely any thing but the saline matters foreign to vegetation.

Chicoraceous Plants.—The *Chondrilla muralis*, and the *Sonchus oleraceus*, live very well in rain-water. The latter acquires a clear yellow colour, a strong smell, and a bitter taste. Treated with tests, and concentrated by evaporation, it is found to contain tannin, a brown gummo-extractive substance, and some salts.

Papaveraceous Plants.—Plants of field poppy *(Papaver Rhæas)* will not live in rain-water; they speedily fade. The white poppy *(Papaver somniferum)* lives very well. The roots produce a yellow colour, a vinous odour, a bitter taste, and the brownish residuum might be taken for opium. This plant is one of those which neither the roots nor the stems cut into pieces, and, steeped in water, produce in it any of the changes which the growing plants communicate.

Euphorbiaceous Plants.—The *Euphorbia cyparisias* and *E. peplus*, are the plants from whose roots Brugmans observed the exudation of drops during the night. The author has not been able to verify this fact by direct observation. The plants vegetate well in rain-water, giving a very strong and persisting odour. Boiling alcohol dissolves the residuum, and deposits, by evaporation, a granular gummo-resinous, yellowish-white, very acrid substance, leaving a strong after-taste.

Solanaceous Plants.—The only plant of this family which I have tried in water is the potato. It lives well in water, and puts forth its leaves. The water is scarcely coloured, leaves little residuum, gives but little taste, which induces the belief this is one of the plants whose roots secrete little or nothing of a decided character. This, however, is the result of only a simple hasty experiment made upon a plant at an early stage of its development.

The inferences which the author deduces from his experiments (acknowledging, however, that more extended trials on a greater number of families and individuals are desirable), are, 1st, That the greater number of vegetables exude by their roots substances unfit for their vegetation. 2d, That the nature of these substances varies according to the families of plants which produce them. 3d, That some being acrid and resinous, may be injurious, and others being mild and gummy, may assist in the nourishment of other plants. 4th, That these facts tend to confirm the theory of rotation due to M. de Candolle.

A few Notes upon the Dark Days of Canada. By the Honourable Chief-Justice SEWELL, President of the Literary and Historical Society of Quebec.

AMONG the atmospherical phenomena of Canada, the dark days of October 1785, and of July 1814, appear worthy of notice. They were remarkable for their peculiarity of character, and for the circumstances by which they were accompanied; and as an attempt to explain the cause of the remarkable obscurity by which they were more particularly distinguished, has never, to my knowledge, been made, I propose in the present paper to offer such accounts of these phenomena as I have been able to collect, with a few observations, which I hope will not be thought unworthy of attention.

The first dark day of which we have any detailed account, was Sunday the 16th of October 1785. On the 9th of that month, a short period of obscurity occurred at Quebec, about four in the afternoon, and during its continuance the sky in the north-east quarter below the city exhibited a luminous appearance upon the line of the horizon, of a yellow tinge. On the 15th, about three o'clock in the afternoon, there was a repetition of the same luminous appearance in the horizon in the same quarter, the north-east, accompanied by a second period of obscurity somewhat longer in duration than the first. Both of these periods were accompanied by violent gusts of wind, by thunder, lightning and rain.*

The morning of Sunday the 16th of October 1785 was perfectly calm, and there was a thick fog, but the fog was nothing more than what is often seen at that season of the year. Towards nine o'clock, a light air from the north-east sprung up, which increased rapidly. The fog by ten o'clock, was entirely dissipated, black clouds were then seen rapidly advancing from the north-east, and by half after ten, it was so dark, that printing of the most usual type could not be read. This lasted for upwards of ten minutes, and was succeeded by a violent gust of wind, with rain, thunder, and lightning, after which the weather became brighter until twelve o'clock, when a second period of so much obscurity

* Quebec Gazette, 20th October 1785.

took place, that lights became necessary, and were used in all the churches: this period was rather longer in its duration than the first. A third period of obscurity came on at two o'clock, a fourth about three, and a fifth at half-past four o'clock, during which the intensity of the darkness was very great, and is described by those who witnessed it to have been that of perfect midnight. During the whole of these periods, and of the intervals between them, vast masses of clouds of yellow appearance, which were very remarkable, were driven with great rapidity from the north-east towards the north-west by the wind. There was much lightning, thunder, and rain. The periods of total darkness were about ten minutes each, and although the intervals were not so dark, they afforded but little light.

The barometer was stationary the whole time at 29.5; and the thermometer, which stood in the morning at 52°, fell two or three degrees in the course of the day.*

The water which fell from the clouds was extremely black, and the next day, upon the surface of what was found in different vessels, a yellow powder was floating, which upon examination proved to be sulphur. A deposit of a black substance like powder was also found in the bottom of all these vessels, but I am not aware that it was submitted to any test whatever.†

Phenomena similar to those which have been described, took place at Montreal, on the same 16th day of October; but the darkness did not there commence until about two in the afternoon. The clouds were of the same remarkable yellow tinge, and were accompanied by gusts of wind, thunder, lightning, and rain. There was a period of obscurity at half-past two o'clock, a second at a quarter past three, and a third at five, and during all of them the darkness was so intense, that to use the expression of one who was an eye-witness, "*jamais nuit ne fut plus obscur.*" A medical gentleman of Montreal perceiving the black colour of the rain, collected upon a strained piece of muslin a certain quantity of the black pulverised matter with which it was charged, and rubbing it between the fingers, and by ignition, this was found to be strongly impregnated with sulphur. It does not, however,

* Meteorological Journal by the late Rev. Dr Sparke.

† Quebec Gazette, 20th October 1785, and Dr Sparke's Journal.

appear that any other experiment was made with it, so that we have no farther data to determine its qualities, a circumstance much to be regretted.*

I shall now lay before the society, some accounts of the more recent appearances of the 3d of July 1814, which will be found to be very similar to those which were observed on the 16th of October 1785. These accounts consist principally in four narratives, which I shall give at large. One from the pen of an officer of the Royal Engineers, who is supposed to be Captain Payne, describes the appearances at the Bay of the Seven Islands above Anticosti, on the 2d and 3d of July. The next describes the appearances during the 2d at Cape Chat, from observations made by some officers, who were on board the Sir William Heathcote transport, which lay the whole of that day at anchor in the river St Lawrence, at that point. The third contains some additional observations respecting the appearances on the 2d of July, made on that day in another ship which also lay off Cape Chat; and the last narrative describes the appearances of the 3d day of July, upon the banks of Newfoundland, of which I was an eye-witness. It is taken from a Journal of a voyage to England, which I made at that period in the *Phœnix*, from Quebec to England.

Before I enter upon these narratives, I beg leave to premise, that the darkness of the 2d of July 1814 does not appear to have extended much beyond Cape Chat. A mixture of ashes, and a black substance in powder, fell in partial showers at Kamouraska; and the day was there observed to be dull and gloomy †, but it was not considered to be peculiarly dark, and on this side of Kamouraska it does not appear to have attracted any particular notice; at Quebec also it exhibited nothing extraordinary, except that yellow tinge upon the clouds, bordering the line of the horizon to the north-east quarter of the heavens, which has already been mentioned, and is not unfrequently seen from the walls of the garrison.

The narrative of Captain Payne is taken from Tilloch's Philosophical Magazine, and Mr Tilloch's correspondent makes the following introductory remark upon it:—"Your philosophical

* Quebec Gazette, 27th October 1785.

† Information from several persons.

readers will not fail to notice the coincidence between the phenomena described below, and those which were observed at St Vincent, and other islands in the West Indies, upwards of a year ago."

This narrative is entitled, "Remarks on board ship in the River St Lawrence, distant about twenty miles from the Bay of Seven Islands above the Island of Anticosti, 3d July 1814.

"Yesterday morning, at six A. M., the weather dark and cloudy, with a few drops of rain falling, winds high and variable, chiefly from the eastward, and through the day carrying all sail: the sails, however, of very little use, from a swell of the sea from the westward, which rendered the pitching of the ship very great, and nearly endangered the carrying away of the masts and yards. Towards evening the swell abated. During the day the clouds appeared to be coming with great rapidity *from the northward*; horizon and atmosphere thick and hazy. At night the darkness excessive, the masts and rigging scarcely visible from deck. About nine P. M. a sort of dust or ashes commenced falling, and continued during the night. Towards the morning the whole atmosphere appeared red and fiery to a wonderful degree, and the moon, then at the full, not visible, and the appearance through the cabin windows and crystal lights on the deck singular in the extreme, as if surrounded by a mass of fire; the sea sparkling much, and in a manner not usual in those latitudes. At half-past seven in the morning, candles lighted in the cabin, and the hour, by a watch, at nine, scarcely visible, the flame of the candle burning of a bright bluish-white colour, and the fire in the cook-house the same, *the wind dying away to a dead calm*. Towards noon to-day, the atmosphere resumed something of its natural appearance, and the sun visible, but red and fiery, as in the winter season, as if seen through the darkened glass of a quadrant, and by degrees becoming more of a yellow colour. Weather hazy and sultry, a dead calm, and the sea scarcely agitated. The sea covered with ashes, and a bucket of water taken up appeared nearly as black as writing ink, from the quantity of ashes which had fallen: they appeared as those of burnt wood, and not of a heavy sandy nature, a strong smell perceptible in the air, and a violent headach complained of by many on board.

Not having a thermometer on board, the temperature could not be observed; it did not, although close and sultry at times, appear to be remarkable for the season of the year, numbers of small birds flying about seemingly much disturbed. The darkness at eight A. M. to-day as great as is usual in London in the month of December at the same hour. From the darkness during the night, the seamen were obliged to use lanterns with candles on deck to conduct the navigation of the ship. Longitude 65° 48′ west, and latitude 49° 49′ north.—July 4th. This day the ashes falling in a small quantity, and the darkness last night excessive again, so much so that the hand could not be observed while touching the face. At half-past three P. M., scarcely able to see the hour by a watch. The ashes collected on deck appeared to be those of burnt wood, but darker and more heavy than the ashes from a tobacco pipe. That collected from the surface of the sea, when dried, resembled a cake of shoe-blacking. Several ships, in different quarters of the Gulf and River St Laurence, observed the same appearance of darkness, which appears to have been pretty general, although not to the same degree. No reason can as yet be assigned for this extraordinary phenomenon:—it is conjectured by many to be the consequence of a volcano, but the ashes by no means resemble those thrown up by the volcano on St Vincent, in the West Indies, some time since."

The narrative of the officers who were on board the *Sir William Heathcote transport*, states, that, on the 2d of July 1814, there was a heavy fall of *ashes and sand*, which was succeeded by a dense haze, which gradually increased until eleven o'clock in the day, when it cleared up, and the sun was of a blood red colour. At one o'clock it again became so dark that the soldiers on board could not see to divide out their dinners without lighted candles. This darkness continued until night, and during the whole time ashes fell in abundance, and completely covered the deck. The transport was the whole day off Cape Chat, the wind blew gently *from the north shore of the St Laurence.* The people residing down the river declared there had not been any appearance of fire in the woods *.

* The above was received from the officers on board the Sir William Heathcote, by Lieut. Ingal, of the 15th regiment, who favoured me with a copy.

The third narrative is as follows:

"On the 2d instant, (July 1814) being off Cape Chat, the sun assumed a very bright blood colour, and at half-past two, a total darkness ensued. This continued till about sunset, when the horison somewhat cleared, but, at nine o'clock, it became so dark, that it was impossible to observe any object, however near, without the help of lanterns. The ship laid-to till two A. M., when the obscurity disappeared. It is difficult to account for this phenomenon, as it was not observed beyond fifteen leagues on either side of the spot where the ship lay. For three days previous, some ashes and smoke had been observed; but, on the second, no symptoms of burnt wood were felt. It may be presumed, that some volcanic eruption has taken place in a north-easterly direction, which caused total darkness in a breadth of about fifteen leagues from each side of Cape Chat *."

The fourth narrative is in these words:

"*3d July* 1814—*Sunday.*—A most extraordinary day. In the morning, dark thick weather, and fog of a deep yellow colour, which increased in density and colour until four o'clock P. M., at which hour the cabin was entirely dark, and we dined by candle light; the binnacle also was lighted shortly after. In the evening, at twenty minutes after sunset, there was total darkness, so much so, that on deck a man could not see another at three feet distance: this continued until the moon arose, when there was some little appearance of light, but very little; it gradually went off, until it disappeared in the morning of the 4th of July. The wind, during this extraordinary obscurity, was *westerly, with some northing*, and the *Phœnix* was in latitude 45′ 50″ north, and longitude 53′ 12″ west.

The relative positions of the ship in which Captain Payne was embarked, the *Sir William Heathcote*, with her associate transport, and of the Phœnix, may be readily seen upon reference to a map of the Gulf of St Lawrence; and from inspection, it will be perceived, that the northerly wind which blew on the 2d of July carried the clouds of ashes, dust, sand, smoke, and vapour, across the river St Lawrence, in a line from the Bay of Seven Islands to Cape Chat; and that by the westerly

* Quebec Gazette, 28th July 1814.

wind which set in in the night of the 2d July, they were carried, probably with more of the same description, across the Gulf of St Lawrence, and the Island of Newfoundland to the place in which the Phœnix then was; and on the *third* of July, enveloped her in the same obscurity with which Captain Payne's ship, the Sir William Heathcote, and the other transports, were enveloped on the preceding day.

For the phenomena of the dark days of Canada which have been thus detailed, there appear to be but two causes to which they can be attributed,—the conflagration of a forest, and volcanic action.

As to the conflagration of a forest, the facts of which we are in possession do not appear to warrant a belief that such can be the cause. It seems impossible to suppose that the conflagration of any forest could have produced a mass of smoke so dense and so extensive as to overspread (as it did in October 1785) the surface of a territory, exceeding certainly 300 miles in length, and probably 200 miles in breadth *, and producing, at its utmost longitudinal extremity, and at mid-day, the obscurity of the darkest night. And as the whole of the cause of this obscurity proceeded apparently from the Labrador country, where forest-trees are few in number, stinted in size, and spread in small isolated patches over a general surface of rock, it is the more improbable. In point of fact, such a mass of wood smoke could not have been collected without exposing the individuals which it enveloped to the danger of suffocation; and it is not said in any of the accounts which are extant, that this was the case, or that their eyes were affected, or that there was even a smell of wood smoke. Captain Payne has indeed observed, that "the *dust or ashes* collected on the deck appeared to be those of burnt wood;" but he immediately adds, that they were darker and more heavy than the ashes from a tobacco pipe, which are also vegetable ashes, though of another description; and from the

* In October 1785, the obscurity extended so as to comprehend on one side, Fredericton, in the province of New Brunswick, and on the other, Montreal. A ship, the *Adamant*, belonging to the house of Brooke, Watson, & Co. in which, it is understood, the late Sir John Johnson was a passenger, on the 16th of October 1785, was, in the morning, off the east end of the Island of Anticosti: there it was then clear weather, but towards the west they saw a heavy black cloud, and by 12 o'clock on the same day had sailed into it, and very shortly afterwards found themselves enveloped in perfect obscurity.

quantity of salts which tobacco contains, tobacco ashes will probably be found heavier, or at least as heavy as an equal quantity of common wood ashes. He mentions also, that the powder which was collected from the surface of the sea, when dried, resembled a cake of blacking ; and from this circumstance, I am led to believe, that what was so collected might be of a bituminous character, or possibly the powder of volcanic matter. If it had been wood-coal in powder, I do not apprehend that it would have caked when dried ; and I may add, that there was no appearance of fire in the wood, and that this fact was particularly noticed by the inhabitants, during their intercourse with the officers on board the Sir William Heathcote, and the third narrative expressly states, that " on the 2d, no symptoms of burnt wood were felt."

But there are among the facts which are detailed, some which cannot be reconciled to the supposition that the phenomena in question were occasioned by the burning of a forest. I allude particularly to the presence of sulphur among the black pulverised matter which fell on the 16th of October 1785, and to the precipitation of the latter in water, from which circumstance it may be presumed to have been of mineral origin, and similar to that which was ejected from the Souffrier mountain of St Vincent's on the 30th of April 1812;—to the extraordinary swell of the sea which preceded the appearances which took place on the 2d of July 1814;—to the bluish-white flame of the lights and fires mentioned by Captain Payne;—to the strong smell which was perceived in the air, and which, without affecting the eyes, produced violent headach;—and to the shower of sand mentioned by the officers who were on board the *Sir William Heathcote.*

These facts appear to me to render it necessary to impute the phenomena of the dark days of Canada to volcanic action, and to indicate strongly the existence of a volcano (not yet extinct) in the Labrador territory ; an inference which is strengthened by these considerations, viz.: That on the second of July, the Bay of Seven Islands and Cape Chat were enveloped in the darkness of that day by a northerly wind, and that on the 3d July, while the weather was clear at Cape Chat, the Bay of Seven Islands, and that part of the Atlantic Ocean which lies in latitude 45′ 50″ north, and longitude 53′ 12″ west, (the position of the Phœnix on that day), were enveloped in similar darkness, by "*a westerly wind with some northing*;" for if a map of the Gulf of St Lawrence and the adjacent coasts be inspected, and the position of Captain Payne's ship, of the Sir William Heathcote transport, and her consort, and of the Phœnix, be considered, it will be evident that the wind, as well on the 2d as on the 3d day of July, traversed the Labrador territory, producing in two different directions from that territory the same effects.

The existence of volcanos in the north of Europe, particularly Hecla and Jan Mayen, afford ground for the belief, that volcanos may also be found to exist in the north of the American continent. The north shore of the St Lawrence appears also to exhibit proofs of volcanic action. Malbaic, the Eboulements, and perhaps the promontory of Quebec, may be cited in support of this assertion; and the frequent recurrence of slight shocks of earthquakes in the places first enumerated, may be mentioned as facts from which a continuance of this volcanic action may be inferred. There is, moreover, a good deal of coincidence in the facts stated in the preceding narratives of the dark days, and those which are stated by Charlevoix, in his description of the earthquake in 1663, which is generally supposed to have been of volcanic origin. "A Tadoussac" (says he), "Il pleut *de la cendre* pendant six heures,"—tom. i. p. 367. And in page 366, he adds, "Une poussiere qui l'eleva fut prise pour une fumée, et fit craindre un embrasement universel."

I will only add, that among the Indian tribes on the north shores of the St Lawrence, a traditional belief of the existence of a volcano in the Labrador country is said to prevail; but of the truth of this assertion, common report is the only evidence I can offer, except indeed to those who may still be inclined to believe that basalt may ultimately be found to be a volcanic and not an aqueous production, for by such persons the recent discovery of basaltic columns on the coast of Labrador, described in the first volume of the transactions of this society *, may be considered to afford some further proof of the authenticity of this tradition.—*Trans. of the Lit. and Hist. Soc. of Quebec*, vol. ii. p. 230.

* Page 71 to 73.

Hygrometrical Observations made at Bancoorah in Bengal. By George Macritchie, Esq. Communicated by the Author.

Sir,

In the communication I had the honour of transmitting to you on the 12th March 1832, I mentioned that I had kept no register of the hygrometer at Bancoorah. But I find a connected series of hygrometrical observations for a twelvemonth at that place, which I now feel pleasure in sending to you.

Table.

1828.	Noon.				
Months.	Temperature of Room.	Dew Point.	Difference.	Barometer at Noon.	Rain in Inches.
	°	°	°	in. l.	
May	91.00	82.50	8.50	30.025	.144
June	87.50	84.25	3.25	29.825	7.368
July	83.50	82.75	0.75	29.475	8.698
August	83.75	82.75	1.00	29.425	5.682
September	83.00	82.25	0.75	29.500	7.272
October	80.75	79.25	1.50	29.700	3.166
November	76.00	74.25	1.75	29.825	.601
December	70.50	68.25	2.25	29.775	
1829					
January	69.00	66.50	2.50	29.775	.152
February	72.75	68.75	4.00	29.775	.080
March	83.25	76.25	7.00	29.975	
April	89.00	81.00	8.00	30.075	.368
Average for the year	80.83	77.39	3.44	29.762	33.531

April 1828 was parching weather throughout; but unfortunately I did not remark the hygrometer before the last day of that month, when at noon the dew point was 76°.50, the temperature of the room being 91°.50, shewing a difference of 13°, the greatest I ever observed.

The average monthly range of the thermometer and of the barometer, whilst I kept a register at Bancoorah at the hours of observation, is subjoined as under.

Table.

Months.	Temperature at 10 A. M, Noon, and 10 P. M.		Months.	Pressure at Noon.	
	From	To		From	To
	°	°		IN. L.	IN. L.
January	62.00	72.00	January	29.700	29.900
February	65.00	79.00	February	29.625	29.850
March	70.00	87.00	March	29.625	29.900
April	79.00	92.00	April	29.700	29.900
May	79.00	94.00	May	29.650	29.900
June	79.50	90.00	June	29.450	29.650
July	79.50	86.00	July	29.300	29.500
August	80.00	85.75	August	29.300	29.550
September	78.00	85.75	September	29.375	29.625
October	75.00	84.50	October	29.550	29.775
November	68.00	78.50	November	29.700	29.875
December	64.00	74.00	December	29.700	29.900

The barometer regularly fell a little after I took my observation at noon, until about 4 P. M., when it rose again towards and after evening. The fall was generally about half a line. But during the latter end of March, and the whole of April and May 1828, and in March and April 1829, when the barometer was above 30 inches, this change was very little.

Deeply sensible of your goodness, I remain, &c.

GEORGE MACRITCHIE.

CLUNIE, 7*th January* 1833.

To Professor Jameson, Edinburgh.

On an Acid Liquid obtained through the Agency of Potash on Alcohol; and on the Nature of the Lampic Acid. By ARTHUR CONNELL, Esq., F. R. S. E. (Communicated by the Author.)

WHILST the interesting properties of the various ethers have made the mutual action of alcohol and the several acids an object of careful study with the chemist, the relation of alcalies to alcohol has been comparatively little examined. Until lately, little or nothing was known on this latter subject; but within the last year or two a few facts have been ascertained, principally from some researches of M. Hess of St Petersburg.* It

* Bullet. des Sciences Chim. Juin, 1831.

has been found, that when a solution of potash in alcohol is exposed to the contact of atmospheric air, oxygen is absorbed; and that the deep brown colour, which it has been long known is assumed by such a solution, is owing to the formation of a red matter, which may be separated in the solid state by saturating the potash with an acid, and which has been supposed to be of the nature of a resin. These facts I had occasion to observe before I had any knowledge of the experiments establishing them, which have been recently published on the subject; but I do not wish to enlarge on them at present, as the object which I have more immediately in view, is to determine whether any products of an acid nature result from the action of potash on alcohol, and what these products are.

1. *Acid Liquid from Potash and Alcohol.*—Berzelius, in his Treatise on Chemistry, observes, that it had been *said* that acetic and carbonic acids were produced during the action in question; but adds, that he was not aware of any special research on the subject, although it was known that the solution did not deposit any carbonate of potash *. Subsequently to these observations of Berzelius, M. Hess, in the course of his researches, made some experiments, with the special view of ascertaining whether acetic acid resulted from the action. He evaporated a considerable quantity of an alcoholic solution of potash; and on treating the residue with sulphuric acid, he states, that he did not find that any acetic acid was disengaged. In making similar experiments, however, I had uniformly observed, that on adding sulphuric acid to the residue of the evaporation, a pungent odour was disengaged, having a strong resemblance to that of acetic acid in its less concentrated forms; and I was therefore strongly induced to suspect that a portion of this acid really did result from the action.

The first instance in which I made a direct and careful research to ascertain the fact, was with a portion of an alcoholic solution of potash, which had been kept in a corked bottle for several months, and had long acquired a deep brown red colour. This solution was poured out into an evaporating dish, and allowed to stand exposed to the air for some days, till the alcohol was evaporated away. The water was then farther evaporated

† Lehrbuch der Chemie, iii. 992.

by heat, nearly to dryness; the residue redissolved in a very small quantity of water, and sulphuric acid added by degrees. Effervescence, of course, took place from the formation of carbonate of potash, by exposure to the air, and a strong odour, resembling that of acetic acid, was disengaged. The liquid was then carefully distilled at a moderate heat. A colourless liquid passed over, which had the following properties: It reddened litmus paper. It had a weak acetic odour. Its taste was slightly acid, and ultimately somewhat empyreumatic. It effervesced, although not strongly, with carbonate of potash, and afforded, by evaporation, a deliquescent salt, which did not crystallize. Mixed with a strong solution of protonitrate of mercury, and heated to boiling, there was a slight effervescence and precipitation of a small quantity of a grey powder, which was metallic mercury. When hot solutions of the salt, formed with potash and of protonitrate of mercury, were mixed together, a similar effervescence and precipitation of metallic mercury ensued.

It was thus sufficiently manifest, that an acid product had resulted from the mutual action of the alcali and alcohol, and it only remained to determine its nature. The reducing action on the salt of mercury pointed to the formic acid: but I immediately thought of the puzzling reducing appearances which were presented by the lampic acid; and it occurred to me that this new acid product might be of a similar nature, and might prove to be a disguised acetic acid. It became necessary, therefore, to examine some of the combinations of the acid liquid with bases; and as the question seemed to lie very much between formic and acetic acids, I followed Berzelius in selecting the salts of magnesia and of lead, as by far the best calculated for distinguishing between these two acids. Portions of the acid liquid prepared by the same process as before, from an alcoholic solution of potash of a similar age, were separately saturated with magnesia and carbonate of lead; and after being concentrated were set to evaporate spontaneously. Comparative trials were at the same time made by saturating portions of the same base separately with acetic acid and formic acid, prepared by Dobereiner's process. The magnesian salt of the acid from alcohol afforded a deliquescent mass; from which, however, after it had been exposed to the air for about a month, several minute crystals were separated, presenting the appearance of somewhat circular looking tables, and exactly similar to the crystals of formate of magnesia, which had been obtained at a much earlier period in the comparative trial. The salt of lead crystallized in prisms, and on examining these, as to their solubility in water, there were evidently present crystals of a much inferior solubility to acetate of lead, although apparently mixed with a more soluble salt. The conclusion which appeared to follow from these observations was, that the acid was a mixture of acetic and formic acids; and the subsequent examination was conducted with the view of obtaining greater certainty on this point, as well as to ascertain whether the acid products were formed in solutions of shorter standing than those before employed.

I accordingly examined solutions of all ages, from ten days to some months; and satisfied myself that in all cases an acid product resulted, apparently increasing in quantity as the exposure to air was prolonged. Probably the readiest way of showing the reaction, is to place an alcoholic solution of potash at the bottom of a tall glass jar, and simply to tie the mouth round with filtering paper. In this way, free access of fresh air is admitted to the solution through the pores of the paper, as the absorption of oxygen goes on, and in eight or ten days a deep coloured red solution is obtained. In this mode of operating, the alcohol is of course gradually weakened by the exposure to the air, and, after a certain time, the formation of acid appears not to increase. The red solution is then to be poured into an evaporating basin, and the alcohol expelled, either by heat, or, which is still better, by simple exposure to the air. The residue is next to be evaporated nearly to dryness, re-dissolved in as small a quantity of water as is sufficient to take up the whole, including the resinous matter, which cannot be separated without at the same time separating some of the acid product in combination with potash. Diluted sulphuric acid is to be added at intervals to the solution contained in a flask, which may be kept cool during the action, by plunging it in water, and the whole then carefully distilled. If the product of the distillation be saturated with carbonate of soda, concentrated by evaporation, again saturated with sulphuric acid, and distilled in a tube retort, a more concentrated acid liquid is of course obtained; and this method may be followed in all cases in which it is wished to have a more concentrated liquid; the acid properties of the product of the first distillation being always weak, especially where too much water of solution has been employed. I also ascertained, that the action is very greatly accelerated by a considerable increase of temperature; whilst, at the same time, a current of atmospheric air is passed through the liquid. A quantity of the alcoholic solution was placed in a matrass, and, through a cork placed in its mouth, two glass tubes were passed, the one tall and having a bulb blown in its centre, and the other reaching to the bottom of the vessel. The liquid was then made to boil, whilst a current of air was passed at short intervals through the latter tube, the former being kept moistened with bibulous paper, and serving the purpose of condensing a part of the alcohol as it rose in vapour. In this way the liquid became deep red in the course of an hour, and by heating the solution as formerly, a similar acid liquid was obtained. A better arrangement would be to perform the operation in a tubulated retort, passing the tube conducting the air through the tubulature to the bottom of the retort, and condensing the volatilized alcohol in a receiver.

In repeating the experiments to obtain the crystals of formate of magnesia from the acid liquid, I found that considerable difficulty was experienced in obtaining them, the crystals never forming until the lapse of some weeks, and in many instances not forming at all. This circumstance is owing to the deliquescent and uncrystallizable acetate of magnesia which accompanies them, and also to the presence of matter probably analogous to the resinous substance; and I have found that, on saturating a mixture of formic and acetic acids with magnesia, the presence of the acetate proved a great obstacle to the crystallization of the formate. By the following process, however, founded on the different degrees of solubility of the acetate and formate of lead, I obtained a very satisfactory result. To insure success, a somewhat considerable quantity of materials was employed. Seventeen ounces of an alcoholic solution of potash were placed at the bottom of several tall jars, the mouths of which were tied round with paper. The liquid was left for eight days, and then by following the process already fully detailed, a quantity of an acid liquid was obtained, which was saturated with carbonate of lead, filtered, concentrated, and crystallized spontaneously. The prismatic crystals obtained were treated with a small quantity of cold water, for the purpose of taking up the more soluble acetate of lead: and the solution decanted. A quantity of fine spicular crystals remained undissolved. These were found to be of very sparing solubility in cold water; but their solution was effected by heat. The oxide of lead was then very carefully precipitated by sulphuric acid; and the sulphate of lead allowed to subside. The decanted liquid was then saturated with magnesia, filtered, concentrated, and set aside. In four or five days it was almost entirely transformed into well characterised crystals of formate of magnesia; the peculiar somewhat circular and tubular form of which is extremely well calculated to enable a person accustomed to observe them, as crystallized on the small scale, to determine the existence of formic acid. The appearance of these crystals, together with the sparingly soluble salt of lead, thus left no doubt as to the presence of this acid in the liquid under examination.

The existence of acetic acid in the same fluid was best ascertained by its action on peroxide of mercury. If peroxide of mercury be boiled in pure acetic acid, it is dissolved, and a solution of peracetate of mercury obtained. If it be treated in the same way with formic acid, it is reduced, metallic mercury being precipitated with effervescence. If instead of either acid in a state of purity, a mixture of the two acids be boiled with the red oxide, the formic acid not being in excess, then this latter acid exercises its reducing action on the oxide, with effervescence; but before the reduction is complete, the acetic acid arrests the metal in the state of protoxide, and a precipitation of protoacetate of mercury ensues on the cooling of the liquid. This is the action which I have constantly obtained on treating peroxide of mercury with a mixture of acetic and formic acids, the latter not being in excess; and it is precisely this action which I have observed on treating that oxide with the acid liquid in question. For this purpose, however, it is necessary to concentrate it as much as possible, by saturating it with an alcali, and redistilling it with sulphuric acid; and if the concentration has not been carried far enough, the experiment will not succeed.

These results leave, I conceive, no doubt that the acid liquid obtained in the manner I have described, consists of a mixture of acetic and formic acids. I have also examined the salts it forms with barytes and lime. The former afforded prismatic crystals, and the latter an imperfect crystallization, resembling that of formate of lime. A concentrated solution of nitrate of silver is also reduced by it, like nitrate of mercury; effects which may be imitated with mixtures of acetic and formic acids.

2. *Nature of the Lampic Acid.*—I have already mentioned, that it occurred to me at an early period of the investigation, that the acid from alcohol and potash might prove to be of an analogous nature with the lampic; and as soon as I had determined the nature of the former of these products, I thought it extremely probable that the latter also would be found to consist of a mixture of acetic and formic acids.

The lampic acid, which was discovered by Sir Humphry Davy, was first examined by Mr Faraday, and was considered by him as a peculiar body *; although, from the very small quantities he was enabled to operate upon, he did not obtain any very definite result. It was afterwards more fully examined by Mr Daniell, who came to the conclusion, that it was a new acid body, and gave it the name which it still bears †. Subsequent experiments, however, induced Mr Daniell to alter his opinion as to its nature, and to conclude, that it was acetic acid, but combined with some substance of a highly disoxygenating nature, to which it owed its property of reducing metallic salts. He was, however, unable to separate this substance from the lampic acid procured from sulphuric ether, or to determine its nature; but he supposed that it was some compound of carbon and hydrogen, differing from ether or alcohol ‡. Very lately, it would appear, that Döbereiner has once more revived the idea, that the lampic acid is a substance of a peculiar nature, and differing both from acetic and formic acids §. I shall proceed, however, now to state the grounds on which I conceive it follows that the lampic acid from sulphuric ether really consists of a mixture of acetic and formic acids; and that the formic acid is the substance which bestows upon it its peculiar reducing qualities. The arrangement adopted for the preparation of the acid, was the following. A small evaporating basin

* Journal of Royal Institution, iii. 77. † Ibid. vi. 318.
‡ Ibid. xii. 64. § Poggend. Annal. xxiv. 608.

containing sulphuric ether, was placed at the bottom of a large cup. A piece of spongy platinum, of the size of a large pea, was then ignited, and suspended by a fine platinum-wire in a large glass funnel, which was inverted in the cup, so as to bring the spongy platinum a little way above the surface of the ether. An alembic head was then suspended a short distance above the upper part of the funnel. The spongy platinum, and the whole length of the platinum-wire, continued to glow as long as any ether remained, and a copious production of pungent acid vapours took place, a great part of which were condensed within the funnel, and fell back into the cup; and a part of those which escaped from the funnel were condensed in the alembic head. By placing one or two slips of glass below the under edge of the funnel, the free access of air was allowed to the inside. By a series of operations of this kind, any quantity of lampic acid which may be required is obtained in no very long time.

The acid thus prepared possessed the usual reducing properties of the lampic acid. Heated with protonitrate of mercury, there was effervescence and precipitation of metallic mercury. Heated with peroxide of mercury, there was effervescence, and, on cooling, a very copious deposit of protoacetate of mercury.

The latter of these experiments demonstrates the presence of acetic acid in the lampic acid. To ascertain whether it contained formic acid, I had recourse, as before, to the salts of magnesia and lead. Portions of the acid were saturated with magnesia, filtered, concentrated, and set aside. When the acid employed was that portion which had been collected in the alembic head, the formation of crystals of formate of magnesia could be more readily observed than when it had been collected in the cup, the former portion probably containing a larger proportion of formic acid, perhaps from that acid being more volatile than the acetic. When the acid from the alembic head was employed, I could generally observe, in the course of five or six days, with the lens, an incipient formation of minute crystals, which slowly increased in size and number; and in some instances, in the course of a week or two, the formation of crystals was sufficiently obvious, although in others it was less distinct. Where the acid collected in the cup was employed, the result was always much slower and less manifest, but still the formation could be observed, after some weeks, with the lens. By far the readiest and most satisfactory result, however, was obtained by the method formerly described, founded on the different solubility of the salts of lead. A quantity of lampic acid, collected in the cup, was saturated with carbonate of lead, filtered, concentrated, and crystallized spontaneously. The crystals were treated with a small quantity of cold water, to take up the acetate of lead. Undissolved spicular crystals were separated, and found to be of sparing solubility in cold water; but were dissolved by the aid of heat. The oxide of lead was then carefully separated, as before, by means of sulphuric acid, and the clear liquid saturated with magnesia, filtered, concentrated, and set aside. In four or five days, the formation of crystals was observed to be commencing, and in three or four more, nearly the whole was transformed into distinct crystals of formate of magnesia. Well characterised formic salts of lead and magnesia had thus been obtained, leaving, as I conceive, no doubt of the existence of formic acid in the lampic acid.

The synthetic proof of the nature of this acid was equally satisfactory. I made mixtures of acetic and formic acids; and found, so far as my examination reached, that all the leading curious effects on metallic solutions and oxides, which were observed by Mr Daniell to be produced by the lampic acid, might be imitated with the mixed acids. Thus, when a solution of chloride of gold was heated with a mixture of acetic aud formic acids, the liquid became muddy, and green by transmitted light, and the tube was coated with metallic gold. The colour of chloride of platinum was deepened by similar treatment. From a concentrated solution of nitrate of silver, the silver was thrown down as a brown powder. When a solution of peroxide of mercury, in acetic acid, was treated with a mixture of the two acids, and then allowed to cool, a copious precipitation of protoacetate of mercury ensued; and, as formerly stated, the same result followed when the peroxide was directly heated with the mixed acids.

I trust, therefore, that I shall be considered as warranted in concluding, that the lampic acid, from sulphuric ether, consists of a mixture of acetic and formic acids; and that it is the last of these acids which bestows upon it its peculiar disoxygenising qualities.

3. *Nature of the Acid obtained by distilling Alcohol, Peroxide of Manganese, and Sulphuric Acid.*—There is still another acid liquid, respecting the nature of which, the opinion of chemists has been divided; and which I have found to have an analogous composition with those already examined. After Döbereiner had made his interesting discovery, that formic acid might be obtained in a state of purity, by the action of sulphuric acid and oxide of manganese on tartaric acid, it is well known, that Gmelin applied the same process to several other organic products, such as sugar, starch, &c. * with an analogous result. Amongst these substances was alcohol, by distilling which with sulphuric acid and peroxide of manganese, he obtained an acid liquid which he regarded as formic acid. This liquid has lately been examined by Döbereiner, who, it would appear, maintains that it contains no formic acid, and consists only of acetic acid, and a portion of a volatile and pungent oily matter†. By similar processes with those already described, I have, however, ascertained, that formic as well as acetic acid enters into its composition. When saturated with magnesia, crystals of formate of magnesia were in due time deposited, surrounded with the deliquescent acetate; and when saturated with carbonate of lead, evidence was obtained of the existence of a prismatic salt, of less solubility than the acetate of lead. When the acid liquid was concentrated by saturation with an alcali, and redistillation with sulphuric acid, and was then heated with peroxide of mercury, effervescence ensued, and on cooling, deposition of protoacetate of mercury. These experiments, I conceive, establish the composition of this acid liquid to be quite analogous to the others which have been the subject of examination. The oily matter which, according to Döbereiner, is contained in it, can only, I should conceive, be viewed as an accompaniment not essential to the constitution of the acid liquid.

It seems also extremely probable, that it will be found that the acetic acid prepared by Döbereiner, in his apparatus for con-

* Poggend. Annalen. xvi. 55.

† Ibid. xxiv. 607.

verting alcohol into acetic acid, by the agency of black platinum powder (platinmohr) *, will be found to contain some formic acid mixed with it. But I throw this out merely as a probable conjecture, as I have never prepared or examined the liquid.

I intend still to make some experiments, with the view of endeavouring to determine the relative proportions of the acetate and formic acids, in the several acid liquids which have been under consideration; and also to examine the lampic acid, as prepared from nitric ether.

To trace minutely the nature of the process by which these acid products are formed, it would be necessary to know all the accompanying substances of a resinous or oily nature, which are produced at the same time, and the exact composition and order of formation of these several concomitant bodies. We may say, however, generally, that the formation of the acid products appears to depend on a slow process of oxidation exerted on alcohol or ether, or on the hydrocarbon contained in them. In the case of the lampic acid, this oxidation is an actual, although slow, combustion. In that of the acid from sulphuric acid, oxide of manganese, and alcohol, the action appears to depend on oxygen being presented to the alcohol, or its constituents, in its nascent state. In the action of potash on alcohol, it has been already stated, that oxygen is absorbed; and it would seem, that the affinity of potash for the acids produced, performs a principal part in determining this oxidation and new arrangement of elements.

On the Instincts of Birds. By John Blackwall, Esq. F.L.S.

The manners and economy of the inferior orders of animals, form one of the most interesting subjects of investigation which can engage the attention of the philosophic naturalist. An acquaintance with this important but greatly neglected branch of zoology, conduces to the correction of numerous erroneous opinions, and groundless prejudices, and opens an inexhaustible source of valuable information and rational amusement. It

* Poggend. Annal. xxiv. 603.

throws also much light on the operations of that mysterious agency which regulates those actions of animated beings, that, although attended with consciousness, do not result from observation, instruction, experience, or reflection, and have, therefore, generally been termed *instinctive actions.*

When we consider how many creatures are objects of superstitious dread or veneration, and what multitudes, even in this enlightened age and country, are sacrificed annually to mistaken notions of their mischievous properties, reason and humanity are alike shocked; and we deeply deplore the prevalence of errors, which the zealous promulgation of more correct ideas and liberal sentiments can alone effectually remedy. That useful bird, the white owl, which, on account of the great number of mice it destroys, ought to be carefully protected by the farmer, is frequently looked upon with terror as a forerunner of death, which it is supposed to announce by its loud and dissonant screams; and a small coleopterous insect, the *Anobiam tessellatum* of entomologists, has obtained the appellation of Death-watch, from a fancied connexion between the ticking sound it produces, and that awful event. The raven and magpie are imagined, by persons of weak intellect and timid dispositions, to prognosticate evil; and this notion has been extended and perpetuated by the allusions made to it in numerous legendary tales, and in the writings of our poets. To take the life of a swallow or martin, or to disturb their nests, is regarded as an unlucky event, portending disaster to the unfeeling aggressor; and the redbreast and wren owe much of their security to popular prepossessions, equally without any rational foundation. Many birds, which subsist almost entirely on insects, as the cuckoo, redstart, and flycatcher, are shot by ignorant gardeners and nurserymen, indiscriminately with those species which feed principally on the seeds of plants and other vegetable productions. The goatsucker and the hedgehog are falsely accused of sucking the teats of animals, and a price, usually paid out of the parish rates, is still given for the latter in many parts of England*; and those

* Sixpence a-head, I am well informed, has been recently obtained for hedgehogs in this parish. Now, it is truly disgraceful that any portion of the public money should be expended to encourage the destruction of an inoffensive animal, which derives its support from insects and vegetables, because, in the opinion of the vulgar, it is injurious to cattle.

beautiful and harmless reptiles, the common snake and blind-worm, are destroyed without pity, upon the groundless supposition that they are venomous.

These are a few instances only, selected from many that have fallen under my own observation, of the pernicious consequences which result from an ignorance of that useful portion of natural history, which at present engages our consideration.

We will now proceed to notice, briefly, some of the numerous advantages to be derived from a successful cultivation of this delightful study; and a correction of the above-mentioned errors and abuses, with the needless waste of life which it would prevent, is not among the least of them. For the preservation of our persons and property from those creatures, by which they are liable to be injured; for the best methods of promoting the increase, improving the condition, and effecting the subjection of such as contribute to our benefit or amusement; and for the skilful management of our valuable reclaimed and domestic animals, which supply us with so many comforts and luxuries, we must depend, in a great measure, upon our knowledge of their habits, manners, and propensities. To this knowledge, also, the practical physiologist is indebted for a means of enlarging his acquaintance with the phenomena of life; the scientific naturalist, and particularly the ornithologist, for an excellent mode of distinguishing species, under circumstances in which the ordinary rules for determining them are of little or no avail; and the physico-theologist, for a more comprehensive view of the power, wisdom, and goodness of the Creator, as manifested in his living works.

Having thus succinctly adverted to the great importance of accurate information in this extensive department of zoology, I shall now limit my remarks exclusively to the feathered tribes; and whoever attentively considers the diversified operations of the various active powers, with which the interesting beings that compose this pleasing division of the animal kingdom are endowed, cannot fail to receive a high degree of mental gratification.

It frequently happens, that the experienced observer is enabled to discriminate birds with the utmost certainty by their notes, manner of flight, or some other peculiarity, when he has no opportunity of procuring specimens of them, or of ascertaining the colours of their plumage. Indeed, in this last particular, distinct species, as the willow wrens, several of the larks, finches, &c., so nearly resemble each other; and individuals of the same species, as many of the falcons, gulls, sandpipers, ducks, &c., are so very dissimilar, and vary so greatly with age, change of season, and other circumstances, that colour cannot always be relied upon as affording sufficient evidence of specific identity. A much surer criterion will be found in the uniformity so conspicuous in the manners and economy of birds of the same kind; a coincidence which can only be accounted for by supposing that their actions are instinctive. That this is actually the case I shall attempt to shew, though it must be admitted that they are occasionally modified, in a considerable degree, by the exercise of the intellectual faculties.

I will not occupy the time of the Society in examining the many vague and contradictory opinions, which have been entertained with regard to the nature of instinct, by the various authors who have written on the subject, being convinced that they are purely speculative, and tend to retard, rather than advance, the progress of science. We must not, however, pass unnoticed, the sophistical doctrine, so ingeniously maintained by Dr Darwin, in Zoonomia*, that what is usually termed instinct in animals, has reference to the powers of intellect solely; since the feathered tribes, notwithstanding the highly curious and unequivocal examples of instinctive actions which they exhibit, have furnished him with some of his most plausible arguments in support of it.

Depending on the assertion of Kircher†, that young nightingales, when hatched by other birds, never sing till they are instructed; and confiding in the remarks of Jonston‡, that the nightingales which visit Scotland have not the same harmony as those of Italy; Dr Darwin was hastily led to conclude, that the songs of birds, in general, are artificial. Having observed, also, that poultry readily obey their usual summons to be fed, and that young ducks, hatched under the domestic hen, soon appear to understand her calls; and giving credit to the mistaken idea,

* See the section on Instinct, vol. i.

† De Musurgia, cap. de Lusciniis.

‡ Pennant's British Zoology.

that wagtails and hedge-warblers feed the young cuckoos they bring up, long after they leave the nest, whenever they hear their cuckooing, which, on the authority of Linnæus*, he states to be their cry of hunger, he was induced to adopt the same opinion respecting their calls. Now, whether the song of the nightingale results from education, as Kircher maintains, or whether it is wholly independent of tuition, I have never had any direct means of deciding, as the bird is only an accidental visitor in this part of the kingdom. From unexceptionable experiments, however, made with the greatest care, on several other species of British singing-birds, I have no hesitation in affirming, that the peculiar song of each is the natural consequence of an instinctive impulse, combined with a suitable state of the vocal organs. This latter condition deserves particular attention, for it is a fact, which has been very generally overlooked, that most of our songsters are absolutely unable to continue their melodious strains beyond the latter end of July, or the beginning of August; the strenuous but unavailing exertions they make to prolong them, sufficiently proving their silence not to be a matter of choice, but of necessity. This circumstance, together with the extreme difficulty they experience in recommencing their songs in spring, clearly demonstrates, that their delightful warblings depend upon the energy of those muscles which contribute to form the voice; an energy which appears to be influenced chiefly by food, temperature, and the exercise of the reproductive functions; for, by due attention to the regulation of these particulars, the vocal powers of caged birds may be called into action, or circumscribed at pleasure. Of this, persons who have the management of breeding canaries may easily satisfy themselves; and female birds, in a state of captivity, when brought into high condition, are known, occasionally, to assume the song of the male. That Jonston must have been deceived in supposing he heard the nightingale in Scotland, is evident, as it is well known that this warbler is never found north of the Tweed, in Great Britain. It has been ascertained, too, contrary to the opinion of Linnæus, that young cuckoos, before they come to maturity, utter a feeble cry only; they cannot, therefore, acquire the calls of their species while

* Systema Naturæ.

they remain in this country. No wonder, then, that the conclusion Dr Darwin arrived at was erroneous, when the premises on which his reasoning is grounded are so inaccurate.

It is not, let me remark, intended to insinuate, that birds are incapable of attaining any knowledge of each other's notes, since our domestic fowls, in many instances, are certainly enabled, by observation and experience, to connect vocal sounds with the ideas they are designed to convey *. The martin also readily learns to distinguish the swallow's call of alarm ; and the ringed plover, sanderling, and dunlin, when associated together, evince, by the promptitude and exactness with which they perform their various aërial evolutions, that they comprehend one general signal. All that is meant to be insisted upon is, that the notes peculiar to every species, in a state of nature, are instinctive. This I have endeavoured to prove, in an essay read before the Society in 1822, and printed in the fourth volume of the new series of Memoirs, by shewing, that even such individuals as are brought up in situations where they have no opportunity of being instructed in their appropriate notes, do, nevertheless, utter them naturally.

The pairing of wild birds, and the period at which they prepare to perpetuate their species, are determined, according to Dr Darwin, by the acquired knowledge, that their joint labour is necessary to procure sustenance for a numerous progeny, and that the mild temperature of the atmosphere in spring is suitable for hatching their eggs, and for producing a plentiful supply of that nourishment which is wanted for their young. This opinion he attempts to support by the fact, that poultry, which have an abundance of food throughout the year, and are protected from the inclemency of the weather, lay their eggs at any season, and never pair. But it should be recollected, that this is not the case with pigeons placed under similar circumstances, which do pair, though they produce only two young ones at a time; and that the pheasant among our naturalized, and the black grouse among our native, birds, though they have both

* When our domestic cock gives notice to his mates that he has discovered some choice morsel of food, the turkey-hens always hasten to secure the delicacy, which the gallant chanticleer suffers them to take, even out of his beak, without the least molestation.

large families to provide for, are, in their wild state, polygamous. Indeed, it is evident from the anatomical researches of Mr John Hunter and Dr Jenner, that the sexual connexions of birds, and the season at which they breed, depend upon certain conditions of their organization, and not upon any information derived from experience or instruction.

The propensity to propagate their species, in this class of animals, is well known to be of periodical occurrence; and dissection clearly proves, that it is always accompanied by a very perceptible alteration in the reproductive system. Besides reclaimed birds, under the influence of a plentiful supply of nourishing food, shelter from the inclemency of the weather, and the various stimuli with which domestication is usually attended, may be kept in this state of sexual excitation for several years, with comparatively little interruption. A check to the greatly increased activity of the reproductive powers, so induced, is speedily given, however, by a diminution of sustenance and exposure to cold; at the same time also, a visible change takes place in the physical condition of the organs of reproduction. In the selection of their mates, the feathered tribes are undoubtedly governed by instinct, as there is reason to believe that different species, in a state of nature, never pair together, however near their affinity or general resemblance may be. The rook is not observed to breed with the crow, the titlark with the lesser field-lark or rock-lark, the sedge-warbler with the reed-wren, or the cole-titmouse with the marsh-titmouse. Now, were every individual left to the unrestrained exercise of its own discretion in a matter of such essential importance, the utmost confusion might be expected to ensue; an unprolific hybrid progeny would be speedily produced, and the total extinction of many species might be the ultimate consequence. But the allwise Author of nature has not suffered the reproduction of his creatures to be liable to such a contingency, but has implanted in the mind of each a powerful predisposition to form sexual unions with its own kind exclusively. Thus the evils which would unavoidably result from the indiscriminate intercourse of various species are effectually prevented.

It must be admitted that an intermixture of distinct species does sometimes occur among our domesticated birds; but this deviation from their ordinary instinct is rare, and may, with great probability, be ascribed to a change in their organization, occasioned by the artificial mode of life to which they have been subjected. Now, as it is a maxim in physiology, that the exercise of every animal function is dependent upon its appropriate material organ, any display of new instinctive phenomena, in birds which have long been under the control of man, may also be attributed to the operation of the same physical cause. The singular propensity of the cropper-pigeon to inflate its craw with air, and the still more remarkable disposition of the tumbler to turn itself over backwards when on wing, which are permanent characters in these varieties of the rock-dove, being transmitted by generation, can be satisfactorily accounted for on the foregoing supposition only. How unsafe it must always be, to draw general conclusions from the habits and propensities of domestic fowls alone, whose instincts are frequently changed almost as much as their plumage, by the unnatural way in which they are kept, needs scarcely to be insisted on.

Dr Darwin conjectures, that birds learn how to build their nests from observing those in which they are educated, and from their knowledge of such things as are most agreeable to their touch in respect to warmth, cleanliness, and stability; but the undeniable fact, that birds, when taken very young, even before they can see, and brought up in confinement, do sometimes construct nests, is alone sufficient to refute this opinion.

The sparrow-hawk and kestril often make use of the deserted habitation of the magpie as a receptacle for their eggs, and the sparrow frequently takes forcible possession of the rustic dwelling of the house-martin for the same purpose. Why, then, are they never known to build nests similar to those which they thus appropriate to themselves? and why does not the cuckoo, which is always brought up in the nest of some other bird, construct one itself*? The reason is obvious, the act of nidification is not regulated by observation or instruction, but is under the immediate direction of instinct.

Guided by this mysterious power, individuals of the same

* I have pointed out the errors into which Dr Darwin has fallen in his remarks on the cuckoo, in my observations on that bird, printed in the fourth volume of the new series of the Society's Memoirs.

species, under the like circumstances, always adhere to the same stile of architecture. Thus, some of the smaller birds, which produce a large number of eggs, constantly make the entrance to their nests very narrow, and line the interior with an abundance of such materials as conduct heat slowly; while the ring-dove, which lays two eggs only, forms so slight a structure, that they may be frequently seen through it. The partridge, land-rail, and those birds whose young are able to run almost as soon as they are hatched, generally give themselves very little trouble in providing nests for their progeny; and some species of water-fowl do not make any, but deposit their eggs in the crevices, and on the projecting shelves and ledges of lofty rocks, or upon the bare ground. The sociable grosbeak builds in society under a common roof. The pensile, Abyssinian, and Phillippine grosbeaks construct curious nests, which they suspend from the slender twigs of trees, particularly such as grow over water; by this means, securing their offspring from the predatory attacks of their numerous enemies; and the tailor-bird frames its temporary abode, by sewing two leaves together with the flexible fibres of the plants, and lining the cavity with the lightest and softest animal or vegetable down.

It is true, that, in preparing their nests, birds occasionally accommodate themselves to some circumstances, and take advantage of others, in a manner which seems to indicate a large share of intelligence. The wren, for example, usually adapts the exterior of its compact fabric to the situation in which it is placed. When built against a hay-stack, hay is almost invariably made use of, and green mosses, or withered leaves and ferns are employed, as green or the various shades of brown prevail in this vicinity. Nor, let it be imagined that these substances, which, from their contiguity, are often most easily procured, are selected as a matter of convenience merely; for I have known this minute bird bring long pieces of straw from a considerable distance with much toil, and, with incredible perseverance, mould the stubborn material to its purpose, solely because its colour approached that of a garden-wall, a hole in which, occasioned by the giving way of a loose brick, it had chosen to place its nest in.

A lady who keeps canaries was obliged to separate a young brood from their parents, having observed that the male bird stripped off the soft feathers from their necks and wings, for the purpose of lining a newly constructed nest with them, notwithstanding a supply of old feathers had been put into the cage. From this remarkable fact, for which I am indebted to Dr W. Henry, it is evident, that canaries do not collect materials for their nests indiscriminately, but that they make a selection, in which they are directed by powers of a higher order than those of a merely instinctive character.

Mr White, in his Natural History of Selborne, page 59, informs us, that in Sussex, where there are very few towers and steeples, the jackdaw builds annually under ground, in deserted rabbit furrows. The same author remarks also, p. 175–6, that many sand-martins nestle and breed in the scaffold-holes of the back wall of William of Wykeman's stables, which stand in a very sequestered enclosure, facing a large and beautiful lake near the town of Bishops Waltham in Hampshire; and some birds, as already represented, frequently spare their own labour, by taking possession of the nests of others.

In these instances there certainly appears to be a great display of sagacity; yet there are facts which seem to render it doubtful, whether the feathered tribes are capable of deriving much benefit from experience, or of exercising any remarkable degree of intelligence. Thus, birds when engaged in the performance of their parental duties, expose themselves without hesitation to dangers, which at another period they would carefully avoid. Many species, also, while under the incitement of appetite, are readily snared by the most simple contrivances, directly after witnessing the capture of their companions; and rooks continue to breed in those rookeries, where the greater part of their young is destroyed every spring *. For three successive seasons a pair of redstarts persisted in making their nest in the upper part of our pump, on that end of the lever which is connected with the rod of the piston, and, of course, always had it disturbed when that engine was used.

* I am assured by T. Leigh, Esq., that many thousands of young rooks are shot every breeding-season in his extensive rookery at Lyme Park, in Cheshire.

Mr White observes, too*, that in the neighbourhood of Selborne, martins build year by year in the corners of the windows of a house without eaves, situated in an exposed district; and as the corners of these windows are too shallow to protect the nests from injury, they are washed down every hard rain; yet the birds drudge on to no purpose from summer to summer, without changing their aspect or house.

These actions, it cannot be denied, seem to indicate a more limited degree of sagacity in birds, than might be inferred from those immediately preceding them. This apparent contradiction, however, may be easily reconciled, by admitting, what in all probability will be thought sufficiently obvious, that the dictates of the understanding are frequently too feeble to resist the powerful influence of instinctive impulse. Several examples illustrative of this view of the subject, will be found interspersed through the remainder of the essay. There is not any necessity, therefore, for entering into a more detailed consideration of it here.

After the business of nidification is completed, parturition commences, which is succeeded by incubation, and as the birds will frequently continue to deposit their eggs in the same nest, though all except one or two should be removed as fast as they are laid, or exchanged for others of a different size and colour; and as they will sometimes, after having produced their appointed number, sit upon a single egg, or the eggs of other birds introduced for the purpose of experiment, on artificial ones of chalk, or even upon stones of any irregular figure; it is plain that the act of depositing and incubating their eggs can be ascribed to instinct only.

The parental offices of birds to their young, are also regulated by instinctive feeling, as is evinced by their bestowing the same attention on the offspring of other species, when committed to their care, as they do upon their own. Thus the titlark and hedge-warbler manifest the warmest attachment to the young cuckoos, their foster nurslings, though they suffer their own progeny, ejected by the intruders, to perish from neglect within a short distance of the nest; and this affection continues with little diminution, till their supposititious offspring have nearly at-

* Natural History of Selborne, p. 160.

tained their full growth. Yet under other circumstances, they would pursue and persecute them with the utmost rancour.

The instinctive nature of these actions is likewise satisfactorily established by the fact, that birds when taken very young and brought up in confinement, not only construct nests occasionally, but also lay their eggs in them, which they will sit upon till hatched, should they prove prolific, and will then carefully attend to the young. An anecdote or two serving more fully to corroborate the opinion advanced above, will not, it is hoped, be unacceptable.

In the beginning of May 1812, having found a buzzard's nest containing a single egg, the egg was taken and a light-coloured stone substituted for it, over which a rat-trap was set. The buzzard sat upon the trap a day and a night, when it was discovered, that the iron ring which confined the spring had not been withdrawn. The ring was then removed, and on visiting the nest afterwards, the female was found caught by the feet. This change of character in so watchful and quicksighted a bird as the buzzard, is certainly very surprising, and must baffle every attempt to connect it with any intellectual process.

A highly interesting anecdote, illustrative of the attachment of the raven to its eggs, is thus admirably related by Mr White*:—"In the centre of a grove there stood an oak, which, though shapely and tall on the whole, bulged out into a large excrescence about the middle of the stem. On this a pair of ravens had fixed their residence for such a series of years, that the oak was distinguished by the title of the raven-tree. Many were the attempts of the neighbouring youths to get at this eiry; the difficulty whetted their inclinations, and each was ambitious of surmounting the arduous task. But when they arrived at the swelling, it jutted out so in their way, and was so far beyond their grasp, that the most daring lads were awed, and acknowledged the undertaking to be too hazardous. So the ravens built on, nest upon nest, in perfect security, till the fatal day arrived in which the wood was to be levelled. It was in the month of February, when those birds usually sit. The saw was applied to the but—the wedges were inserted into the opening—the woods echoed to the heavy blows of the beetle or

* Natural History of Selborne, p. 6.

mallet—the tree nodded to its fall; but still the dam sat on. At last when it gave way, the bird was flung from her nest; and though her parental affection deserved a better fate, was whipped down by the twigs, which brought her dead to the ground."

That ardent affection which most birds feel for their young, seems to awaken their dormant energies, and to inspire them with a degree of courage and address, that is called forth on no other occasion. Nor is the violence of this affection, to use the language of Mr White, more wonderful than the shortness of its duration. Thus, every hen is in her turn the virago of the yard, in proportion to the helplessness of her brood, and will fly in the face of a dog or a sow, in defence of those chickens which in a few weeks she will drive before her in relentless cruelty. The partridge will tumble along before a sportsman, in order to draw away the dogs from her helpless covey; and a very exact observer (the Rev. John White), has remarked, that a pair of ravens nestling in the rock of Gibraltar, would suffer no vulture or eagle to rest near their station, but would drive them from the hill with amazing fury; and that even the blue thrush, at the season of breeding, would dart out from the clefts of the rocks to chase away the kestril or the sparrow-hawk. Indeed, so regardless of danger are some species while their nestlings are small, that I have known the redbreast, whinchat, great titmouse, &c., when introduced to their nests, after having been forcibly removed to a distance from their unfledged young, remain quietly upon them as if they had not been molested. Yet, although this instinct, the transient effects of which depend most likely on a temporary excitation of the parental feelings by some physical modification of the corporeal organs, thus for a time powerfully predominates, its manifestations are nevertheless frequently influenced by the active co-operation of the intellectual faculties, as in the following examples:—

"The fly-catcher," says Mr White *, "builds every year in the vines that grow on the walls of my house. A pair of these little birds had one year inadvertently placed their nest on a naked bough, perhaps in a shady time, not being aware of the inconvenience that followed. But a hot sunny season coming

* Nat. Hist. of Selborne, p. 151.

on, before the brood was half-fledged, the reflection of the wall became insupportable, and must inevitably have destroyed the tender young, had not affection suggested an expedient, and prompted the parent birds to hover over the nest all the hotter hours, while, with wings expanded, and mouths gaping for breath, they screened off the heat from their suffering offspring."

"A further instance," continues the same author *, "I once saw of notable sagacity in a willow-wren, which had built in a bank in my fields. This bird a friend and myself had observed as she sat on her nest; but were particularly careful not to disturb her, though we saw she eyed us with some degree of jealousy. Some days after, as we passed that way, we were desirous of remarking how this brood went on; but no nest could be found, till I happened to take up a large bundle of long green moss, as it were carelessly thrown over the nest, in order to dodge the eye of any impertinent intruder."

Actuated by a similar motive, old birds, which have their young much handled, use every art to induce them to desert the nest as early as possible; and I have known the redbreast, on such occasions, take off her nestlings long before they could make the slightest use of their wings. That this mode of proceeding must be referred to intelligence, cannot, I think, be doubted, as the danger of allowing their progeny to remain in a state of insecurity is evidently perceived, and the surest means of avoiding it is deliberately adopted in consequence.

Many birds, under particular circumstances, manifest a natural inclination to fight. This disposition is remarkably conspicuous in the ruff, the quail, and the domestic cock. That the feeling is innate, and dependent upon organization, is clearly proved by the established fact, that careful breeding and training exercise a powerful influence upon the last species with regard to this propensity.

Dr Darwin states that pheasants and partridges teach their young to select and take up their food; and hence he seems disposed to infer that all birds receive instruction in these particulars; but that they are impelled, by instinct, independently of education and experience, to exercise the functions of their various corporeal organs, whose structure is admirably adapted to

* Nat. Hist. of Selborne, p. 151.

the several offices they have to perform, admits of such numerous and decisive proofs, that it is truly amazing how a person of so much observation as Darwin could so entirely overlook them.

Those young birds which do not acquire the use of their eyes for several days after they are hatched, open their mouths for food as soon as they are stimulated by hunger, not only when the old ones bring it to them, but when any thing approaches the nest. Nestlings, too, as soon as they are grown sufficiently large, mute over the edge of the nest, though the parent birds carefully convey to a distance whatever drops from them, that they do not succeed in ejecting. These actions occur also when birds are brought up in confinement, however young they may be when taken, and therefore must be instinctive.

The common duck has its toes connected by a strong membrane, which enables it to swim with facility; and the young of this species, though hatched under birds which instinctively avoid committing themselves to the water, rush to it with avidity almost as soon as they are extricated from the shell, notwithstanding the utmost exertions of the foster mother to divert them from it.

Young swifts are rarely, if ever, observed to perch; and, as they cannot easily be distinguished from old ones by their flight, they must display a considerable command of wing the very first time they quit the nest.

Many of the gallinaceous tribe scratch up the earth with their feet in search of food; and they will frequently repeat this action, when fed on a stone or boarded floor, where it can answer no useful purpose. Now, as they do not correct this error, it is plain that the action itself does not originate in observation, experience, or reflection. Neither can it be attributed to education; nor is this particular misapplication of it to be ascribed to the force of habit, as it may often be observed in very young chickens, which have never associated with others of their kind. But, what is still more to the purpose, and indeed decisive of the general question, even pheasants and partridges, as well as ducks, chickens, turkeys, and guinea-fowls, which have been hatched by artificial heat, possess the instincts peculiar to their respective species, as I have had several opportunities of ascertaining. How young birds, by their struggles in the egg, can at all facilitate the use of their legs, as Dr Darwin conjectures, is to me inconceivable, especially when the position in which they lie is taken into consideration. But even supposing this notion to be correct, it does not in the least affect the instinctiveness of the act; unless we conclude with Darwin, that instinct has nothing to do with any of those actions which result from the repeated efforts of the muscles, under the conduct of the sensations or desires,—an opinion so manifestly erroneous, that it does not require a formal refutation.

The habits and manners of birds are sometimes so greatly modified by the exercise of the intellectual faculties, that, in many cases, it becomes extremely difficult, if not impossible, to determine what is due to their influence; but that no small portion of intelligence is exhibited in the following instances will scarcely be denied.

The white-headed eagle, and several of the gulls, which prey upon the finny inhabitants of the waters, frequently save themselves the trouble of fishing, by robbing their more expert and less powerful congeners of the fruits of their industry, occasionally compelling the objects of their violence even to disgorge their undigested food *.

The pied and yellow wagtails run close to the legs and noses of cattle which are grazing, in pursuit of the insects disturbed by them. The same motive also induces these and many other birds to follow the husbandman, when he is busy with the plough or harrow; and the redbreast attends the gardener in his labours, and seizes the worms which he turns up with his spade.

Mr White states †, that the great titmouse, in severe weather, frequents houses; and, in deep snows, as it hangs with its back

* John James Audubon, Esq. the celebrated author of the splendid work on American Ornithology, now publishing in London, informs me that when the white-headed eagle pursues the fish-hawk, or osprey, for the purpose of depriving it of its prey, it does not attempt to rise above, as stated by Wilson, in his Ornithology of the United States of America, vol. iv. p. 90–1; but, following it closely, urges it from below to as great a height as possible, in order that, when the hawk quits its prize, it may be able to secure the fish before it reaches the water. As the fish-hawks are not capable of contending individually with the white-headed eagle, they sometimes combine together in considerable numbers, to expel the marauder from their haunts.

† Nat. Hist. of Selbourne, p. 106.

downwards, draws straws lengthwise from the eaves of those buildings which are thatched, in order to pull out the flies that are concealed between them; and I have seen hooded crows, on the eastern coast of Ireland, after many unavailing efforts to break with their beaks some of the mussels on which they were feeding, fly with them to a great height in the air; and, by letting them fall on the stony beach, fracture their shells, and thus get possession of the contents. Perhaps it would not be easy to select a more striking example of intelligence among the feathered tribes than this, where, on one expedient proving unsuccessful, after a sufficient trial had been made of it, another was immediately resorted to.

Chickens, in their early attempts to catch flies and other winged insects, shew little or no address, but repeated failures teach them to use more circumspection; and they soon learn to distinguish between an active vigilant prey, and the inanimate substances on which they likewise feed. This cautiousness of proceeding is clearly the effect of information obtained by experience, and affords an example of an instinctive power being excited to activity by the intellect; but a still more extraordinary instance of acquired knowledge is given by Montague, in the Supplement to the Ornithological Dictionary. This gentleman observed two crows by the sea-shore employed in removing some small fish (the refuse of a fisherman's net) from the edge of the flowing tide. They carried them one by one just above high-water-mark, and there deposited them under large stones, or broken fragments of rocks, after having amply satisfied the immediate calls of hunger. Now it must be conceded, that these birds were aware, that the advancing flood would sweep away their prize, unless they conveyed it beyond the limit of its usual rise, or their conduct is quite inexplicable. It is equally plain, that this knowledge, in the practical application of which they manifested so much foresight and sagacity, could be derived from observation and experience only; because, if it originated in a blind instinct, it would be common to every individual of the species, and consequently often displayed; whereas, although I have seen hundreds of crows feeding in situations similar to that above described, I never perceived any of them resort to this effectual means of preserving their prey from the encroaching waters, and I believe the instance related by Montague is solitary in the records of ornithology.

This propensity to hide the food it cannot devour, is not, however, peculiar to the crow. I have noticed it in the raven and magpie; and rooks, in the autumn, frequently bury acorns in the earth, probably with the intention of having recourse to them when their wants are more urgent; but, sometimes forgetting where they have concealed them, they germinate, and not unfrequently excite surprise, by the singularity of the situations in which they grow, far distant from any trees by which they could have been produced, and where it is very evident that they have not been planted by man.

It may be proper to remark here, in order to obviate misapprehension, that, notwithstanding the circumstances attending this seemingly provident mode of securing a supply of food against a future occasion, sometimes afford unequivocal evidence of an intelligent and discerning agent, yet the act of hiding is induced by a purely instinctive propensity. This will be admitted by every one who considers that the species of birds which are remarkable for this peculiarity, practise it, however well they may be fed, when brought up from the nest in a state of domestication.

In addition to the numerous proofs of the intelligence of birds already given, I may mention their susceptibility of receiving instruction by education. Thus, eagles, falcons, and hawks, have been trained to limit the effects of their instinctive propensity to kill, to a particular species of game; and to return to the call and line of the falconer, after having struck down the quarry. The cormorant, too, was formerly employed with success in taking fish. Here, then, not only great attachment to their keepers, and much docility of disposition, are evinced by birds which are naturally wild and voracious, but a considerable share of memory is displayed, and a surprising degree of controul exercised, over some of their most active instincts.

Several birds of the finch, grosbeak, and warbler genera, acquire the art of piping long and difficult tunes with facility and precision; and it is well known that some of the parrots, and also the jay, starling, jackdaw, and magpie, readily learn to pronounce single words, and even short sentences, with tolerable exactness. Yet, although I have excellent opportunities of observing the last species, and have been almost in the daily practice of investigating, I never knew it display any unusual exertion of its capacity for imitation in a state of nature, though, when domesticated, it appears to have this faculty more highly developed than almost any other British bird.

The congregating of gregarious birds, which takes place in the autumn, when they have finished breeding, is perhaps intended to promote their mutual security, as they are much less liable to be surprised by enemies, when associated together in large numbers, than they are when separate. What tends to strengthen this opinion is the fact, that some species provide for the general safety, by appointing sentinels to give notice of approaching danger. This social disposition, which (with the well known exception of rooks) usually continues no longer than the next pairing season, seems, from the uniformity of the actions that result from it, to be of instinctive origin; though it certainly would be difficult to bring any direct proof that such is the case.

In treating of the migration of birds, Dr Darwin observes, that as all species are capable of remaining throughout the year in those countries in which they were bred, any departure from them must be unnecessary, and therefore cannot be instinctive. This reasoning, however, is extremely fallacious, inasmuch as it restricts the operations of instinct solely to what is necessary; whereas we have seen that the singing of birds, and the practice of concealing their superfluous food, though not absolutely indispensable, are, nevertheless, decidedly instinctive. It is, moreover, built on the gratuitous assumption, that several of the periodical summer birds, as the swallow, flycatcher, cuckoo, goat-sucker, &c., which feed almost entirely on insects, and consequently would not be able to procure a sufficient supply of nourishment in the winter months, have the property of passing the cold season in a state of torpidity; an hypothesis directly at variance with well-established facts. Indeed, how very defective and unsatisfactory the arguments advanced in support of the hybernating system are, does not require insisting upon, as those who have considered the subject impartially, must be well aware, that they are almost wholly founded on the hearsay reports of ignorant and credulous persons.

The history of the cuckoo proves, most incontrovertibly, that the propensity to migrate in this species is instinctive, since nearly all the young ones brought up annually in the north of Europe, quit it without receiving the least instruction that such a proceeding is requisite, and without any guide to direct them in their novel undertaking. But I forbear to dwell on the instincts of this extraordinary bird, partly on account of their being so very anomalous, but chiefly because I have considered them at length on a former occasion *. The highly curious fact, that the swallow, house-martin, sand-martin, and puffin, sometimes leave their last hatched brood to die of hunger in the nest, in order to accompany their species in their autumnal migration, is alone sufficient to establish the instinctiveness of that inclination which can thus overcome their parental affection,—a feeling so energetic as frequently to counteract one of the most powerful laws of nature, self-preservation. No theory, in short, which is not founded on the opinion that birds of passage, in undertaking their annual journeys, are influenced by an instinctive desire to migrate, liable to be called into action by various exciting causes, can satisfactorily account for the remarkable phenomena which result from this periodical disposition to wander.

The certainty with which the carrier-pigeon directs its course towards its accustomed home, from distant places where it has never been before, after every precaution has been taken in its conveyance to prevent it from obtaining any knowledge of the way by observation, must, as well as the act of migration, to which it bears a striking resemblance, be likewise attributed to instinct.

It appears, then, from the foregoing observations, that the principal action of birds, though liable to be considerably modified by the operations of the intellectual powers and changes of organization, as well as by various external circumstances, are, contrary to the opinion of Dr Darwin, decidedly of instinctive origin.

* See observations conducive towards a more complete history of the cuckoo, printed in the fourth volume of the new series of the Society's Memoirs.

Many additional arguments might be advanced, and a multitude of highly respectable authorities quoted, in support of this doctrine; but conceiving that sufficient evidence has been already produced, I shall only add, that I am not aware of any serious objection which can be urged against it.—*Memoirs of the Literary and Philosophical Society of Manchester. Second Series*, vol. v.

Additional Remarks on Ercilla, Macromeria, Aitonia, and Citronella. By DAVID DON, Esq. Librarian of the Linnean Society; Member of the Imperial Academy Naturæ Curiosorum; of the Imperial Society of Naturalists of Moscow; of the Royal Botanical Society of Ratisbon; and of the Wernerian Society of Edinburgh, &c. (Communicated by the Author.)

ERCILLA, vol. xiii. p. 237.

In my remarks on this genus, I have stated the reasons which led me to dissent from the opinion of M. Adrien de Jussieu, respecting its affinities; and although, in the absence of a knowledge of the perfect seeds, I have spoken rather too confidently of its intimate affinity to the *Phytolaceæ*, yet the points of agreement between them are so numerous, and so marked, that they appear to indicate more than mere analogies of structure, and render the correctness of the above arrangement at least probable. In the eighth part of the "Botanical Miscellany," Dr Hooker and Mr Arnott have given an accurate figure and description of this plant under the name of *Bridgesia spicata*, and have proposed to refer it to the *Rutaceæ*; but I regret that I am obliged to differ entirely from the views of my learned friends on this subject, being fully persuaded that here there is but little affinity. The *Rutaceæ* have terminal and very differently constructed stigmata, the anthers erect and inserted by their base, and the normal form of the leaf compound, and furnished with glandular dots. In the structure of the perianthium and pistillum, *Ercilla* agrees with *Coriaria*, but, except in these particulars, I am not disposed to think that there is much affinity between them. As *Ercilla*, however, differs from the rest of the *Phytolaceæ* in its axillary inflorescence, a point, I admit, of no mean importance, it is not improbable that it may ultimately be found to constitute the rudiments of an entirely new group.

MACROMERIA, p. 239.

In my observations on this genus, I have erroneously stated the inflorescence of *Symphyteæ* to be rarely revolute, which is not the case, it being revolute in the early state in all the genera enumerated.

AITONIA, p. 242.

Farther observations have convinced me that I have expressed myself too decidedly on the affinities of this genus, since, according to Gærtner, the seeds of *Melianthus* are copiously supplied with albumen, a circumstance which will hardly admit of its being associated with *Aitonia*, which I am now disposed to regard as the type of a new group, differing essentially both from *Meliaceæ* and *Rutaceæ*, and apparently more nearly related to *Geraniaceæ* than to either. To those who have the opportunity, I would recommend a farther examination of the seeds, to ascertain if the embryo is really erect and wholly destitute of albumen, for I regret that my materials were but imperfect, the fruit in the specimens having been nearly devoured by insects. I have described the leaves as being furnished with pellucid dots; but this is an error, these dots proving to be nothing more than cutaneous glands.

CITRONELLA, p. 243.

M. Adrien de Jussieu seems inclined to regard this genus as belonging to the *Menispermeæ* rather than to the *Aquifoliaceæ* or *Ilicinæ*, to which, however, I am still disposed to refer it. Not having myself seen the ripe fruit, that part of my description is wholly derived from that of M. Adrien de Jussieu. M. De Candolle, who first separated the *Aquifoliaceæ*, has lately referred them to the *Celastrinæ*.

Geology of the Valley of Oodipoor. By James Hardie, Esq. Bengal Medical Establishment, Member of the Asiatic Society, &c. (Communicated by the Author.)

The city Oodipoor, the modern capital of Méwar, is built upon an elevated ridge of rocks connected with the hill ranges which skirt, to the westward, the picturesque valley to which it gives its name. It is situated in Lat. 24° 25′ N., Long. 73° 44′ E.

The valley itself is enclosed by the hill-ranges which form the eastern barrier of the elevated plateau, known as the Aravulli mountain chain, which, rising into rugged hills and ridges, stretches north through Ajmer, and south towards the Narbudda. I am not prepared to enter into a general account of the geology of this mountain mass, but shall content myself with directing your attention to that portion of it which immediately surrounds the city of Oodipoor.

The surface of the valley * of Oodipoor, exhibits an uneven plain, studded with numerous low hills and collines, the whole being surrounded by hill-ranges of a higher altitude, distinguished by sharp spines and crests, denticulated and craggy ridges, and peaks of a bold and striking character. The average elevation of the valley is about 2000 feet above the sea, its circumference, without attending to all its numerous sinuosities, may be estimated at about 60 miles, its greatest length being from north to south. The breadth of the Aravulli plateau (if so irregular and rugged a tract deserves the name), is in this portion of the country about 60 miles in a direct line from east to west, its highest pinnacles to the westward rising to an elevation of 3600 feet above the sea. In the neighbourhood of Oodipoor, the height of the hills varies from 400 to 700 or even 800 feet above the plain.

The hilly belt which surrounds the valley, is traversed by numerous deep and rugged ravines. The gorges and passes through which the routes or rather paths to the city wind, are difficult of access. One, indeed, has at considerable expense and labour been rendered passable for wheel carriages, but the others, three or four in number, can with difficulty be threaded

* Though not strictly speaking a valley, but rather an irregular plateau, I have retained the name as in common use.

by a single horseman. To the geologist this belt is interesting; the almost prependicular sides of the ravines furnish him with sections of the strata, many of the confined upland valleys, with their narrow and precipitous outlets, tell of a period when they were the basins of lakes, the remains of which may still be traced in the tanks and *gils* which they enclose; while the hill rivulets, escaping by numerous gorges and chasms from superior basins, would seem to indicate similar revolutions. In examining into the ancient history of these, however, we must be careful not to confound the cause with the effect. That these ancient lakes have been drained by the bursting of the barrier which restrained them is sufficiently obvious, but this rupture having once take place, be the cause what it may, the effect would still be the same, and in many instances at least it would seem that water was not the agent concerned. I have hazarded this remark to avoid misapprehension; but this is not the place to enter into a critical examination of the question.

The inhabitants of the valley have taken advantage of the narrow outlets of their upland basins, to strengthen the defences of the already almost impassable barrier which surrounds them. Not only have they erected fortified gateways to guard the principal gorges, but in some cases they have restored to their pristine form of lake, the elevated valleys of the belt, by throwing a strong and induring *bund* (dike) across the ravine which serves as an outlet for the water, and through the defiles leading to which the only accessible path lies *. Such an opponent in such a situation would indeed be irresistible; the *bund* once destroyed, the result may be imagined.

In travelling towards Oodipoor from the eastward, the boundary of the Aravulli mountain mass appears like a continuous hill-range, rising abruptly from the level plains of Méwar. On passing the barrier, and entering the valley of Oodipoor by the Dubari gate †, the scene is completely altered. The country

* The small lake or *gil*, situated in an elevated valley which commands the deep ravine, in which the famous temple of Ekiïngee stands, is an example of this. To this remarkable spot I shall have occasion to allude hereafter. In fact, all the lakes of this part of India, the Dhabur, the Kunkurowllee, the Oodisagor, the Puchola, &c., have been formed in a similar manner.

† A fortified gateway, now in ruins, which guards the entrance to the valley from the east. A short distance to the south of this position is the *bund* of the Oodisagor (lake.)—See Malcolm's Cent. India.

is broken and rugged; craggy and precipitous cliffs rise around us, and nature assumes a peculiarly barren and sterile aspect. We look in vain for any trace of that amazing fertility for which this valley is famed, and our first impression is decidedly an unfavourable one; nor is this impression much relieved, when, on gaining the summit of a steep ascent, at no great distance from the barrier, the palace of the Ranah presents itself to our view, rising in the vista like a huge mass of unfashioned masonry, amid apparent ruin and sterility. All, however, who have examined the engravings of Colonel Todd's Rajasthan, must be well aware, that this valley includes within its circumference some of the most beautiful scenes in nature, and that the modern capital of the *Hindu Put*, the descendant of a thousand kings, is not altogether unworthy of the glory of his ancestors. Scenes such as those which the painter has so beautifully and correctly delineated, are frequently concealed from view, till, by a sudden turn of the route, the doubling of a projecting point, or the ascent of a rising ground, they burst upon us in all their splendour. But I must not dwell on details of this nature.

Within the Valley of Oodipoor, there are two lakes of considerable extent*. One (the Puchola) washes to the westward the narrow ridge upon which the city stands, the other (the Oodisagor) at the southern extremity of the valley, is bounded by the range of hills which forms the eastern barrier of the Aravulli plateau. Besides these, there are numerous small tanks and sheets of water, and, during the rains, the greater portion of the low land is flooded. The level of the Puchola is high above the surrounding country†. A *bund* has been thrown across a deep and precipitous chasm in the ridge immediately to the south of the palace, and the overflow of the lake here forms a picturesque waterfall. Another rivulet, during the rains, issues from the

* About six miles in circumference during the dry season. During and immediately after the rains about ten to twelve.

† A great portion of the city is situated below the water level of the Puchola. The Bund to the south of the Palace, was, during the rains of 1829, reported in a dangerous condition, the inhabitants were in daily dread of its bursting, and watchmen were stationed in a proper position to give the first alarm on the approach of danger, when the inhabitants were recommended to betake themselves to the heights. This Bund has been lately repaired.

northern extremity of the lake, which, rushing in cascades through a rocky and precipitous ravine, joins the small river Bedus. This stream *(Nullah)*, rising high in the hills to the northward, flows, like the other streams of the valley, into the Oodisagor. In fact, the whole of the Valley of Oodipoor might, with no great difficulty, be converted into a large inland lake, studded with numerous islands, now appearing in the form of insulated hills. To effect this, little more would be necessary than to raise somewhat higher the *bund* of the Oodisagor, and to block up the narrow chasm which now gives issue to the *Bedus* at the same point; and there are many facts connected with its geology, which seem to indicate that in such a condition it at one time existed. The value of these facts will be better appreciated when we have described the rock-formations of the valley, and the geological phenomena which attend their occurrence.

The more elevated portions of the Valley of Oodipoor, and the rounded collines which diversify its surface, are barren and unproductive. The soil in such situations is exceedingly scanty, and, during the greater portion of the year, is utterly destitute of vegetation. The low lands, however, are covered with a rich and luxuriant mould, and the cultivator has every advantage which an abundant supply of water, and the greatest facilities for irrigation, can afford. The cultivated land is, in consequence, productive to an amazing degree. The soil is obviously derived from the disintegration of the neighbouring rocks, and no appearance of the older alluvial deposits can be traced. The only shells found belong to recent genera, such as still exist in the lakes and streams. These sometimes present themselves in considerable abundance in the soils: remains of Uniones and Planorbes are by far the most numerous.

A saline efflorescence sometimes appears on the surface of the soil in the valley. On the plains of Méwar, in the Ajmeer and Jeypoor districts, and indeed throughout the whole of Rajpootana, a similar efflorescence is constantly observed covering the surface, and occupying the dried-up beds of marshes and nullah courses, in appearance exactly like hoar frost. This efflorescence is called by the natives *Reh*, and is used by them in the manufacture of soap, as well as in the preparation of an impure sulphate of soda, and other saline compounds employed by them in medicine. It consists principally of carbonate of soda, with associated sulphate of soda and chloride of sodium, and is consequently a natron. As purchased in the bazaars, it is mixed up with a great quantity of impurities, such as quartz grains, carbonate of lime, &c., the alkaline salts being in the proportion of about one-fourth of the whole. 100 grains of the alkaline salts obtained by crystallization from a solution of impure *reh* in water, afforded me of dry carbonate of soda 32.492.

I shall not inquire by what chemical process this efflorescence is formed. A certain degree of moisture seems necessary to its development, as also the presence of carbonate of lime, which last very generally exists as a constituent of the soils of this portion of India. The felspars and sodalites of the granites, and other compound rocks, might furnish the alkaline basis in abundance. This efflorescence must be carefully distinguished from another, consisting principally of chloride of sodium, which is an abundant production of certain extensive tracts in India.

I shall now proceed to consider the ROCK-FORMATIONS of the Valley of Oodipoor. Commencing, then, with the surface, our attention is immediately arrested by numerous beds of that singular calcareous deposit well known in India under its native appellation of KUNKUR.

Kunkur is a term applied to an imperfect rock-formation, very extensively distributed throughout Hindustan*. It is a name, however, used very indefinitely by the natives to indicate a variety of substances of distinct origin, which possess nothing in common, except their capability of affording lime for economical purposes. The deposit to which I am about to call your attention, overlies, geologically speaking, all the *true* rock formations as yet discovered in India; it does not, however, ap-

* Mr Calder, in his Outline of the Geology of India, has the following remarks:—"Its (Kunkur's) prevalence is very extensive, although less abundant in the southern portion of the peninsula, neither has it yet been observed on the Malabar coast, and in Bengal it appears to be bounded to the eastward by the Gundăk river." He adds in a note, that "the prevailing laterite of the Malabar coast is characterized by a proportion of calcareous matter." (See Trans. Ph. Class, Asiatic Society, part i. p. 17.) The laterite, Captain Franklin believes to have been formed by "diluvian agency," and it is possible that this rock may be of cotemporaneous origin with the kunkurs.

pear to be a very recent deposit, but rather to belong to an era intermediate between the period which gave birth to our newer marine formations and the deposition of the more ancient alluvial beds. We shall, therefore, consider the kunkur as a distinct and separate formation, to which the term, "*The Kunkur Formation*," may be applied, till such time as we can accurately determine its real place in the geological scale. We must, at the same time, be careful not to confound the true kunkur beds with those numerous deposits of calc-tuff which are daily forming, or with calcareous soils, containing imbedded portions of nodular kunkur, often in immense quantity. From its loosely adhering nature, the kunkur must have been peculiarly liable to be affected by floods and other denuding agencies; and hence we are prepared to find vast accumulations of its debris in situations the most remote from its original locality. The great depth at which imbedded portions of this substance are found, may be gathered from a Report (published in the Asiatic Transactions, vol. xii.) of Borings for Fresh Water, effected in Calcutta, during the year 1814 *.

In central India the kunkur is constantly observed occupying the beds and banks of nullahs, or forming small rounded swells, or tumuli, generally in low situations. It is also discovered reposing under the soils of our elevated plains and plateaux, and in several instances I have observed it resting on the summits of the hills, and in situations between 2000 and 3000 feet above the level of the sea †.

The kunkur beds are not, generally speaking, thick. In this respect, however, they vary in different localities. They include numerous imbedded masses, both spheroidal and angular, of different kinds of rock, and many of these would seem to have been transported from a distance. The imbedded masses vary from the size of a pin's head to that of blocks two or three feet in diameter.

* From this report it appears, that kunkur was observed at the greatest depth attained by the borers. Solid rock would seem to exist at a depth of about 140 feet below the surface, and kunkur is imbedded in the stratum which immediately overlies this.

† A bed of kunkur occurs on the summit of a granite hill at Buneera, in Méwar. Also on the tops of the hills at Nauthwarra, in the same district, and in several other similar situations which I have visited.

The basis, or cementing medium, of kunkur, is invariably calcareous; and its chemical composition I have found to be very uniform in situations remote from each other. My researches, however, have been confined to the kunkurs of Méwar and neighbouring districts; and I am not prepared to say how far they may be applicable to the analogous deposits of the rest of India.

A very common variety of the substance under review is, the "Nodular Kunkur" of Indian authors. This varies in colour from dirty-white to dark reddish-brown, the nodules are sometimes concentric-laminar, externally they have an earthy aspect, but their internal texture is more crystalline, and they are very generally ferruginous. Many of the kunkurs acquire a dark colour on exposure to the atmosphere, some specimens in appearance exactly resemble pisolite, and when the associated fragmentary particles have been finely comminuted, the mass occasionally assumes the character of a calcareous sandstone. When this last includes grains of quartz, crystals of felspar, and other ingredients of disaggregated granitic rocks, it might, by a careless or hasty observer, be mistaken for granite in a partial state of decomposition. The kunkur also assumes various imitative forms, and occurs in large irregular masses, and globular concretions. Some varieties are almost compact, with but little of foreign admixture; others are loose and friable, of a whitish or yellowish colour; some have a partially oolitic structure, and in one or two situations I have observed kunkur of a *regular chalky texture, appearance, and colour.*

The kunkur beds are not generally stratified; their most common form is that of irregular and amorphous masses, enveloping the inequalities of the original site upon which they were deposited, and frequently exhibiting a corroded surface. In some cases we may occasionally trace appearances of a divisionary structure, somewhat analogous to stratification; and Captain Franklin has described a conglomerate, which he refers to the kunkur formation, as occurring in horizontal strata. This conglomerate, he remarks, " when the particles are fine, resembles calcareous sandstone, and has sufficient cohesion for architectural purposes."

I have not heard of any well authenticated instances of organic remains having been found in kunkur, nor have I myself been able to detect any decided traces of such bodies. On this subject Mr Benson has remarked: "In the course of my researches in the Gangetic tract, I have never yet met with any fossil shells but those which are still to be found in the rivers, or feeding on the shrubs of their banks; these I have sometimes found incrusted or filled up with calc-tuff, which is forming every day in the streams *." Mr Benson, whose conchological labours have been attended with such happy results, has had every opportunity of ascertaining the fact, and, as far as my experience goes, his remark may be extended to Méwar. I have in many situations found species of Planorbes, Uniones, &c. in the soils reposing on the kunkur, but never in the kunkur itself. We must not, however, infer from the above observations, the total absence of organic remains in the kunkur. Future research may probably bring many to light. At the same time, the great apparent scarcity of such bodies is a singular feature in the natural history of this formation, and one which ought not to be passed over in silence in a communication of this nature.

In its composition, kunkur varies considerably in different situations. This diversity, however, may be attributed more to the nature and kind of its foreign ingredients, than to any irregularity in the chemical constitution of the cementing medium. When these ingredients have been reduced to a very fine state of comminution, they are so incorporated with the mass, that it presents the form of a homogeneous substance of a harder or softer nature, according to the nature of the fragmentary particles. The purer varieties are burned for lime, which forms an excellent mortar for ordinary purposes; though, for finer work, the lime (*chunam*) prepared from marble or compact limestone is alone used.

In kunkur, a large proportion of silica and alumina is uniformly associated with the earthy carbonates, which seldom exist in larger proportion than 60 or 70 per cent. and generally in a still smaller proportion. Oxide of iron is invariably present, and traces of manganese I have also detected; but the characteristic feature in the composition of kunkur is the uniform pre-

* See Gleanings in Science (Calcutta), vol. i. p. 263.

sence of carbonate of magnesia. From 10 to 15 per cent. of this substance I have separated from the purer varieties, the quantity being greater or less according to the quantity of carbonate of lime present in the specimen analyzed.

I have premised these remarks of a general nature, in the hope that they will render more intelligible the few observations I have to make on the kunkur of the Valley of Oodipoor. The characteristic features of the kunkur are here the same as elsewhere; and I need not therefore repeat what I have already said on the subject.

In the Valley of Oodipoor the kunkur-beds are very extensively distributed. They are constantly observed reposing under the soil, or mantling over the collines which diversify its surface. They are not, however, universally present, and considerable intervals occur where the older strata alone make their appearance at the surface. Almost all the varieties of kunkur, above briefly alluded to, occur. We have specimens exhibiting a partially oolitic texture, others assuming a globular, botryoidal, or concentric laminar form, while others are nearly compact. We have them, too, of every shade of colour, from dirty white, through yellowish and reddish-brown, up to a very dark brown, approaching to black. The kunkur-beds seldom exceed a few feet in thickness, often not more than two or three feet. Internally these beds very often exhibit a series of masses of spheroidal or imitative forms, closely packed together in a loosely adhering marl, from which they are easily removed, resembling, when accumulated for economical purposes, a heap of water-worn pebbles. This variety is the one most commonly employed in the manufacture of lime. Other beds, more especially of the dark ferruginous varieties, have a more uniform and rocky character; but the most common form of the kunkur in the Valley of Oodipoor, is one which we but rarely meet with in the plains beyond. This variety may be described as a conglomerate, consisting of an immense accumulation of imbedded masses, varying from the size of a millet-seed to that of blocks occasionally several feet in diameter. These are dispersed through a matrix of a dark grey colour, consisting of finely comminuted particles of the softer argillaceous rocks, agglutinated by calcareous matter. Quartz-grains, crystals of felspar, and scales of mica, are very often included in this matrix, which gives it the appearance of partially decomposed granite. In this, as in other kunkurs, carbonate of magnesia is uniformly associated with the carbonate of lime; but the earthy carbonates bear a very small proportion to the other ingredients present. When beds of this kunkur immediately overly strata of the softer varieties of argillaceous schist, the latter are occasionally impregnated, to a considerable depth, with calcareous matter, obviously the produce of percolation. In such cases, the line of demarcation between the kunkur and the schists is often scarcely traceable. The one seems to pass insensibly into the other, and the deception is increased by the peculiar arrangement and position of the imbedded masses of the kunkur, which give rise to an appearance somewhat resembling vertical stratification. To this peculiarity I shall have occasion immediately to revert.

The imbedded masses of these kunkur-beds consist of spheroidal and occasionally angular fragments of a variety of different rocks, such as granite, gneiss, micaceous and argillaceous schist, quartz-rock, limestone, and limestone-schist. The masses of quartz-rock are very abundant; their usual colour is white; others are reddish-white, and some specimens I obtained of a sapphire-blue tint. The granites are various, some are red and fine granular, others are coarse-grained and of a grey colour; in others hornblende is seen in large proportion, while fine-grained sienitic granite is also common. The gneisses are equally various, as are also the argillaceous and siliceous schists.

Into a minute account of the mineralogical characters of the different rocks found imbedded in the kunkur, it is not necessary to enter. It is sufficient to remark, that the varieties are very numerous; that the original localities of most of them are as yet unknown, though a number may be traced to the hills immediately surrounding the valley; and that it is exceedingly probable that many of them have been transported from a distance. Neither granite nor gneiss occur *in situ* in the valley of Oodipoor, though both are found abundantly to the westward, in the plains of Méwar and elsewhere. Some of the imbedded masses would even seem to belong to a class of rocks of a more recent date than any which have as yet been discovered in this neighbourhood; but our knowledge of the geology of the country, especially to the westward, is far too limited to admit of our reasoning with any thing like certainty on the subject. I shall only farther remark, that masses of a very peculiar and characteristic *siliceous* limestone, hereafter to be described as constituting one of the hills in the vicinity, are found imbedded in great abundance in a kunkur bed, about one and a-half miles to the south-east of the original locality, and that the majority of the masses traceable to the strata of the surrounding hills, have been transported in a similar direction.

The kunkur beds are often traversed by quartz veins, which are not, however, cotemporaneous with the kunkur: they can invariably be traced to veins or dikes in the subjacent rocks. When these latter are of a nature liable to be affected by atmospheric influences, the more durable quartz of the numerous linear veins which traverse them is, during the process of disintegration, left projecting above the surface. In situations where no kunkur occurs, such appearances are constantly observed; the vein quartz projecting in long narrow tubular masses, to the height of several feet above the surface. When kunkur happens to have been deposited in situations so circumstanced, it is sufficiently obvious that the projecting quartz will assume the form of veins in this formation; and it is perhaps not going too far to suppose, that a similar process, but on a much larger scale, may, in some instances, have given birth to the so-called dikes and veins so frequently observed in nature.

I have alluded above to a peculiarity in the arrangement of the imbedded masses of the kunkur conglomerate of the valley of Oodipoor. These masses are of various forms, frequently flat lenticular, or they are elliptical; and I have almost invariably observed that such masses are placed edgeways, their larger axis being vertical. From the spheroidal and water-worn aspect of the majority, we may infer that they have been long exposed to the action of running water; yet the position which they have assumed in the kunkur, is at variance with the idea of their having been slowly accumulated previous to the deposition of the matrix, in the situation where they are now found, like the pebbles of the channels of rivers and beds of lakes; and we must account for the phenomenon on other principles.

Perhaps the easiest way of explaining the fact, is to suppose that the masses, previously rounded and eroded, were hurried onward by a sudden rush of water, which, accumulating in the valley of Oodipoor, permitted them to sink towards a bottom covered, we may suppose, with a semifluid mud, into which they could easily penetrate. In this case, they would naturally retain the position assumed by them in sinking, which is the precise position in which they are now found. The composition of the matrix, consisting, as it does, of finely comminuted particles of argillaceous rocks, agglutinated by a calcareous cement, gives an air of probability to such a supposition, which will be still farther strengthened, if we believe that, at that period, the valley of Oodipoor existed in the form of an inland lake. The vertical and inclined positions assumed by the imbedded pebbles of the sedimentary formations, found reposing on the sides of many of the European mountain chains, have been attributed to a very different cause; but the fact that the kunkur is spread in amorphous beds, of not more than a few feet in thickness, over a wide surface, formed by the edges of the vertical strata, is at variance with the idea, that the position of the included pebbles has been modified at the period when the neighbouring hill ranges issued from the bowels of the earth. Besides, the phenomena attending the quartz-veins above alluded to, clearly prove that the subjacent strata had, in such cases, acquired a vertical position long previous to the deposition of the kunkur. In the purer varieties of kunkur, the imbedded masses are much less numerous, and of a smaller size; and I am not aware that they exhibit any peculiarity in their mode of arrangement.

In speculating on the probable age and origin of the kunkur formation, it is exceedingly difficult, from want of data, to arrive at any thing like a satisfactory conclusion; future observation may supply this deficiency, and, in the mean time, I may be permitted to offer the few following observations, in the hope that they may have the effect of directing to the subject, the attention of the many talented geologists at present in India.

I have already pointed out the necessity of distinguishing between the more ancient kunkur beds and the recent calc tuff, but we must at the same time bear in mind, that a similar process to that which is in daily progress before our eyes, may have given origin to some of the older varieties. It is well known that rain-water possesses the property of dissolving the limestone rocks over which it flows. To this source many of the recent calc tuffs are traceable; and the same cause operating at a former period, and for an indefinite length of time, may very probably have given birth to some of our kunkur deposits.

The kunkur, considered as a formation, seems referable to an era posterior to that which gave birth to our newer marine deposits, but many causes may have simultaneously contributed to the production of calcareous beds, variously modified, according to the sites upon which they were deposited, the phenomena attending their deposition, and the nature of the causes concerned. Hence we may have lacustrine kunkurs, and kunkurs traceable to the solvent properties of rain and river water, of cotemporaneous formation, with others of a very different origin.

From the extensive distribution of the kunkur formation, from the uniformity in the composition of the cementing medium, the chemical portion of this deposit, and from the great similarity in point of texture and appearance between the kunkurs of remote localities, we may infer that one cause at least, of a very general and uniform character, operated in its production. But, while we attribute to this one distinct cause the principal share in the deposition of kunkur, considered as a widely distributed formation, we must at the same time allow that local causes may, in many instances, have modified the character and appearance of the rock itself, or given birth to cotemporaneous beds of calcareous substances, in many respects analogous to the others. Beds, too, of this last description, may have been formed at various periods, and many extensive geological changes may have taken place in the subjacent strata, during the æra which gave origin to the kunkur formation, considered on the great scale.

In making geological inductions, it is a good general rule to inquire, in the first place, whether or not any of the causes still in active operation on the surface of our globe are, on the supposition of their having been equally active at a remote period, sufficient in themselves to explain the phenomena which happen to engage our attention. If we come to the conclusion that such causes do exist, we need not look for others of a more occult or of an unknown nature. If, in this spirit, we speculate on the origin of kunkur, our attention will naturally be directed to the great deposits of travertin and tuffaceous limestone, the produce of calcareous springs. The texture of the kunkurs, the spheroidal, concentric laminar, and oolite forms which it assumes, are characteristic of many of the travertins, which owe their origin to the calcareous springs of Italy and other countries, while the appearance of the kunkur beds, and their mode of distribution, would all point to a similar origin. There seems no limit to the power of production of such springs, and we need be under no apprehension that the cause is not proportionate to the effect: they issue from all kinds of rock, from the most ancient to the most recent, and have been discovered to a greater or less extent in almost every country hitherto explored.

My attention was first forcibly directed to the subject, on witnessing the calcareous brine-springs of the volcanic island of Java, and I was much struck by the great similarity between several of the Javan tuffaceous limestones and the Indian kunkur-beds. The facts of this paper are copied without addition, from notes taken previous to my visit to Java, and at a period when I was rather inclined to take a different view of the origin of kunkur, so that there is every security that I was not biassed in making my observations by preconceived theory.

The description which Lyell has given of the *calcareo-magnesian* travertins of the baths of San Philippo, and other deposits of a similar nature, exhibits many points of analogy with the account which I have given of the kunkur. Mr Lyell also points out the striking analogy between the concentric structure of the travertins and the spheroidal forms of the English magnesian limestone of Sunderland, which last he supposes to have been formed under "circumstances perfectly analogous" to the travertins of mineral springs.

Mineral springs, both cold and thermal, rise up beneath the waters of lakes and seas; and the mineral substances to which they gave birth, must be modified by the circumstances under which the deposition takes place. Many of the Javan calcareous tuffas have obviously been formed in this manner *, and the

* The Javan beds include numerous remains of marine shells, which have in general a strong resemblance to shells of the present day. Mr J. D. E.

resemblance between such beds and many of the kunkur deposits was occasionally exceedingly striking. Deposits formed under such circumstances we will naturally expect to find much intermixed with foreign matter, such as sand, gravel, rolled pebbles, &c. It must at the same time be borne in mind, that mineral springs frequently carry matter from beneath upwards; and to this source, perhaps, may occasionally be attributed the foreign ingredients of kunkur.

The absence, or rather great apparent scarcity, of organic remains in the kunkur beds, is a somewhat perplexing circumstance; but there are many phenomena attending the occurrence of such bodies, which have hitherto been kept perfectly unexplained. The process by which, in many cases, the original materials composing them has been removed, and in its place a substance of an entirely different nature substituted, is as yet unknown; and, before we presume to reason upon a subject of so difficult a nature, we must be content to wait till such time as facts have been substituted for conjectures. In the above particular the kunkurs are similarly circumstanced to the magnesian limestones; and if Mr Lyell's opinion in regard to the origin of the latter be correct, the scarcity of organic remains in the kunkur, supposing the fact to be fully established, will present no obstacle to the adoption of the view which I have taken of the subject.

Sowerby, with a kindness and liberality for which I cannot be too grateful, has examined minutely a collection of these remains, which I placed in his hands for the purpose. The most important result of this examination he communicates to me in the following words:—"All the shells which can positively be referred to a genus among your fossils are marine. Among them are Lenticulites and Ratalites, such as occur in the London clay; and in the same masses, are at least two, perhaps three, species of a genus of crustaceous animals, which are no way to be distinguished from Cypris." The above discovery ought to make us exceedingly cautious in drawing conclusions from solitary or ill-ascertained facts. The occurrence of remains of Cypris in the Wealden clays have been made the basis of a theory, upon what slender grounds, may be imagined from the fact, that the so-called Cypris of the Wealden "cannot be distinguished from a marine genus (Cytherina Lam.), in which the animal alone affords the generic character." An account of the deposits in which these remains were discovered, I hope to be enabled, at no distant period, to draw out, when the result of Mr Sowerby's valuable researches shall, with his permission, be communicated.

The solvent power of water holding carbonic acid in solution is well known; and this and similar agencies may have had a powerful influence in effecting the removal of foreign bodies. Calcareous springs, too, are very generally, especially in volcanic countries, of a high temperature, and hold in solution various other substances, such as the muriate of soda, &c., facts unfavourable to the existence of terrestrial or fresh water testacea in their immediate vicinity.

It were useless to object that thermal springs do not now exist, to any great extent, in India. This continent has long ceased to be the scene of active volcanic operations; and the gradual disappearance of such springs, is in exact accordance with what has been observed in other countries. Where thermal springs do exist, their site is invariably marked by great internal derangement of the strata,—a derangement indicative of the occurrence of earthquakes, and other volcanic phenomena. The number of thermal springs which occur in India has not yet been ascertained, neither are we possessed of correct accounts of the geological appearances accompanying such as have been visited by Europeans; their number, however, would appear to be pretty considerable. In Rajpootana several have been mentioned. One at Gungra, on the borders of the sandstone formation, which flanks the primitive rocks of Méwar, I have described elsewhere; and in Harowtee they are also common. But in this portion of India we need not look to thermal springs, in support of the opinion that it has been the theatre of great volcanic operations. Within the historical era (in 1819) we have had a volcanic eruption in Kutch, accompanied with the submergence and upraising of large tracts of land; and tradition has preserved the account of a shower of volcanic ashes having, at a remote period, overwhelmed the city of Ougein in Malwa. The existence alone, in this part of India, of the great Malwa trap, obviously of igneous origin, is of itself sufficient to satisfy us on this point; and the great derangement observable in the position of the sandstone and limestone strata, near their line of junction with the older formations, makes assurance doubly sure. These strata are in other situations horizontal; but near their line of junction with the older rocks, they have acquired an inclined position, and are occasionally much distorted. An excellent example of this we have a short distance to the westward of Chitor, where, within a square surface of not a great many yards, the so-called lias strata exhibit almost every variety of dip and inclination. Mineral springs have invariably been found to accompany or succeed the development of extensive volcanic operations; and we are entitled to conclude that India formed no exception to this rule. The Gungra spring in the vicinity of Chitor, and the springs of the neighbouring district of Harowtee, remain to attest the truth of this fact, and to warn us that the latent cause of these disturbances has not yet become entirely extinct.

There is another question connected with our subject, to which I shall do little more than advert in this place. I have already directed your attention to the fact, that kunkur is observed resting on the tops of several of the hills of Méwar; and I have cited a hill at Buneera as an example of this. Have the kunkur beds, so circumstanced, been deposited posterior to the elevation of the hills upon which they rest? or have they been upheaved to their present elevated position? In the case of the Buneera hill, at least, I am inclined to adopt the latter opinion. I am aware that calcareous springs have been seen to issue from the summits of hills in various parts of the world; but there are several facts connected with the occurrence of the Kunkur bed in question, that seems to point to a different origin. In this case, the bed is insulated, is of limited extent, exhibits no trace of a laminated or divisionary structure, and contains numerous imbedded portions of mineral substances, which are not found associated with the rock (granite) of which the hill is constituted. These consist principally of masses of quartz, of agate, of agate jasper, and botryoidal hæmatite, exactly similar to those which occur abundantly associated with a quartzose breccia, which I have elsewhere described as a member of the great sandstone series which flanks the Malwa trap. An accumulation of such masses we would not expect to find in beds deposited from a spring issuing from the confined summit of a rocky hill; and the most natural conclusion seems to be, that the kunkur bed in question owes its elevation to the upheaving agency which raised the hill upon which it reposes.

The epoch of elevation of the hill ranges of this portion of

India, seems referable to a period posterior to the deposition of the last formed of our true rock formations; and, if the above conclusion be legitimate, the date of elevation of some of them at least, is, comparatively speaking, recent.

Paroxysmal elevations may have occurred at various periods, and I have reason to suspect, that considerable tracts in this portion of India were upheaved *en masse*, at an epoch posterior to that which gave origin to the inclined or vertical position of many of the older strata. I have not space to illustrate the subject more minutely, but I may refer to the appearances exhibited by the hills and hill ranges of that portion of Harowtee immediately bordering upon Méwar.

The Harowtee district is flanked to the southward by a linear hill range (the Mokundra range), composed of highly inclined sandstone strata, which have been forced through a superjacent formation of horizontally stratified sandstones and limestones. Upon the Harowtee side of this range, the latter have been partially upraised, and repose upon the plane formed by the inclined strata, as they emerge from beneath the surface. On the Malwa side, on the contrary, the truncated edges of the inclined strata form an abrupt escarpment, and horizontally stratified limestones, exactly similar to those of Harowtee, are observed close upon the base of the range. The tubular masses of sandstone which form the Mokundra range, seem to have been subjected to an upheaving agency, which imparted to them a movement round their inferior edges as a hinge,—a movement which, while it would modify the position of the superjacent strata of Harowtee, might be supposed, from the intervention of the fracture-line, to have had but little effect upon the similarly constituted strata of the Malwa side*. A different kind of movement seems to have effected the elevation of the hills in the interior of Ha-

* How far the appearances attendant on the upheavings of hills and hill-ranges may have been modified by the nature and character of the rocks acted upon, or by the direction in which the elevating force was exerted, I am not prepared to say. We would naturally expect that the elevation of narrow linear ridges, composed entirely of regularly stratified rocks, having a uniform dip, would be accompanied by phenomena in many respects different from those which have attended the upheaving of mountain-masses having a granitic axis, or an axis composed of amorphous rocks.

rowtee. These have a tubular form, and exhibit mural precipices, and abrupt escarpments, which display the horizontally stratified rocks of which they are composed. The aspect of the country is singular, and, as viewed from the heights, I could compare it to nothing else than a huge plain studded with enormous cubic crystals, of a perfectly regular and determinate form.

In the northern portion of the district, the sandstones are seen reposing in an unconformable, overlying, and insulated position, upon the tops of hills formed of the nearly vertical strata of the older rocks, which now begin to make their appearance. The hill upon which the fort of Mandulghur stands is an example in point*. In such cases, the unconformable rocks must have been deposited upon strata which had already assumed a vertical position.

While we refer the epoch of elevation of the hills and hill-ranges of this portion of India to a period posterior to that which gave birth to the formation to which the horizontally stratified limestones and sandstones belong, we may, at the same time, suppose that, prior to this date, the older rocks had, in some localities, been subjected to paroxysmal elevations, which had imparted to the strata a vertical position, and that, in after times, they were still farther elevated *en masse*, heaving upwards on their summits tubular portions of the formations which had been deposited upon them.

The tubular hills, composed of horizontally stratified rocks, would seem to have owed their origin to a similar upheaving agency exerted in a vertical direction, and perhaps the tendency of such rocks to be ruptured along fracture-lines, at right-angles, or nearly so, to each other, and the disposition of their fragments

* Immediately to the northward of this position, we have a succession of rocks of the argillaceous and micaceous schist series, which are succeeded, in the same direction, by the granitic rocks of Ajmeer. The phenomena alluded to in the paper may all perhaps be explained, on the supposition that the energy of the agent which upheaved the granites was in the inverse ratio of the distance from the centre of elevation. In Harowtee, this agent, operating upon the inferior rocks, may have caused internal commotions and upheavings sufficient to modify the position, and, in some cases, to effect the rupture and dislodgment of the superjacent sandstones, without being able to accomplish the elevation of the older rocks through these sandstones.

to assume, on fracture, a rhomboidal form, might have had a material influence in modifying the shape of the hills. The strata, too, of this neighbourhood very generally exhibit the slightly waved aspect which characterises the rocks of Chitor *, an appearance indicative of internal upheavings,—while the phenomena observable near the line of junction of the older and newer formations of the Méwar, clearly prove that the former were elevated at a period posterior to the deposition of the latter. Whether, in this particular instance, the elevation was effected prior to the assumption of an inclined position by the older strata or not, the appearances, as yet observed, do not precisely indicate: the older strata dip under the newer formations; and the dislocations observable near the line of junction, may perhaps be attributed to a movement similar to that which modified the position of the sandstone strata on the Harowtee side of the Mokundra range.

The kunkur conglomerate of the valley of Oodipoor was obviously deposited over strata which had already assumed a vertical position—the phenomena of the quartz veins are sufficient to establish this fact. I have already remarked, however, that among the kunkur beds, there may be many which have owed their origin to local causes, operating at different and remote periods; and I have reason to believe, that the Oodipoor conglomerate comes under this last description of kunkur, and that it may be considered as a comparatively recent variety.

I shall in another communication proceed to consider the geology of the older formations of the valley of Oodipoor, and trust I shall then be enabled to direct your attention to some few facts farther corroborative of the views at which I have just hinted. In the mean time, I must pause; my remarks have been extended to a greater length than I at first anticipated. In this country, however, little more of the kunkur is known than its name; and I have thought that a short general description of a deposite so singular, might not be altogether without interest to the English reader.

* See Edinburgh New Philosophical Journal, No. xxi. p. 86.

The Life and Writings of Francis Huber. By Professor A. P. De Candolle.

Every thing which brings into view the surmounting of a great difficulty, is gratifying to the human mind. Those who are the least adventurous or inventive, are pleased with the exhibition of examples by which the bodily or mental strength of their fellow-creatures has been enabled to conquer obstacles which appeared to be insuperable; and it is in a feeling of this nature that all the wonderful tales of ancient times have had their origin. Those who are more accustomed to reflection, love to follow such examples into their details, and to study the process by which men of genius have succeeded in overcoming trials, or turning them to a good account. If such efforts are of short duration, they are admired as facts of fleeting occurrence; but if the obstacle is permanent, and the efforts continue unrelaxed, the admiration which is excited by a momentary burst of genius or energy is increased, by the more profound sentiment which results from the contemplation of that sustained force, that voluntary and immoveable patience, which is the gift of so small a portion of our race. Such examples ought to be preserved for the honour of humanity, and for the encouragement of those who are inclined to turn aside at the prospect of difficulty. It is right to demonstrate from time to time to young people, that, if patience and resolution are not, as some have asserted, the only elements of genius, they are at least its firmest auxiliaries, its most powerful instruments; and that they are faculties so important, as to lead not unfrequently, in the search of truth, to the same results as genius itself. These reflections, though they may perhaps appear at the first glance to be somewhat pretending, will receive support from the history of the individual to whose memory this notice is devoted.

Francis Huber was born at Geneva, on the 2d of July 1750, of an honourable family, in which vivacity of mind and imagination seemed hereditary. His father John Huber, had the reputation of being one of the most witty men of his day; a trait which was frequently noticed by Voltaire, who valued him for the originality of his conversation. He was an agreeable musician, and made verses which were boasted of even in the saloon at Ferney. He was distinguished for lively and piquant repartee; he painted with much facility and talent; * he excelled so much in the cutting out of landscapes, that he seems to have been a creator of this art. His sculpture was better than that which those who are simply amateurs are able to execute †; and to this diversity of talent, he joined the taste and the art of observing the manners of the animal creation.

His work on the Flight of Birds of Prey is still consulted with interest by naturalists. John Huber transmitted almost all his tastes to his son. The latter attended from his childhood the public lectures at the college, and, under the guidance of good masters, he acquired a predilection for literature, which the conversation of his father served to develop. He owed to the same paternal inspiration his taste for natural history, and he derived his fondness for science from the lessons of De Saussure, and from manipulations in the laboratory of one of his relatives, who ruined himself in searching for the philosopher's stone. His precocity of talent was manifest in his attention to nature, at an age when others are scarcely aware of its existence, and in the evidence of deep feeling, at an age when others hardly betray emotions. It seemed that, destined to a submission to the most cruel of privations, he made, as it were instinctively, a provision of recollections and feelings for the remainder of his days. At the age of fifteen, his general health and his sight began to be impared. The ardour with which he pursued his labours and his pleasures, the earnestness with which he devoted his days to study, and his nights to reading of romances by the feeble light of a lamp, and for which, when deprived of its use, he sometimes substituted the light of the moon, were, it is said, the

* Several pictures of game, a kind in which he excelled, and his own portrait, are deposited in the Museum of the Fine Arts, given by his family.

† A trait of his talent is preserved which is indicative of his character. He is presenting a piece of bread to his dog in such a way as to make him bite it upon all sides, and there results from it a very striking bust of Voltaire.

‡ Observations sur le Vol des oiseaux de proie; par M. Jean Huber, Geneve, in 4to, 1774.

causes which threatened at once the loss of health and of sight. His father took him to Paris, to consult Tronchin, on account of his health, and Venzel on the condition of his eyes.

With a view to his general health, Tronchin sent him to a village (Stain) in the neighbourhood of Paris, in order that he might be free from all disturbing occupations. There he practised the life of a simple peasant, followed the plough, and diverted himself with all the rural concerns. This regimen was completely successful, and Huber retained, from this country residence, not only confirmed health, but a tender recollection and decided taste for a rural life. He loved to narrate the hospitality of these good peasants, their mother-wit, their kindness towards him, and the tears which flowed on his taking leave of them, not only from his own eyes, but from those of his male, and also, as it is said, his female, acquaintance among the villagers.

The oculist Venzel considered the state of his eyes as incurable, and he did not think it justifiable to hazard an operation for cataract, then less understood than at present, and announced to young Huber the probability of an approaching and entire blindness. His eyes, however, notwithstanding their weakness, had, before his departure, and after his return, met those of Maria Aimée Lullin, a daughter of one of the syndics of the Swiss Republic. They had been companions at the lessons of the dancing master, and such a mutual love was cherished as the age of seventeen is apt to produce. It had become almost a part of their existence, and neither of them thought it possible that any thing could separate them. The constantly increasing probability, however, of the blindness of Huber, decided M. Lullin to refuse his consent to the union ; but as the misfortune of her friend and chosen companion became more certain, the more did Maria regard herself as pledged never to abandon him. She had become attached to him at first through love, then through generosity and a sort of heroism ; and she resolved to wait until she had attained the lawful age to decide for herself (the age of twenty-five), and then to unite herself with Huber. The latter perceiving the risk which his infirmity would probably occasion to his hopes, endeavoured to dissimulate. As long as he could discern some light, he acted and spoke as if he could see, and often beguiled his own misfortune by such a confidence. The seven years thus spent made such an impression on him, that during the rest of his life, even when his blindness had been overcome with such surprising ability as to furnish one of his claims to celebrity, he was still fond of dissembling: he would boast of the beauty of a landscape, which he knew of only by hearsay or by simple recollection,—the elegance of a dress,—or the fair complexion of a female whose voice pleased him; and, in his conversation, in his letters, and even in his books, he would say, *I have seen, I have seen with my own eyes.* These expressions, which deceived neither himself nor any one else, were like so many recollections of that fatal period of his life when he was daily sensible of the thickening of the veil which was constantly spread between him and the material world, and increased his fear not only of becoming entirely blind, but of being deserted by the object of his love. But it was not so; Miss Lullin resisted every persuasion—every persecution even—by which her father endeavoured to divert her from her resolution; and, as soon as she had attained her majority, she presented herself at the altar, conducted by her maternal uncle, M. Rilliet Fatio, and leading, if we may so term it, herself the spouse who in his happy and brilliant days had been her choice, and to whose saddened fall she was now determined to devote her life. A friend, a relation, an intimate confidant, was at her side; that friend was my mother, and the story of this wedding of love and devotion, often related by her to me in my youth, is connected in my heart with the sweetest of my recollections.

Madame Huber proved, by her constancy, that she was worthy of the energy which she had manifested. During the forty years of their union, she never ceased to bestow upon her blind husband the kindest attention: she was his reader, his secretary, his observer, and she removed, as far as possible, all those embarrassments which would naturally arise from his infirmity. Her husband, in alluding to her small stature, would say of her, *mens magna in corpore parvo. As long as she lived,* said he also, in his old age, *I was not sensible of the misfortune of being blind.*

This affecting union has been alluded to by celebrated pens. Voltaire often noticed it in his correspondence; and the episode of the Belmont family, in Delphine*, is a true description, though somewhat glossed, of Monsieur and Madame Huber. What can I add to a picture traced by such masters? Let me hasten, then, to the works which have placed Huber in the rank of savans.

We have seen the blind shine as poets, and distinguish themselves as philosophers and calculators; but it was reserved for Huber to give a lustre to his class in the sciences of observation, and on objects so minute that the most clear sighted observer can scarcely observe them. The reading of the works of Reaumur and Bonnet, and the conversation of the latter, directed his curiosity to the history of bees. His habitual residence in the country inspired him with the desire, first of verifying some facts, then of filling some blanks in their history; but this kind of observation required not only the use of such an instrument as the optician must furnish, but an intelligent assistant, who alone could adjust it to its use. He had then a servant named Francis Burnens, remarkable for his sagacity and for the devotion he bore for his master. Huber practised him in the art of observation, directed him to his researches by questions adroitly combined, and aided by the recollections of his youth, and by the testimonials of his wife and friends, he rectified the assertions of his assistant, and became enabled to form in his own mind a true and perfect image of the minutest facts. *I am much more certain*, said he one day to me, smiling, *of what I taste than you are, for you publish what your own eyes only have seen, while I take the mean among many witnesses.* This is, doubtless, very plausible reasoning, but it will hardly render any one mistrustful of his own eyes! He discovered that the nuptials, so mysterious and so remarkably fruitful of the queen bee, the only mother of the tribe, never take place in a hive, but always in the open air, and at such an elevation as to escape ordinary observation,—but not the intelligence of a blind man, aided by a peasant. He gives a detailed account of the consequences of the early and late periods of this aërial hymen. He confirmed, by multiplied observations, the discovery of Schirach, until then disputed, that bees can transform, at plea-

* Delphine, par Madame Stael, iii. partie, lettre xix.

sure, the eggs of working bees into queens, by appropriate food; or, to speak more precisely, neuters into females. He shewed also how certain working bees are able to lay fertile eggs. He described with much care the combats of queens with each other, the massacre of drones, and all the singular occurrences which take place in a hive, when a strange queen is introduced as a substitute for the natural queen. He shewed the influence which the dimensions of the cells exert upon the shape of the insects which proceed from them; he related the manner by which the larvæ spin the silk of their coccoons; he proved demonstratively that the queen is oviparous; he studied the origin of swarms, and was the first who gave a natural and accurate history of those flying colonies. He proved that the use of the antennæ is to allow the bees to distinguish each other; and, from the intimate knowledge he had acquired of their policy, he prescribed excellent rules for their economical administration. The greater number of these delicate observations, and which had escaped his predecessors, were due to his invention of various forms of glass hives. One of these, which he called the book or leaf hive, and another which he denominated the flat hive, permitted him to observe the labours of the community in their details, and follow each bee in its operations. They were greatly facilitated by the skill of Burnens, and, by his zeal in the search of truth, he braved, without hesitation, the anger of a whole hive, in order to discover the least fact; and he would seize an enormous wasp's nest, in spite of the painful attacks of the whole horde which defended it. We may judge from this of the enthusiasm with which his master (and I here employ the term in the sense, not in the relation of a master to a servant, but that of an instructor to his pupil), we may judge, I say, of the enthusiasm in favour of truth or fact with which Huber was able to inspire his agents.

The publication of these works took place in 1792, in the form of letters to Ch. Bonnet, and under the title of "*Nouvelles Observations sur les Abeilles* *." This work made a strong impression upon many naturalists, not only from the novelty of

* One vol. 8vo, Geneva. Another edition was printed in Paris in 1796, in one volume 12mo; in which a short practical treatise on the management of bees was anonymously subjoined to the works of Huber.

the facts, but from their rigorous exactness, and the singular difficulty against which the author had to struggle with so much ability. Most of the academies of Europe (and especially the Academy of Sciences of Paris) admitted Huber, from time to time, among their associates. The poet Delille * celebrated his blindness and his discoveries; and from this time he was placed in the first rank among the most skilful, I was going to say the most clear-sighted, observers.

The activity of his researches was relaxed neither by this early research, which might have satisfied his self-love, nor by the embarrassments which he suffered in consequence of the Revolution, nor even by a separation from his faithful Burnens. Another assistant of course became necessary. His first substitute was his wife,—then his son, Pierre Huber, who began from that time to acquire a just celebrity in the history of the economy of ants, and various other insects, commenced his apprenticeship as an observer, in assisting his father. It was principally by his assistance that he made new and laborious researches relative to his favourite insects. They form the second volume of the second edition of his work published in 1814, which was edited in part by his son.

The origin of the wax was at that time a point in the history of bees much disputed by naturalists. By some it was asserted, though without sufficient proof, that it was fabricated by the bee from the honey. Huber, who had already happily cleared up the origin of the *propolis*, confirmed this opinion, with respect to the wax, by numerous observations; and showed very particularly, with the aid of Burnens, how it escaped in a laminated form from between the rings of the abdomen †. He instituted laborious researches to discover how the bees prepare it for their edifices; he followed step by step the whole

* See the seventh chant in the poem Des Tros Regnes, which begins with

" Enfin de leur hymen savant depositaire
L'aveugle Huber l'a vu par les regards d'autrui,
Et sur ce grand probleme un nouveau jour a lui," &c.

† The work of Huber on this subject appeared in the Bibliotheque Britannique, under the title of " Premiere Memoire sur l'Origine de la Cire," t. xxv. p. 59; but they have been resumed and extended in the second edition of his Researches.

construction of those wonderful hives, which seem, by their perfection, to resolve the most delicate problem of geometry; he assigned to each class of bees the part it takes in this construction, and traced their labours from the rudiments of the first cell to the completed perfection of the comb. He made known the ravages which the *Sphinx atropos* produces in the hives into which it insinuates itself*; he even endeavoured to unravel the history of the senses of the bees, and especially to examine the seat of the sense of smell, the existence of which is proved by the whole history of these insects, while the situation of the organ had never been determined with any certainty. Finally, he prosecuted a curious research into the respiration of bees. He proved by very many curious experiments that bees consume oxygen gas like other animals. But how can the air become renewed, and preserve its purity in a hive plastered with cement, and closed on all its sides, except at the narrow orifice which serves for a door? This problem demanded all the sagacity of our observer, and he at length ascertained that the bees, by a particular movement of their wings, agitated the air in such a way as to effect its renovation;—and having assured himself by direct observation, he farther proved its correctness by means of artificial ventilation.

These experiments on respiration required some analysis of the air of hives, and this circumstance brought Huber into connexion with Sennebier, who was much engaged in analogous researches with respect to vegetables. Among the means which Huber had conceived for ascertaining the nature of air in hives, was that of causing certain seeds to germinate in it, founded on a vague opinion that seeds will not sprout in air much deprived of oxygen. This experiment, imperfect as it respects the direct object in view, united the two friends in the engagement of pursuing their researches into the nature of germination, and a curious fact with respect to this association between a blind man and one of clear vision, is, that more frequently it was Senebier who suggested the experiments, and Huber that performed them. Their works have been published in their joint names,

* This part of his researches had already appeared in the Bibliotheque Britannique, in 1804, t. xxvii. pp. 275 and 358, under the title of "Letter to M. Pictet.

under the title of "*Memoirs on the Influence of Air in the Germination of Seeds.*" They fully demonstrated the necessity of oxygen gas in germination, the impossibility of success in a medium deprived of free oxygen, and the formation of carbonic acid by the combination of this oxygen with the carbon of the grain. This work, conceived principally by Sennebier, and edited by him, has little of the impress of Huber, and it is evident that, in separating himself from his love of bees, he took less interest in other researches.

This perseverance of a whole life, in a given object, is one of the characteristic traits of Huber, and probably one of the causes of his success. Naturalists are divided from taste, and often from position, into two series. The one love to embrace the *tout ensemble* of beings, to compare them with others, to seize the relations of their organization, and to deduce from them their classification and the general laws of nature. It is this class who have necessarily at their disposal, vast collections; and they mostly dwell in large cities. The others take pleasure in the profound study of a given subject, considering it under all its aspects, scrutinizing into its minute details, and patiently following it in all its peculiarities. The latter are generally sedentary and isolated observers, living remote from collections, and far from great cities. The former may be charged with the neglect of details, in consequence of their attention to extensive generalities. The second, from being circumscribed in a limited circle, may be disposed to exaggerate its importance, and hence to judge incorrectly of the connexion in the entire series. But such mutual accusations are in reality idle. Natural history requires both of these classes, in the same manner as the architect stands in need of the stone-cutter for the preparation of his materials, and the stone-cutter requires the science of the architect in the construction of the well planned edifice.

Huber is evidently to be placed in the school of special observers: his situation and infirmity retained him in it, and he acquired therein an honourable rank, by the sagacity and precision of his researches; but it is plainly perceptible, in reading his works, that his brilliant imagination urged him toward the region of general ideas. Unprovided with terms of comparison, he sought them in that theory of final causes, which is gratifying to every expanded and religious mind, because it appears to furnish a reason for a multitude of facts, the employment of which, however, as is well known, is prone to lead the mind into error; but we must do him the justice to acknowledge, that the use he makes of them is always confined within the limits of philosophical doubt and observation. He had, in early life, derived ideas of this general nature from the *Natural Theology* of Derham, and from the writings of his friend Ch. Bonnet; they found a ready reception in his sensitive and elevated mind, which loved to admire the Author of Nature in the harmony of his works. His style is, in general, clear and elegant; always retaining the precision requisite to the didactic, it possesses the attraction which a poetic imagination can readily confer upon all subjects; but one thing which particularly distinguishes it, and which we should least expect, is, that he describes facts in a manner so picturesque, that in reading them, we fancy that we can see the very objects, which the author, alas, was never able to see! In reflecting on this singular quality in the style of a blind man, the difficulty appeared to be solved in thinking of the efforts which he must have made in arranging and connecting the statements of his assistants, so as to form in his own mind a complete image of the facts. We who enjoy, often with so much indifference, those valuable senses by which we are enabled to embrace at once such a diversity of objects, and so many parts of the same object, often neglect to study those parts upon which others are dependent, and which ought to claim the first place in the explanation; our descriptions are often confused, precisely because our impressions of objects are made simultaneously and without effort. But Huber was obliged to listen with attention to the recital of others, to class them methodically, to reproduce an image of the object by his own conceptions; and his written narration, after this laborious operation, presents the subject to our view, under all the aspects which have enlightened his own. I venture also to add, that we find in his descriptions so many masterly touches, as to justify the conclusion, that if he had retained his sight he would have been like his father, his brother*, and his son, a skilful painter.

* Jean Daniel Huber, a skilful painter of animals.

His taste for the fine arts, unable to derive pleasure from forms, extended to sounds; he loved poetry, but he was more especially endowed with a strong inclination for music. His taste for it might be called innate, and it furnished him with a great source of recreation throughout his life. He had an agreeable voice, and was initiated in his childhood in the charms of Italian music. The method by which he studied tunes deserves to be related, as it may be useful to others: "It was not by simple recollection," his son writes me, "that he retained airs; he had learned from Gretry the counterpoint in a dozen of lessons, and in studying by himself, he had become an able harmonist. In teaching him an air, we first dictated to him the base of a musical phrase; he arranged it according to the succession of tones; then came the song which he executed with his voice; a phrase thus disposed he understood perfectly, and a single repetition was sufficient; we proceeded to the second, and so on to the end of the piece, which he would then repeat from one end to the other, without tiring the patience of any one who dictated to him: he owed much in this respect to the complaisance of his sister."

His musical talents rendered him in his youth extremely popular, and after his infirmity it afforded him many agreeable relations, among whom may be mentioned, those which he held, at an advanced age, with a female noted for her wit, and between whom there was the double sympathy of being passionately fond of music, and being blind.

The desire of maintaining his connection with absent friends, without having recourse to a secretary, suggested the idea of a sort of printing press for his own use; he had it executed by his domestic Claude Lechet, whose mechanical talents he had cultivated, as he had before done those of Francis Burnens for natural history. In cases properly numbered, were placed small prominent types which he arranged in his hand. Over the lines thus composed he placed a sheet blackened with a peculiar ink, then a sheet of white paper, and with a press, which he moved with his feet, he was enabled to print a letter which he folded and sealed himself, happy in the kind of independence which he hoped by this means to acquire*. But the difficulty of putting

* I am indebted for these details, as well as others, here and there stated, to his nephew M. T. Huber, who has distinguished himself by his literary talents.

this press into action prevented the habitual use of it. These letters, and some algebraic characters formed of baked clay, which his ingenious son, always anxious to serve him, had made for his use, were, during more than fifteen years, a source of relaxation and amusement to him. He enjoyed walking, and even a solitary promenade by means of threads which he had caused to be stretched through all the rural walks about his dwelling. In following them by his hand he knew his way, and by small knots in the thread he was warned of the direction he was taking, and of his exact position.

The activity of his mind rendered these diversions necessary. It might have rendered him the most unhappy of men, if he had been less favourably connected: but all who lived with him had no other thought than that of pleasing him, and contributing to relieve his infirmity. Naturally endowed with a benevolent heart, how were those happy dispositions too often destroyed by the collisions of the world, preserved in him? He received from all that surrounded him nothing but kindness and respect. The busy world, the scene of so many little vexations, had disappeared from his view. His house and his fortune were taken care of, without any embarrassment to him. A stranger to public duties, he was in a great measure ignorant of the politics, the cunning, and the fraud of men. Having rarely had it in his power (without any fault of his own) of being useful to others, he never experienced the bitterness of ingratitude. Jealousy, even notwithstanding his success, was silenced by his infirmity. To be happy and prosperous in a situation in which so many others are given up to continual regrets, was accounted to him as a virtue. The female sex, provided their voices were agreeable, all appeared to him as if he had seen them at the age of eighteen. His mind preserved the freshness and candour which constitute the charm and happiness of adolescence; he loved young people, for with their sentiments his own were more in accordance than with those of the aged and experienced. He took pleasure, to the very last, in directing the studies of the young, and possessed, in the highest degree, the art of pleasing and interesting them. Though fond of new acquaintance, he never abandoned his old friends. "One thing I have never been able to learn," said he in extreme old age, "that is, to forget how to love." Thus had he the good sense justly to appreciate and enjoy the balance of advantages which were furnished him, by the very condition in which he was placed. He appeared to be afraid either of the loss of many of his illusions, or of the excitement of hopes in which he might be deceived, for he always repelled the proposition of having a portion of his sight restored by an operation on one of his eyes, which appeared to be affected only by simple cataract; the other was blinded from gutta serena, which rendered it incurable.

Far be it from me, nevertheless, to attach too high a value to the compensations which he himself found in his infirmity, and for not having put into requisition the nobility and courage of his philosophy. He never was the first to speak of his misfortune, and was disposed to avoid the idea of it. He never complained, and his strong and enlightened mind ranked courage and resignation, and cheerfulness among his primary duties.

His conversation was generally amiable and gracious; he was easily led into the humorous; he was a stranger to no kind of knowledge; he loved to elevate his thoughts to the gravest and most important subjects, as well as to descend to the most familiar sportiveness. He was learned, in the ordinary sense of the word, but, like a skilful diver, he went to the bottom of each question by a kind of tact and a sagacity of perception, which supplied the place of knowledge. When any one spoke to him on subjects which interested his head or heart, his noble figure became strikingly animated, and the vavacity of his countenance seemed, by a mysterious magic, to animate even his eyes, which had so long been condemned to darkness. The sound of his voice had always something of the solemn. I now understand, said a man of wit to me one day, who had just seen him for the first time,—I understand how young people willingly grant to the blind the reputation of supernatural inspiration.

Huber spent the last years of his life at Lausanne, under the care of his daughter, Madame de Molin. He continued to make additions at intervals to his former labours. The discovery of bees without stings, made in the environs of Tampico, by Captain Hall, excited his curiosity, and it was a high satisfaction to him, when his friend, Professor Prevost, procured for him at first a few individuals, and then a hive of these insects.

It was the last homage which he rendered to his old friends, to whom he had devoted so many laborious researches, to whom he owed his celebrity, and, what is more, his happiness. Nothing of any importance has been added to their history since his time. Naturalists of unimpaired vision have found nothing of consequence to subjoin to the observations of a brother who was deprived of sight.

Huber retained his faculties to the last. He was loving and beloved to the end of his days. At the age of eighty-one, he wrote to one of his friends,—*There is a time when it is impossible to remain neglectful; it is, when separating gradually from each other, we may reveal to those we love, all that esteem, tenderness, and gratitude, have inspired us with towards them.* * * * *I say to you alone*, adds he, farther on, *that resignation and serenity are blessings which have not been refused.* He wrote these lines on the 20th of December last; on the 22d he was no more; his life became extinct, without pain or agony, while in the arms of his daughter.

I have always admired the sagacity of his researches, his resolute perseverance, his love of truth, and his resignation at once mild and stoical. I loved his amiable conversation, and his benevolent disposition. While living, I consecrated his name, to the gratitude of naturalists, by giving it to a genus of beautiful trees from Brazil *. I have now endeavoured to render the last homage to his memory; happy shall I be, if those who have known and loved him find the portrait correct,—if young people learn from his example the value of resolute determination in the direction and concentration of labour; and especially, if those who are subject to the same misfortune should learn, by the example of Huber, not to yield to discouragements on account of their condition, but to imitate his admirable philosophy.—*Bib. Univ. Fev.* 1832.

* Huberia laurina. Memoir on the Melastomaceæ, p. 61, pl. 10, Prodr. 3, p. 167.

Characters of some New or little known Genera of Plants.

By Robert Wight, Esq., M. D., F. L. S., Hon. E. I. C. S., and G. A. Walker Arnott, Esq., A. M., F. R. S. E. and L. S. (Communicated by the Authors.)

The following new or little known genera are all from India, and required early attention while engaged in arranging our materials for the Prodromus Floræ Peninsulæ Indiæ Orientalis, which we are now preparing for publication. The plan and limits of that work not affording us room to describe them with a fulness of detail, necessary to make them properly understood, and altogether preventing us from entering into any discussion on their affinities, we propose doing so through the medium of this Journal.

With this view we shall, from time to time, transmit detailed characters of such genera as may require elucidation.—*Arlary, 20th February* 1833.

Gen. 1. HEMECYCLIA, *Nob.*

Lin. Syst. DIOECIA OCTANDRIA.
Ordo Nat. EUPHORBIACEÆ. *Juss.*

Flores dioëci. *Perianthium* 4-partitum. *Glandulæ* petaloideæ nullæ. Masc. *Stamina* 8, submargine disci plani carnosi inserta. *Filamenta filiformia* exserta. *Antheræ* subcordatæ, loculis connectivo disjunctis. Fæm. *Stigmata* duo, sessilia, semicircularia, margine dentata; dentibus triangularibus cito arcte supra stigma inflexis. *Ovarium* disco carnoso impositum, biloculare, loculo unico mox cum stigmati proprio abortiente; loculis 1-ovulatis. *Fructus* subdrupaceus, unilocularis, monospermus. *Semen* ad latus sub apice affixum, suspensum, ad hilum arillatum. *Albumen* carnosum: *Embryo* centralis: *Cotyledones* planæ, tenues, foliaceæ, magnæ, cordato-subrotundæ: *radicula* brevis supera.

Frutex *glaber*, *ramosus*. Folia *alterna, breviter petiolata, elliptica, obtusa, coriacea, supra præsertim nitida.* Pedunculi *solitarii binive ex gemmula minuta imbricata axillari vel laterali.* Fructus *globosus, pisi magnitudine, subgriseus.*

1. H. Sepiaria, Nob. *in Prod. Fl. Penins. Ind. Or.* (ined.)—Wight's Cat. No. 940.

Hab. In arenosis, versus littora maris, ad promontorium "Point Calimere" dictum, provinciæ Tanjorensis.

This plant, which we have referred to the natural order Euphorbiaceæ, ranks near *Gelonium*, being nearly allied in habit. It forms a rigid, ramous, densely interwoven bush, rising to the height of 8 or 10 feet, of rather frequent occurrence in the station above indicated. We believe it is also met with in the numerous jungles, occurring in dry sterile soils, of the Coromandel coast, but appears to be rarely found in a sufficiently perfect state of fructification to admit of its place in either the artificial or natural systems of botany being determined. Hence it seems to have been hitherto overlooked, or at least left undescribed by botanists. The leaves in their rigidity and texture resemble those of *Celastrus emarginatus*.

Gen. 2. MICROELUS, *Nob.*

Lin. Syst. DIOECIA PENTANDRIA.

Ord. Nat. EUPHORBIACEÆ, *Juss.*

Flores dioeci. Masc. *Perianthium* 5-partitum ; segmentis æqualibus, incurvis, cuculatis, stamina opposita occultantibus. *Æstivatio* subimbricativa. *Glandulæ* petaloideæ, (Petala, *Juss.*) nullæ. *Stamina* 5, sub pistilli rudimento fungilliformi, apice concaviusculo, inserta. *Filamenta* subnulla. *Antheræ* cordato-ovatæ, biloculares; loculis juxta positis. *Glandulæ* nullæ inter stamina.—Fœm. *Perianthium* .... *Ovarium* 3-loculare ; loculis biovulatis. *Styli* 3, liniares, elongati, integri, recurvi, flexuosi, hinc intus glandulosi: *Fructus* rupiformis, vix (loculicidæ) dehiscens, 3-locularis; loculis monospermis. *Semina* lævia. *Albumen* carnosum. *Embryo* axilis. *Cotyledones* planæ, foliaceæ, cordato-orbiculares. *Radicula* brevis, supra. Arborescens. Folia *pinnatim trifoliata, alterna, petiolata ;* foliolis *lateralibus breviter, terminali longius, petiolatis, glabris, minute pelucido-punctatis, penninervibus, late ellipticis, subiter acuminatis, denticulato-serratis.* Paniculæ *axillares, petiolum superantes.* Flores *masculi minuti, viridescentes.* Fructus *globosus, pisi magnitudine, fuscus.*

1. *M. Roeperianus*. Nob. *in Prod. Fl. Penins. Ind. Or.* (ined.) Wight's Cat. N. 941. Andrachne ? trifoliata, *Hort. Beng.* 70. fid. specim. in herb. Hamilton. in Universit. Edinburg. No. 2194.

Hab. In dumetis montium provinciæ Madura, et "in Nepala inferiore et Bengala orientali," Ham. l. c.

This is a small tree, of rather rare occurrence in alpine jungles, and, so far as we have yet been able to learn, not converted to any use. The foliage is totally unlike any other Euphorbeaceæ with which we are acquainted. The abortive pistil in the male flowers makes it rank with Ad. de Jussieu's first section, including *Buxus* and its allies.

GEN. 3. SARCOSTIGMA, *Nob.*

Linn. Syst. DIOECIA (PENTANDRIA?)

Ord. Nat. HERNANDIACEÆ, *Blum.*

Flores dioeci. MASC. . . . . . FŒM. *Perianthium* basi involucro monophyllo brevissimo campanulato 5-dentato instructum, monophyllum, infundibuliforme, 5-fidum; laciniis oblongis recurvis. *Torus* perianthii tubum implens, eique adhærens. *Stamina* sterilia 5, liniaria, perianthii laciniis alternantia. *Ovarium* liberum, oblongo cylindraceum, hirsutum, uniloculare. *Ovulum* solitarium, pendulum. *Stigma* magnum, carnosum, integrum, deciduum. *Drupa* oblonga, compressa. *Nux* rugosa. *Semen* . . . .

"Frutex *scandens, ramosus.* Folia *alterna, breviter petiolata, oblonga, acuminata,* 5 *pollices longa,* 2 *lata, integerrima, glabra, venosa.* Flores *in racemo simplici, spicato, longo, sessiles.* Racemi *aggregati, vel singuli, e ramulorum nodis a casu foliorum ortis.*"—Klein. MSS.

1. *S. Kleinii*, Nob. *in Prod. Fl. Penins. Ind. Or.* (ined.) Dioecia. *Herb. Kleine.* Wight Cat. 943.

HAB. Alway, provinciæ Travancorensis, anno 1817. Cel. *Kleine.* Nom. vernac. *Odtam.*

We think that we are borne out by the above analysis, however imperfect it be, in consequence of the absence of male flowers, in referring this genus to the neighbourhood of *Inophyllum*, which is now placed in Hernandiaceæ. The involucre in both genera is similar, and bears a very strong resemblance to a calyx, and the perianth to a corolla. The leaves shew a similar venation and texture in both. In our plant the parts of the flower are sometimes disposed in a quaternary order.

GEN. 4. GYNOON, *Ad. de Juss.*

Linn. Syst. MONOECIA MONODELPHIA.

Ord. Nat. EUPHORBIACEÆ, *Juss.*

Flores monoeci. MASC. *Perianthium* 5-6-partitum. *Stamina* 3—6. *Filamenta* infra in columnam triangularem coalita, superius distincta. *Antheræ* filamentis ad latera subapice adnatæ, biloculares, extrorsæ. FŒM. *Perianthium* 6-partitum. *Stylus* nullus. *Stigmata* 3—6, hinc convexa, inde angulata, crassa, connata in massam unicam ab apice usque ad basin intus perviam, ovoideam, ovario duplo majorem, 3—6-partibilem. *Ovarium* globosum, 3—6-loculare; loculis biovulatis. *Fructus* . . . .

Caulis *lignosus.* Folia *alterna, 2-stipulacea, integra, plus minusve coriacea, glabra.* Flores *minuti, fasciculati, breviter pedicellati, fasciculis axillaribus, multibracteatis; fœminei masculis mixti.*

1. *G. triandrum*, Nob.; foliis coriaceis, perianthio maris 5-partito, staminibus stigmatibusque tribus, ovario triloculari.

HAB. in Insula Zeylana.

2. *G. Heyneanum*; foliis oblongo-ovatis subcoriaceis integerrimis, perianthio maris 6-partito, staminibus stigmatibusque sex, ovario 6-loculari.—G. Heyneanum, *Wight & Arnott in Prod. Fl. Peninsul. Ind. Or.* (ined.) Monoecia Tetrandria? *Herb Rottler.* Wight Cat. No. 942.

HAB. in provincia 'Circars' dicta. Beat. *Heyne.*

We felt some surprise, on examining the specimens from the Circars, to find that, while they had the same most remarkable form of stigma that characterises the genus, they differed essentially in the number of parts. That both species, however, belong to the same genus, cannot for a moment be doubted; and we have accordingly given the above specific character to the Ceylon plant, which, we regret to say, we are only acquainted with from Jussieu's description. In the Circars plant, although the filaments of the stamens be united with a triangular column, yet each face, a little below the apex, bears two anthers, making in all six. We, as well as Jussieu, are unacquainted with the fruit.

(To be continued.)

Ancient Geological Changes in England. By Dr FITTON.

THE country around Hastings, and that of some neighbouring districts, is principally of secondary formation; the deepest or oldest rock visible is Portland-stone, above which, in succession, there are Wealden beds (consisting of Purbeck beds, Hastings sands, and Weald clay), lower greensand, gault, upper greensand, and chalk as the uppermost or newest rock of the series. In Dr Fitton's delightful Geological Sketch of the Vicinity of Hastings just published, we find the following as general results, obtained from a consideration of the geognostical arrangements around Hastings and the vicinity.

"We have thus," says Dr Fitton, "gone through the list of the strata connected with the tract in the vicinity of Hastings, from the chalk down to the Portland-stone; and the general inferences from what has been mentioned are so obvious, that a statement of them will be more like a repetition of the facts themselves, than a train of laborious reasoning.

"1. The Portland limestone, No. 8, containing the remains of none but marine animals and shells, must have been deposited beneath salt water. The species of these shells, it is true, no longer exist; but of the genera, no one living species is known to inhabit fresh water—all are marine.

"2. The mass of the Portland strata must have been raised from the waves, and must have continued to be dry land for a time sufficient for the growth of the trees and Cycadeæ, whose remains are still found upon their surface *.

"3. But above the soil affording these trees and plants, we now find beds of slaty limestone,—in the Isle of Portland, in Wilts, and Buckinghamshire; and, in the Isle of Purbeck, besides such slaty beds, a considerable thickness of compact limestone, full of shells, is so connected with the strata of the Hastings sands and Weald clay, as to prove that the whole were deposited continuously. To admit of this, it is obvious, that, *after* the plants and trees had grown and flourished on the top of the Portland beds, the whole surface of what then was land must have been submerged, to such a depth, as to allow of the accumulation over it of all the Wealden group, which cannot be estimated at less than 700 feet in thickness. And this submersion, to all appearance, whether sudden, or, as seems most probable, gradual and slow, was effected tranquilly; for in many cases the trunks of the petrified trees retain their upright position, within the substance of the calcareous strata, by which they are now surrounded.

"4. The fossils of the beds, thus deposited above the vegetable soil of Portland, are all such as might have been produced in fresh water communicating with the sea. In the waters of this estuary, and of the river of which it may have been the mouth, the aquatic animals must have been nourished, whose remains we now find so profusely throughout the strata of the Wealden. But dry land also must have been near at hand: —'In fact, its existence at no great distance seems clearly indicated, by the remains of the vegetables and amphibia of Tilgate Forest; some of the former must have grown on the borders of

* These trees occur in a bed, upwards of a foot thick, of a bituminous clay or soil, named *dirt bed*, which is interposed between the Portland and Purbeck beds.

a river or lake; and the habits of the recent species more nearly related to the latter, warrant a similar conclusion, since they are well known to frequent the rivers and marshy tracts of tropical regions, in the sands and banks of which they deposit their eggs.' *

"5. The group thus accumulated is distinguished by many peculiar circumstances. Among these are, the marked difference in the character of the fossils from those of the marine strata, both below it and above;—the novelty of the fossils themselves, many of them not having hitherto been found in any other situation;—the proofs which they afford of a great subsequent change in the climate of this part of the globe;—the limited space which the formation appears to have occupied,—and its gradual diminution in thickness towards its borders, so far at least as it has yet been possible to trace the subterranean boundaries of a group, of which, unfortunately, such small portions are disclosed. All these facts, it will be observed, accord with the hypothesis of its origin in fresh water communicating with the sea.

"6. After the depression of the surface last mentioned,—to a depth not yet beyond the access of deposits from fresh water,—next comes a farther depression of the surface, still covered with water, and along with it, most probably, of the land from which the fresh water was supplied,—to such a depth, that it became accessible to sea-water alone; for above the Wealden group, we find a numerous succession of strata,—the greensands, the gault, and the chalk,—abounding in fossils, *not one of them belonging to any genus of which the existing species inhabit fresh water*; and it may be added (and the observation, indeed, applies to all the strata we have mentioned), *not a single one of which belongs to any species at present known to exist in any recent sea!*

"7. The duration of this last epoch of submersion, that during which the greensands, gault, and chalk, were deposited, we are not enabled to measure, except by the mass of the strata accumulated during its progress,—a thickness, at the lowest estimate, of not less than 1200 feet. But, though the contrast of the fossils of the Wealden, and of these incumbent beds, is sudden and

* Mantell, in Sussex, p. 57.

complete, there is no mark of violence at their junction; and the change, for any thing that appears to the contrary, may have been effected, simply by slow and gradual depression, to a greater depth than before, beneath the general level of the sea.

"8. Operations of a different character now succeed. The strata we have mentioned have all the characters of tranquil deposition, and they must have been originally horizontal, or very slightly inclined. But they are now found to be elevated uniformly, though at a small angle, towards the west by north; the whole of the existing land in the east of England having been, to all appearance continuously, uplifted in that direction. And, besides this more extensive raising, the entire mass of the strata has been in some places broken through by partial and more violent heavings; which seem to have acted in continuous or parallel lines, directed in a general view from east to west. In the Isle of Wight, the chalk beds, which form the eastern ridge of the island,—and along the Dorsetshire coast, all the strata, from the chalk down to the Portland-stone, are nearly vertical. In the chalk ridge, on the west of Guildford, in Surrey, the strata rise at an angle not much less than 45°; and within the ridge of the Hastings sands, not only inclined portions, but distinct fractures of the strata, are very frequent.

"Whether these fractures and upheavings took place entirely beneath the sea, or after the strata had been in part, or wholly, raised above its surface at once, or at distant epochs, we have no facts that enable us to decide. It is indeed not impossible, that the very act of rending the strata may have itself effected their protrusion from beneath the waves. Nor can we tell how long these operations were going on, though the appearance of violence in many places seem to prove, that they were not so gradual and tranquil as some geologists have supposed.

"*Lastly*, Since the disclosure of the land thus broken up, the surface appears to have been comparatively undisturbed; but it has been cut into by torrents,—worn away by the incessant action of rains and frosts,—and, finally, its asperities softened down by the effects of vegetation;—and thus it has been gradually moulded into the forms which we now behold.

"If we have succeeded in explaining the facts referred to in the preceding pages, there will now be no difficulty in answering the question proposed by Cuvier, after treating of the wonders which his own researches in comparative anatomy had brought to light. 'At what period was it, and under what circumstances, that turtles and gigantic crocodiles lived in our latitudes, and were shaded by forests of palms and arborescent ferns * ?" We cannot, indeed, reply to this question by reference to any measure of time connected with the history of man, nor tell how many years or ages may have passed silent and uncounted, during the wide interval by which the present time is separated from that remote period; but we can state, almost with certainty, some of the principal events in the series of geological occurrences which marked their progress, and specify at least one epoch during which the wonders which Cuvier refers to may have co-existed. If we are not deceived, our readers will themselves be now enabled to anticipate the reply of the geologist, and to pronounce that, along with the turtles and the crocodiles, were the iguanodon, the megalosaurus, the plesiosaurus, and other enormous reptiles of the lizard tribe, and all the other strange and curious animals and plants whose remains are found within the strata of the Wealden. The period of their existence was unquestionably prior to the deposition of the greensands and the chalk, and they must have lived and died during the interval that followed the submersion of the land which bore upon its surface the Cycases, and the trees of Portland, when the Ganges and the Niger of former continents sent down their waters to the seas which then existed, when the Cyprises, the Cyclases, Unios, and Paludinas, of species now unknown, lived in the rivers; and oysters, also of species which exist no longer, inhabited the shallows at their junction with the sea.

There is proof, therefore, in what has been stated even in this little volume, from an examination of the vicinity of Hastings, of most extraordinary revolutions in the state of the earth's surface, of alterations in its form, its climate, in the structure and appearance of the animals and plants by which it has been inhabited. If we had pursued these inquires, and traced the history of other formations, we should have had before us evidence of changes not less striking in the former surfaces of the globe, at periods both antecedent and subsequent

* Cuvier, quoted by Mantell's Sussex, p. 57.

to the deposition of the strata which have been just described. Decisive evidence of this description is to be found in the beds below those of the Isle of Portland; and, above the chalk, the proofs of repeated submersion and disclosure are not less clear. The fact, indeed, of great and frequent alteration in the relative level of the sea and land, is so well established, that the only remaining question regards the *mode* in which these alterations have been effected, whether by elevation of the land itself, or subsidence in the level of the sea? and the nature of the force which has produced them? The discussions upon these points have been some of the most interesting in geology; but they would lead us far beyond the limits of our present publication. It will be sufficient to say, that the evidence in proof of great and frequent movements of the land itself, both by protrusion and subsidence, and of the connexion of these movements with the operations of volcanoes, is so various and so strong, derived from so many different quarters on the surface of the globe, and every day so much extended by recent inquiry, as almost to demonstrate that these have been the causes by which those great revolutions were effected; and that, although the actions of the inward forces which protrude the land, has varied greatly in different countries, and at different periods, they are now, and ever have been, incessantly at work in operating present change, and preparing the way for future alteration, in the exterior of the globe. But for the detail of the proofs upon this great and leading point in the theory of the earth, we must refer to various publications of modern date, and most especially to the writings of Dr Hutton and Mr Playfair, and the more recent extension and beautiful illustration of their doctrines by Mr Lyell.

These, then, are some of the results to which we are conducted by inquiries such as we have been engaged in. They are not like the visions of the old cosmogonists, the creations of fancy, but sound and legitimate consequences, flowing naturally and inevitably from the plainest evidence, from facts obtained with great labour, and scrupulously weighed. It is this exercise of the intellect to which geological researches so directly lead, that constitutes their great charm and attraction; it lightens and ennobles the labour of detail, and gives to the pursuit the dignity by which it is eminently distinguished as a department of natural science.

TABLES, shewing the Temperature and Pressure of the Atmosphere, at Clunie Manse, in Perthshire, for Eight Years. By the Rev. WILLIAM MACRITCHIE. Communicated by the Author.

1825.	Monthly medium Temperature at 10 A. M., adding the columns.	Monthly medium Temperature at 10 P. M. adding the columns.	Monthly medium Pressure at Noon, adding the columns.	1825.	Monthly medium Temperature at 10 A. M. adding the two extremes.	Monthly medium Temperature at 10 P. M. taking the two extremes.	Monthly medium Pressure at Noon, taking the two extremes.
January	38½°	37¼°	30.02	January	38½°	37½°	29.82
February	39	38¾	29.67	February	37¼	37	29.82
March	42½	39	30.07	March	44½	39	29.85
April	49	42¾	29.95	April	51	43½	29.97
May	53¼	46¼	29.95	May	52½	48	29.90
June	60¾	52	29.85	June	63½	52	29.80
July	67¼	57½	30.12	July	67	59½	30.07
August	63	56¼	29.80	August	66½	55½	29.65
September	59¼	53¼	29.77	September	56	52½	29.80
October	50½	46¼	29.75	October	50¾	45¾	29.70
November	39¼	36½	29.50	November	41¼	40	29.45
December	38¾	37½	29.50	December	37½	35	29.30
Yearly average	$50\frac{0}{4}\ \frac{4}{12}$	$45\frac{1}{4}\ \frac{1}{12}$	29.83	Yearly average	$50\frac{1}{2}\ \frac{1}{12}$	$45\frac{1}{4}\ \frac{9}{12}$	29.76
1826.				1826.			
January	35	33½	29.97	January	34	31	29.75
February	42¼	39¼	29.57	February	42	38½	29.45
March	43¾	39	29.90	March	46½	43¼	30.00
April	50½	43¾	29.77	April	46¾	43	29.72
May	58¾	48¾	30.07	May	58½	47½	30.05
June	70	58	30.17	June	68	58¾	30.15
July	68¼	58½	29.87	July	65	58½	29.80
August	64¼	56¾	29.82	August	64¼	57½	29.80
September	57	51	29.85	September	59	49½	29.80
October	51	46	29.72	October	49	45½	29.60
November	38¼	36¾	29.75	November	40½	36¾	29.70
December	40¼	39	29.72	December	40½	38	29.72
Yearly average	$51\frac{1}{2}\ \frac{5}{12}$	$45\frac{3}{4}\ \frac{5}{12}$	29.85	Yearly average	$51\frac{0}{4}\ \frac{8}{12}$	$45\frac{1}{2}\ \frac{7}{12}$	29.79

TABLES continued.

1827.	Monthly medium Temperature at 10 A. M. adding the columns.	Monthly medium Temperature at 10 P. M. adding the columns.	Monthly medium Pressure at Noon, adding the columns.	1827.	Monthly medium Temperature at 10 A. M. taking the two extremes.	Monthly medium Temperature at 10 P. M. taking the two extremes.	Monthly medium Pressure at Noon, taking the two extremes.
January	35°	35¼°	29.72°	January	36°	36°	29.45°
February	34¾	33½	30.10	February	35	34½	29.85
March	41½	37½	29.40	March	42½	39½	29.30
April	48¼	42½	29.87	April	48½	42½	29.80
May	54½	47¾	29.65	May	53	48	29.60
June	61½	52½	29.72	June	62	52½	29.75
July	64¼	56¼	29.90	July	65	56¼	29.87
August	61¾	54¼	29.95	August	60	54½	29.82
September	58½	52¾	29.90	September	59½	52	29.77
October	53	49½	29.70	October	52¾	47¾	29.70
November	42½	40¾	29.87	November	41	38½	29.70
December	40¾	41	29.47	December	39¼	41	29.67
Yearly average	49½ $\frac{9}{12}$	45¼ $\frac{3}{12}$	29.77	Yearly average	49½ $\frac{2}{12}$	45¼	29.69
1828.				1828.			
January	41½	38	29.80	January	38½	40	29.67
February	40	37¾	29.72	February	42½	40¼	29.65
March	45¾	41¼	29·75	March	44½	41¼	29.45
April	48¼	41¾	29.65	April	50½	44	29.65
May	55¾	48¼	29.82	May	56½	48	29.82
June	62½	54¼	29.87	June	63½	54	29.72
July	64	56¾	29.63	July	63¾	55	29.61
August	62½	54¼	29.72	August	62½	52½	29.75
September	57¾	52¼	29.85	September	57½	50	29.61
October	49½	44¾	29.81	October	51	44½	29.79
November	45¾	43¾	29.69	November	45	43½	29.80
December	42⅔	42¾	29.70	December	41½	43¾	29.79
Yearly average	51¼ $\frac{4}{12}$	46¼ $\frac{3}{12}$	29.75	Yearly average	51¼ $\frac{9}{12}$	46¼ $\frac{7}{12}$	29.69
1829.				1829.			
January	33½	32¼	29.87	January	31½	30¾	29.71
February	38½	36½	29.97	February	40	36	29.83
March	42	36½	29.87	March	42	37	29.77
April	45	40¼	29.45	April	45	40½	29.39
May	56¼	49	29.95	May	56¼	46¼	29.88
June	63¼	54	29.91	June	63	50½	29.89
July	63½	55	29.68	July	61½	55½	29.81
August	60¼	52¾	29.76	August	61½	52	29.54
September	55¼	47¼	29.61	September	58	49	29.70
October	48½	44¾	29.83	October	50	45½	29.81
November	40	38¼	29.91	November	39¾	38½	29.86
December	37	36	30.08	December	40	38¼	30.12
Yearly average	48½ $\frac{4}{12}$	43½ $\frac{2}{12}$	29.82	Yearly average	49	43¼ $\frac{3}{12}$	29.77

TABLES continued.

1830.	Monthly medium Temperature at 10 A. M. adding the columns.	Monthly medium Temperature at 10 P. M. adding the columns.	Monthly medium Pressure at Noon, adding the columns.	1830.	Monthly medium Temperature at 10 A. M. taking the two extremes.	Monthly medium Temperature at 10 P. M. taking the two extremes.	Monthly medium Pressure at Noon, taking the two extremes.
January	36°	34½°	30.02	January	37°	35°	29.90
February	37¾	34¾	29.69	February	40	36¼	29.64
March	47½	42½	29.80	March	47	42	29.77
April	49	43	29.58	April	47	39	29.55
May	55¼	47¾	29.81	May	54½	47	29.63
June	58	50¼	29.74	June	57	50½	29.82
July	63	56½	29.76	July	64¾	58	29.82
August	59¼	51	29.75	August	61	52½	29.70
September	54	49¼	29.53	September	54	49¼	29.56
October	50	46	30.07	October	47½	47	29.98
November	42½	41	29.59	November	46½	42	29.59
December	35¼	35¼	29.59	December	32¼	32¾	29.65
Yearly average	$48\frac{3}{4}\ \frac{10}{12}$	$44\frac{1}{4}\ \frac{3}{12}$	29.74	Yearly average	$49\frac{0}{4}\ \frac{2}{12}$	$44\frac{1}{4}\ \frac{1}{12}$	29.72
1831.				1831.			
January	34¼	33½	29 86	January	35	34¾	29.93
February	39¾	36¾	29.68	February	40¼	38¾	29.62
March	44½	40¾	29.73	March	45½	40¼	29.80
April	49¾	44¼	29.76	April	49	45½	29.87
May	57	47¼	29.91	May	53½	44¼	29.85
June	64¼	54	29.84	June	62¾	53	29.80
July	66	57½	29.89	July	67¾	56¾	29.80
August	66	57	29.87	August	65¼	55½	29.84
September	57¾	51¾	29.82	September	57	50	29.86
October	53½	51	29.58	October	50½	50	29.73
November	40	37¼	29.67	November	43½	40	29.61
December	40	38¾	29.57	December	38½	38¼	29.53
Yearly average	$51\frac{0}{4}\ \frac{3}{12}$	$45\frac{3}{4}\ \frac{2}{12}$	29.76	Yearly average	$50\frac{1}{2}\ \frac{10}{12}$	$45\frac{1}{2}\ \frac{4}{12}$	29.77
1832.				1832.			
January	39	38¼	29.83	January	37½	36	29.81
February	40	39	29.93	February	41¾	39	29.85
March	44	39¾	29.68	March	45¼	39¾	29.55
April	50¼	43½	29.96	April	50	43½	29.85
May	55¼	46¼	29.89	May	55¼	45½	29.83
June	63½	54¾	29.76	June	61¼	55¼	29.80
July	63¾	54¾	29.96	July	63½	52½	29.90
August	62½	54½	29.72	August	63	53	29.72
September	58¼	52¼	29.90	September	57¾	50	29.87
October	51	47	29.78	October	50½	47¼	29.78
November	40½	39	29.64	November	40½	38¾	29.56
December	38½	37¾	29.65	December	39	38¾	29.55
Yearly average	$50\frac{1}{2}\ \frac{2}{12}$	$45\frac{1}{2}\ \frac{3}{12}$	29.81	Yearly average	$50\frac{1}{4}\ \frac{9}{12}$	$44\frac{3}{4}\ \frac{9}{12}$	29.76

TABLES concluded.

Years.	Average Temperature per annum at 10 A. M. adding the columns.	Average Temperature per annum at 10 P. M. adding the columns.	Average Pressure per annum at Noon, adding the columns.
1825	$50\frac{0}{4}^{\circ}\ \frac{4}{12}$	$45\frac{1}{4}^{\circ}\ \frac{1}{12}$	29.83
1826	$51\frac{1}{2}\ \frac{5}{12}$	$45\frac{3}{4}\ \frac{5}{12}$	29.85
1827	$49\frac{1}{2}\ \frac{9}{12}$	$45\frac{1}{4}\ \frac{2}{12}$	29.77
1828	$51\frac{1}{4}\ \frac{4}{12}$	$46\frac{1}{4}\ \frac{3}{12}$	29.75
1829	$48\frac{1}{2}\ \frac{4}{12}$	$43\frac{1}{2}\ \frac{2}{12}$	29.82
1830	$48\frac{3}{4}\ \frac{10}{12}$	$44\frac{1}{4}\ \frac{3}{12}$	29.74
1831	$51\frac{0}{4}\ \frac{3}{12}$	$45\frac{3}{4}\ \frac{2}{12}$	29.76
1832	$50\frac{1}{2}\ \frac{2}{12}$	$45\frac{1}{2}\ \frac{3}{12}$	29.81
Average for the 8 years	$50\frac{0}{4}\ \frac{11}{12}$	$45\frac{1}{4}$	29.79

Years.	Average Temperature per annum at 10 A. M. taking the two extremes.	Average Temperature per annum at 10 P. M. taking the two extremes.	Average Pressure per annum at Noon, taking the two extremes.
1825	$50\frac{1}{2}^{\circ}\ \frac{1}{12}$	$45\frac{1}{4}^{\circ}\ \frac{9}{12}$	29.76
1826	$51\frac{0}{4}\ \frac{8}{12}$	$45\frac{1}{2}\ \frac{7}{12}$	29.79
1827	$49\frac{1}{2}\ \frac{2}{12}$	$45\frac{1}{4}$	29.69
1828	$51\frac{1}{4}\ \frac{9}{12}$	$46\frac{1}{4}\ \frac{7}{12}$	29.69
1829	49	$43\frac{1}{4}\ \frac{3}{12}$	29.67
1830	$49\frac{0}{4}\ \frac{2}{12}$	$44\frac{1}{4}\ \frac{1}{12}$	29.72
1831	$50\frac{1}{2}\ \frac{10}{12}$	$45\frac{1}{2}\ \frac{4}{12}$	29.77
1832	$50\frac{1}{4}\ \frac{9}{12}$	$44\frac{3}{4}\ \frac{9}{12}$	29.76
Average for the 8 years	$50\frac{0}{4}\ \frac{11}{12}$	$45\frac{0}{4}\ \frac{5}{12}$	29.74

TABLE shewing the fall of Snow in Inches.

Months.	Depth of Snow in inches.	Total depth of Snow in inches.	In the Years
February	$4\frac{1}{2}$		
March	$4\frac{1}{2}$		
November	$6\frac{1}{2}$		
December	2	$17\frac{1}{2}$	1825
January	2		
February	$1\frac{1}{2}$		
November	$\frac{1}{2}$		
December	1	5	1826
January	5		
February	$6\frac{1}{2}$		
March	$18\frac{1}{2}$		
April	6		
November	$1\frac{1}{2}$	$37\frac{1}{2}$	1827
January	18		
February	18		
March	3	39	1828
January	$5\frac{1}{2}$		
February	$3\frac{1}{2}$		
March	$1\frac{1}{2}$		
December	$2\frac{1}{2}$	13	1829
January	6		
February	21		
December	$3\frac{3}{4}$	$30\frac{3}{4}$	1830
February	17		
March	$2\frac{1}{2}$		
November	$4\frac{1}{4}$	$23\frac{3}{4}$	1831
February	$\frac{1}{2}$		
March	$2\frac{1}{2}$		
December	$4\frac{1}{2}$	$7\frac{1}{2}$	1832

General Table of the Weather.

YEARS.	Number of Fair Days for each Year.	Number of Foul Days for each Year.	Number of Sunshine Days for each Year.
1825	219	146	206
1826	222	143	226
1827	172	193	189
1828	192	174	166
1829	196	169	172
1830	166	199	135
1831	153	212	129
1832	161	205	144
Yearly average	$185\frac{1}{8}$	$180\frac{1}{8}$	$170\frac{7}{8}$

N. B. The Fair days include the Sunshine days; and by the Foul days is meant, that, in each, more or less rain, hail, or snow fell.

TABLE denoting the Course of the Winds, and the number of Days in which each Wind prevailed.

Years.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	N.
1825	35	34	32	7	93	50	97	17
1826	35	19	38	15	92	41	100	25
1827	53	23	23	8	94	41	96	27
1828	51	35	40	7	110	34	79	10
1829	45	39	39	6	65	35	107	29
1830	29	46	31	11	103	44	76	25
1831	41	34	40	16	91	49	71	23
1832	26	33	32	18	120	62	63	12
Average number of days	$39\frac{3}{8}$	$32\frac{7}{8}$	$34\frac{8}{8}$	11	96	$44\frac{4}{8}$	$86\frac{1}{8}$	21

N. B.—N.E. includes all the intermediate points between N. and E.; and the same with regard to S.E., S.W., and N.W.

Table of Phenomena which occurred during the Eight Years.

Years.	Solar halos.	Lunar halos.	Parhelia.	Mock-moons.	Hurricanes.	Bright Aurora-borealis.	Thunder storms.	Lunar rainbows.	REMARKS.
1825	5	5	1		4	1	1		Bright luminous arches frequently appeared during this tempestuous season in the heavens, resembling the aurora-borealis, with occasional vivid meteors.
1826	7	8	2		2	2			This season unique for heat and drought, and for early harvest.
1827	2	5			4	4			The earlier part of the season remarkably tempestuous.
1828	8	10	1		2	2	1		
1829	4	2		2	1	1	1		The mock-moons occurred on the 20th February at 9 P. M. The hurricane on the 3d of August exceeded in severity any ever remembered.
1830	2	3				7	1		
1831	5	3				5			Large fire-ball on the 2d August at 11 P. M.
1832	3	5	3		1	3	1	1	The Lunar rainbow on the 16th March, at half-past 8 P. M.

A new Solution of that Case of Spherical Trigonometry, in which it is proposed, from Two Sides and their contained Angle, to determine the Third Side. By EDWARD SANG, Teacher of Mathematics. (Communicated by the Author.)

ALL the solutions that have hitherto been given for this case, require the use of some auxiliary angle. When the other two angles, as well as the third side, are wanted, the ordinary form of the calculation is quite sufficient, but when the third side only is wanted, it introduces unnecessary work. Several attempts have been made to determine the third side, independently of a knowledge of its adjacent angles, but in all the methods that have yet been proposed, the calculation consists of two distinct operations.

While in search of an easy plan for clearing the lunar distance from the effects of parallax and refraction, a solution of this case occurred to me, which enables me to determine the third side by a single simple operation; and which renders even the computation of the other angles through its means more simple than the common one.

The different solutions of this case are so well known, and its importance so easily recognised, that it is needless for me to show wherein the method which I am about to offer, differs from the known ones, or wherein its superiority consists.

α and β being the known sides, and c their included angle, the common formula for the cosine of the third side, is

$$\cos\gamma = \cos\alpha.\cos\beta + \sin\alpha.\sin\beta.\cos c.$$

Multiplying each side by 4, and converting the products of the sines and cosines into sums and differences, we obtain

$$4\cos\gamma = \left\{\begin{array}{l} 2\cos(\alpha-\beta) + \cos(\alpha-\beta-c) + \cos(\alpha-\beta+c) \\ +\,2\cos(\alpha+\beta) - \cos(\alpha+\beta-c) - \cos(\alpha+\beta+c) \end{array}\right\}$$

Or, putting δ for the difference, and σ for the sum of the sides,

$$4\cos\gamma = \left\{\begin{array}{l} 2\cos\delta + \cos(\delta-c) + \cos(\delta+c) \\ +\,2\cos\sigma - \cos(\sigma-c) - \cos(\sigma+c) \end{array}\right\}$$

By means of this formula, the third side γ is at once determined, and, except when it is either near 0° or 180°, with great precision.

The determination of the other angles from γ is so simple, that it is quite needless for me either to indicate or to illustrate it.

As the cosines of obtuse angles have to be taken, it is advisable to inscribe on the pages of the Canon the proper angles all the way up to 360°, and also, instead of a subtractive cosine, to write the versed sine of the angle with a 9 prefixed, in order to avoid subtractions. These remarks will suffice, to render the following processes quite intelligible.

Example I.

The two sides being 37° 18′ and 56° 23′, and their included angle 71° 38′, required the third side and the remaining angles.

α = 37° 18′		log sin = 9.782 4643
β = 56 23		log sin = 9.920 5200
δ = 19 05	+ 2 cos = 1.890 0882	
c = 71 38		log sin = 9.977 2934
σ = 93 41	+ 2 cos = 9.871 5160	
$c - \delta$ = 52 33	+ cos = 0.608 0689	
$c + \delta$ = 90 43	+ cos = 9.987 4921	
$\sigma - c$ = 22 03	− cos = 9.073 1434	
$\sigma + c$ = 165 19	− cos = 0.967 3415	
	4)2.397 6501	
γ = 53° 10′ 20″	cos = .599 4126	log cos = 0.096 6707
a = 34 48 03		log sin = 9.756 4284
b = 80 53 15		log sin = 9.994 4841

Example II.

At noon, Greenwich, on July 1. 1832, the moon's place will be N. P. D = 74° 53′ 08″, AR = 147° 33′ 36″; required her angular distance from the star Spica Virginæ, at that instant.

This question corresponds exactly with that for the solution of which the method that I have given was originally intended, and serves at once to exhibit the aptitude of the calculus.

	N. P. D.	AR
	° ′ ″	° ′ ″
Moon's	74 53 08	147 33 36
Spica's	100 16 56	199 05 32
Diff. N. P. D.	25 23 48	2 cos = 1.806 7205
Diff. AR.	51 31 56	
Sum N. P. D.	175 10 04	2 cos = 8.007 1087
	26 08 08	+ cos = 0.897 7544
	76 55 44	+ cos = 0.226 1602
	123 38 08	— cos = 0.553 9083
	226 42 00	— cos = 0.685 8184
		4 | 2.177 4705
Distance =	57 01 06	cos = .544 3676

As a matter of course, the very same method can be applied to the converse case; that in which the two angles and the interjacent side are known, and the third angle required.

Let A and B be the known angles, γ the interjacent side, then a similar method would give

$$4 \cos C = \begin{cases} -2\cos(A-B) + \cos(A-B-\gamma) + \cos(A-B+\gamma) \\ -2\cos(A+B) - \cos(A+B-\gamma) - \cos(A+B+\gamma) \end{cases};$$

or, if we put $A - B = D, \quad A + B = S$

$$4 \cos C = \begin{cases} -2\cos D + \cos(D-\gamma) + \cos(D+\gamma) \\ -2\cos S - \cos(S-\gamma) - \cos(S+\gamma) \end{cases}.$$

I subjoin a single example.

Two angles of a triangle, being $37° 17'$ and $41° 22'$; and their interjacent side $57° 29'$; required the third angle:

A =	37° 17′	
B =	41 22	
D =	4 05	— 2 cos = 8.005 0770
γ =	57 29	
S =	78 39	— 2 cos = 9.606 3964
γ — D =	53 24	+ cos = 0.593 8871
γ + D =	61 34	+ cos = 0.476 1359
S — γ =	21 10	— cos = 9.067 4660
S + γ =	136 08	— cos = 0.720 9544
		4 | 8.469 9168
C =	112 29 24″	cos = 9.617 4792

Were we possessed of complete tables of versed sines; the expressions

$$4 \text{ ver } \gamma = \left\{ \begin{array}{l} + 2 \text{ ver } \delta + \text{ver } (\delta - C) + \text{ver } (\delta + C) \\ + 2 \text{ ver } \sigma + \text{suv } (\sigma - C) + \text{suv } (\sigma + C) \end{array} \right\} - 2;$$

$$4 \text{ suv } C = \left\{ \begin{array}{l} + 2 \text{ ver } D + \text{suv } (D - \gamma) + \text{suv } (D + \gamma) \\ + 2 \text{ ver } S + \text{ver } (S - \gamma) + \text{ver } (S + \gamma) \end{array} \right\} - 2;$$

would be much more convenient, as then all the quantities would be additive.

EDWARD SANG.

32 ST ANDREW SQUARE,
16th June 1832.

Remarks on Electrical Decompositions. By WILLIAM M. HIGGINS, F. G. S. and J. W. DRAPER. Communicated by the Authors.

METALLIC reduction by the galvanic battery is always conducted in one of the three following ways: Either the substance to be decomposed is presented in solution with water, as in the case of sulphate of copper and nitrate of silver; or it is only moistened with water, as when hydrate of potassa is acted upon; or it is presented in a liquid form by heat, as in Davy's experiments with the carbonate of lithia.

The galvanic battery has generally no effect on solids, so that metallic salts must be presented in the form of solutions, for effectual decomposition.

All the simple bodies are either very good or very bad conductors; and the greater the number of substances in a compound, the more easily is it decomposed.

At temperatures between 40° and 120° F., compound substances, not containing oxygen as one of their elements, are non-conductors of galvanic electricity.

When metallic salts in solution, with an excess of water, are presented to the galvanic battery for decomposition, no hydrogen gas is given off at the negative pole, if the power of the battery be proportionate to the strength of the solution, provided the revived metal can exist in water. If it cannot exist in water, then, as soon as an equivalent is revived, decomposition of the water ensues, and hydrogen gas is liberated. This is the case with potassium and sodium. That a real decomposition of the oxide has taken place appears, when we submit mercury, in contact with a solution of muriate of soda, to the battery. Chlorine is evolved from one pole, and hydrogen, with which it was before combined, uniting with the oxygen of the sodium, forms water. Now, in this case, the mercury may act as a kind of endless valve; for, from the intense affinity which it possesses for sodium, it instantly allows it to penetrate, and to be diffused through every part of its mass; but, by excluding the water of the solution, no action can take place on the sodium, save only on that part which exists merely at the surface of the amalgam.

There is, however, between these extremes, a class of metals, manganese is an example, which, in a very comminuted state, decompose water at common temperatures, although they cannot effect it, when they are in mass. The galvanic battery cannot revive any metal in solution, which is not reducible by means of hydrogen gas, below a red heat; and, in all these cases, this view may in general be taken, that the electrical decomposition of an oxide is produced by nascent hydrogen. If peroxide of iron be exposed to a current of hydrogen, decomposition ensues, water is formed, and a black cinerous substance is left, which, though it is a non-conductor, is pure iron, and, in this state, will often inflame at 100° F. The same happens when a saturated solution of protosulphate of iron is decomposed by electricity, the hydrogen which would be liberated from the negative pole, is expended in reducing the protoxide of iron; and the more violent the voltaic action, the more comminuted will be the metallic matter produced; and, in this state, even at low temperatures, iron has the power of decomposing water.

When the substance to be decomposed is merely moistened with water, we still bring the reducing agency of hydrogen into action. Hydrate of potassa is a non-conductor; but, when a new compound of it is formed with water, that compound is not only a conductor of electricity, but is more readily decomposed. The first object is to dissolve the surface of the hydrate in the smallest possible quantity of water, so as to give it a conducting power. The action produced is then sufficient to separate the water, and to melt the hydrate; one equivalent of the oxygen is given off from the water of the hydrate, and its corresponding equivalent of hydrogen uniting with the oxygen of the potassa, the metal is separated. The process is analogous, when the hydrate of potassa is decomposed in a gun-barrel. The iron unites with the oxygen of the water of the hydrate, at a white heat, and the nascent hydrogen separates the oxygen from the potassium, the water produced being simultaneously decomposed by the iron. The facility of this decomposition is doubtless owing, in a great degree, to the volatile nature of the potassium, and the fixidity of the oxygen of iron. But we may be certain that hydrogen is the main cause, for oxide of potassium is decomposed, in like manner, at a white heat. Gay Lussac and Thenard have shewn * that hydrogen cannot decompose hydrate of potassa, on account of the water it contains, which must be decomposed before any action on the oxide can be produced.

At temperatures between 40° and 120° F., no decomposition can be effected by the voltaic battery, if hydrogen gas does not exist in the substance, and is not presented to it in a nascent state. And as, at the same temperatures, no substance is a conductor which does not contain oxygen as one of its elements, therefore water must always be present in all galvanic arrangements for decomposition at those temperatures. But at temperatures greater than 300° F., we meet with many fluids of such conducting power that, without the presence of either hydrogen or oxygen, they may be decomposed by the battery. This is the case with liquid iodine of potassium and chloride of sodium.

Every instance of reduction effected by the galvanic battery, at temperatures between 40° and 120° F., may be performed by chemical means, when hydrogen gas is employed, and evolved under similar circumstances, provided the temperature be higher than a red heat.

These few results, from a long series of experiments, are presented to the scientific, as important principles in electrical decompositions. It is, however, much to be regretted that galvanic arrangements have been so little improved. Nearly all the results mentioned in this paper have been determined by expe-

* Recherches Physico-Chimiques.

riments made with four pair of half inch plates, mounted in tubes, as Berzelius recommends, which, in decompositions, have a decided advantage over eighty pair of four inch plates.

110. Chancery Lane,
August 1832.

Observations made during the Summer of 1832, *on the Temperature and Vegetation of the Scottish Highland Mountains, in connection with their Height above the Sea.* By Hewitt C. Watson, Esq. (Communicated by the Author *.)

To a "Notice of Botanical excursions into the Highlands of Scotland from Edinburgh" last summer, written by Dr Graham, and published in this Journal, are added some observations made by myself on the relative altitudes at which the mountain plants were found. At the time when those remarks were written, other occupations prevented a more detailed account of the altitudinal ranges of individual species; nor would such have altogether accorded with the object of Dr Graham's Notice. But, as the tract of country passed over during that season, included many of the highest hills of Scotland, observations made on the range of absolute elevation within which particular species were seen, as well as those on the temperature of the air during the same period, must possess some interest to the philosophic naturalist. The measurements of heights were all made with Adie's Sympiesometer, the observations at the different stations being made in succession, *not simultaneously*; but by a repetition of those at the lower stations in returning from the higher, and making due allowance for any variation in the pressure of the atmosphere, no very important error could occur. It may, however, be stated in general terms, that these observations usually made the summits of the loftier hills from 50 to 100 feet below their reputed heights. In using the Sympiesometer, it is necessary to have it with its attached thermometer in the shade. This circumstance caused me always to

* The author of this interesting communication has lately printed, at the office of Neill & Co., a valuable work entitled "Outlines of the Geographical Distribution of British Plants, belonging to the Division of Vasculares or Cotyledones. 8vo. 334 pages. For *private distribution.*

record the temperature in connection with the elevation; and from the observations made each day at different heights, by taking the mean altitude and the mean of the thermometrical indications,* are obtained the following results:—

Means of Altitudes and Temperatures.

Place.	M. Alt. in Feet.	Temperature.	Date.	Number of Observations.
Clova Mountains, . . .	$2409\frac{1}{6}$	56°	July 16.	11
Clova to Braemar, . .	$2227\frac{2}{3}$	54.66	17.	3
Ben-na-Buird, ...	$2581\frac{1}{4}$	47.75	23.	8
Braemar Moors, . . .	1752	49.80	21.	5
Ben-na-muic-diuch, . .	$2590\frac{1}{6}$	46.33	24.	6
Ben Heeal, ...	1186	57.10	31.	5
Ben Loyal, ...	$1839\frac{1}{4}$	60.37	Aug. 1.	4
Ben Hope, ...	$1935\frac{1}{6}$	53	5.	5
Ben Nevis, ...	$1638\frac{3}{4}$	54.70	14.	5
Ditto, ...	$3086\frac{1}{3}$	52.42	15.	8
Loch Eil Moors, . . .	$1288\frac{5}{6}$	62.08	16.	6
Red Cairn, ...	$2417\frac{2}{3}$	57.33	17.	9
Means	$2079\frac{1}{2}$	54.7		

These observations were usually made between 11 A. M. and 5 P. M.; sometimes an hour or two earlier or later. This will probably cause an excess of 2° or 3° above the true temperature for the 24 hours; so that in general terms (for the observations are not sufficiently numerous to speak with confidence) we may say that the temperature of the Highland Mountains, at a mean elevation of 2000 feet, is about 52° Fahrenheit during the hottest month. The mean temperature of July and August, at Leadhills, in the south of Scotland, is 56°, the height above the sea 1280 feet. The next table gives the elevation and temperature of the highest and lowest points, of which the record was kept, on each of the before-mentioned days:—

* An example will more clearly explain this. On the ascent of Ben-na-muic-duich, the Sympiesometer indicated as follows:—

Altitude in Feet.	Temperature.
1805	52
3052	42
4320	39
2688	45
2369	47
1307	53
$2590\frac{1}{6}$	46°33 Means.

Elevation and Temperature of the Highest and Lowest Points recorded.

Place.	Lowest Elevation.	Temperature.	Highest Elevation.	Temperature.	Difference of Elevation.	Difference of Temp.
Clova Mountains, .	972	60°	3111	50°	2139	10°
Clova and Braemar,	1677	54	2789	49	1112	5
Ben-na-Buird, . .	1346	50	3503	44	2157	6
Braemar Moors, .	1159	51	2216	47	1057	4
Ben-na-muic-duich, .	1307	53	4320	39	3013	14
Ben Heeal, . . .	350	63	1720	53	1370	10
Ben Loyal, . . .	920	70	2637	53½	1717	16½
Ben Hope, . . .	789	55½	2943	50	2154	5½
Ben Nevis, . . .	310	62½	2678	47	2368	15½
Ditto, ...	1023	58	4338	45½	3315	12½
Loch Eil Moors, .	733	64	2390	57	1657	7
Red Cairn, ...	1217	60	3816	52	2599	8
Means, . .	983½	58·4	3038½	48·9	2055	9½

The observations at the upper stations were usually made between 1 and 3 P. M.; those at the lower preceding or following them by 2 or 3 hours. Notwithstanding this advantage for the upper stations, the decrease of heat appears to be very rapid; namely, 1° Fahrenheit for 216 feet of elevation. Perhaps the difference of time may be partly compensated by the fact, that ascents were commonly commenced on fine mornings, which were in some instances followed by wet and stormy afternoons. This was particularly the case in Ben Loyal, and the first partial ascent of Ben Nevis; while on Red Cairn and Ben Nevis the second day, the weather was fine, and generally without mist. The mean of the two former gives 1° of temperature for 128 feet, that of the two latter only 1° of temperature for 243 feet. Making allowance for the time of day when taken, we should from these details assume the temperature of the month to be thus:—

Alt.	Temp.
1000 feet . . .	57°
2000	52
3000	46
4000	40

It is true that these can only be regarded as approximations, but they are worth recording, for comparison with any future observations of a similar kind. The temperature of the small-spring wells near the top of Ben-Nevis (alt. 3758 feet, on the west side) was 39°; a bubbling spring, forming a small well at the height of 2209 feet on the moors northward of Loch Eil, Argyleshire, gave 43°; both, probably, influenced by the atmospheric temperature.

After passing 2000 feet in the eastern Highlands, 1500 feet in the western, and 1000 feet in the north-western, vegetation undergoes a decided and rapidly increasing deterioration. Cultivation has ceased; trees dwindle down to meagre bushes, and the graceful verdure of our fields and groves gives place to a small rigid vegetation, such as clothes the shores of Arctic lands. The following is a list of species which I have observed between the heights denoted. Several of them may occur (especially on the Breadalbane mountains) rather higher than is here specified. All I can yet say is, that they do grow at least as high or as low, and probably not much more; but, no doubt, some of the spring flowers below 2000 feet were overlooked.

Species above 4000 *feet.*—Aira alpina, Carex rigida, Empetrum nigrum (very rarely), Festuca verna, Gnaphalium supinum, Juncus trifidus, Leontodon palustre, Luzula arcuata, L. spicata, Oxyria reniformis, Rumex Acetosa, Salix herbacea, Saxifraga stellaris, Sibbaldia procumbens, Silena acaulis, Vaccinium Myrtillus, Viola palustris. The absence of soil, rather than the height, probably arresting others. To these 17, we may add 6 others seen on the very summit of Ben-Lawers, which is said to be 4015 feet above the sea; viz. Cherleria sedoides, Cerastium alpinum, Polygonum viviparum, Saxifraga oppositifolia, S. nivalis, Saussurea alpina. Total 23.

Species between 3000 *and* 4000 *feet.*—Achillæa Millefolium, Aira flexuosa, Alchemilla alpina, A. vulgaris, Anthoxanthum odoratum, Apargia Taraxaci, Arabis petræa, Arenaria rubella, Azalea procumbens, Calluna vulgaris (rare, and never to 3500 feet), Caltha palustris, Campanula rotundifolia, Cardamine hirsuta, C. pratensis, Carex dioica, C. panicea, C. pilulifera, C. pulea, Cerastium latifolium, C. viscosum, Chrysosplenium alternifolium, C. oppositifolium, Cochlearia officinalis, Draba rupestris, Eleocharis cæspitosa, Epilobium alpinum, Eriophorum angustifolium, Euphrasia officinalis, Galium saxatile, Juncus biglumis, J. triglumis, Myosotis alpestris, Nardus stricta, Narthecium ossifragum, Oxalis Acetosella, Poa alpina, P. annua, Ranunculus acris, Rhodiola rosea, Rubus Chamæmorus, Salix reticulata, Saxifraga cernua, S. hypnoides, S. rivularis, Silene maritima, Statice Armeria, Stellaria cerastoides, S. uliginosa, Thalictrum alpinum, Thymus serpyllum, Tormentilla officinalis, Trifolium repens, Tussilago Farfara, Vaccinium uliginosum, V. Vitis-Idæa, Veronica alpina, V. serpyllifolia. In all 57 species. To these may be added the 23 former, all of which (except Luzula arcuata) I have seen below 4000 feet. L. arcuata, in Sutherland, must be below this, if not below 3000 feet. Total, 80 species.

Species between 2000 *and* 3000 *feet.*—Achillæa Ptarmica, Adoxa moschatellina, Ajuga reptans, Alopecurus alpinus, Anemone nemorosa, Apargia autumnalis, Arabis hirsuta, Arbutus Uva-ursi, A. alpina, Astragalus alpinus, Avena pratensis, Bellis perennis, Betula alba, B. nana, Carex atrata, C. binervis, C. cæspitosa, C. capillaris, C. curta, C. flava, C. pauciflora, C. pulicaris, C. rariflora, C. stellulata, C. Vahlii, Comarum palustre, Cornus suecica, Digitalis purpurea, Draba incana, Draba verna, Drosera rotundifolia, Dryas octopetala, Eleocharis pauciflora, Epilobium alsinifolium, E. angustifolium, Erica cinerea, E. Tetralix, Erigeron alpinus, Eriophorum vaginatum, Festuca duriuscula, Galium pusillum, Genista anglica, Geranium sylvaticum, Geum rivale, Gnaphalium dioicum, Gymnadenia conopsea, Habenaria albida, H. viridis, Hieracium alpinum, H. Halleri, H. prenanthoides, Juncus castaneus, J. squarrosus, J. uliginosus, Juniperus communis, Leontodon Taraxacum, Linnæa borealis, Listera cordata, Lotus corniculatus, Luzula campestris, L. sylvatica, Melampyrum pratense, Melica cœrulea, Montia fontana, Orchis maculata, Orobus tuberosus, Oxytropis campestris, Phleum alpinum, Pinguicula vulgaris, Pinus sylvestris, Polygala vulgaris, Potentilla alpestris, Pyrola minor, P. rotundifolia, P. secunda, Pyrus Aucuparia, Ranunculus Flammula, Rhinanthus Crista-Galli, Rosa canina (rarely), Rubus saxatilis, Sagina procumbens, Salix arenaria, S. cinerea? S. lanata, S. Myrsinites, S. oleifolia? S. vaccinifolia (probably other willows), Saxifraga aizoides, Scabiosa succisa, Senecio Jacobæa, Sisteria cœrulea, Solidago virgaurea, Sonchus alpinus, Spergula saginoides, Stellaria holostea, Tofieldia palustris, Trientalis europæa, Triglochin palustre, Trollius europæus, Urtica dioica, Vaccinium Oxycoccos, Veronica Beccabunga, V. saxatilis, Vicia sylvatica, Viola canina, V. lutea. To these 106 species, may be added all the preceding 80, except Saxifraga cernua, Draba rupestris, Luzula arcuata, which I have not seen below 3000 feet. Total, 183 species.

Species between 1000 *and* 2000 *feet.*—Agrostis alba, Aira cæspitosa, A. caryophyllea, A. cristata, Alnus glutinosa, Alopecurus geniculatus, A. pratensis, Anthriscus sylvestris, Anthyllis vulneraria, Arrhenatherum avenaceum, Artemisia vulgaris, Briza media, Bromus mollis, Bunium flexuosum, Capsella Bursa Pastoris, Carduus acanthoides (very rarely), Carex pallescens, C. recurva, C. vulgatum, Chrysanthemum Leucanthemum, Cnicus arvensis, C. heterophyllus, C. lanceolatus, C. palustris, Corylus Avellana, Cynosurus cristatus, Cytisus scoparius, Dactylis glomerata, Drosera anglica, Epilobium palustre, Euphorbia Peplus, Fragaria vesca, Galeopsis Tetrahit, Galium boreali, G. verum, Gentiana campestris, Geranium Robertianum, Gnaphalium sylvaticum, Helianthemum vulgare, Heracleum Sphondylium, Hieracium murorum, H. paludosum, H. pilosella, H. pulmonarium, H. sylvaticum, Holcus lanatus, Humulus lupulus (very rarely, at 1090 feet in Braemar), Hypericum pulchrum, Hypochæris radicata, Juncus effusus, Lamium purpureum, Lathyrus pratensis, Linum catharticum (probably higher), Lobelia Dortmanna, Lolium perenne, Lonicera Periclymenum, Luzula pilosa, Lycopsis arvensis, Lysimachia nemorum, Melica uniflora, Mentha arvensis, Menyanthes trifoliata, Mercurialis perennis, Meum athamanticum, Myosotis arvensis, M. palustris, M. cæspitosa, Myrica Gale, Myriophyllum spicatum, Parnassia palustris, Pedicularis palustris, P. sylvatica, Pimpinella saxifraga, Plantago lanceolata, P. major, P. maritima, Poa fluitans, P. trivialis, Polygonum aviculare, P. Convolvulus, Populus tremula, Potentilla anserina, P. Fragariastrum, Primula vulgaris (probably higher), Prunella vulgaris, Prunus Padus, Pyrethrum inodorum, Pyrola media, Ranunculus Auricomus, R. repens, Rosa spinosissima, R. tomentosa, R. villosa, Rubus Idæus, Rumex crispus, R. obtusifolius, Salix Andersoniana, S. fusca (some other willows), Senecio aquaticus, S. sylvaticus, Sinapis arvensis, Sonchus oleraceus, Spergula arvensis, Spiræa Ulmaria, Stellaria media, Subularia aquatica, Teucrium Scorodonia, Trifolium medium, T. pratense, Triodia decumbens, Ulex europæus (introduced), Urtica urens, Valeriana officinalis, Veronica arvensis, V. Chamædrys, V. officinalis, V. scutellata, Vicia Cracca, V. sepium, Viola tricolor. To these 120, we may add all the previous 186 species, except Aira alpina, Alopecurus alpinus, Apargia Taraxaci, Arenaria rubella, Astragalus alpinus, Carex atrata, C. pulla, C. rariflora, C. Vahlii, Cerastium alpinum, C. latifolium, Cherleria sedoides, Draba rupestris, Erigeron alpinus, Gnaphalium supinum, Juncus biglumus, J. castaneus, Luzula arcuata, Myosotis alpestris, Oxytropis campestris, Phleum alpinum, Poa alpina, Salix lanata, S. reticulata, Saxifraga cernua, S. rivularis, Sesleria cœrulea, Sibbaldia procumbens, Sonchus alpinus, Spergula saginoides, Stellaria cerastoides, Veronica alpina, and V. saxatilis, which I have not seen below 2000 feet, and it is not likely that any of them will be found much below this height. Deducting 33 from 306, we have 273 species left. Probably several others will hereafter be added to them.

Species below 1000 *feet.* These it will be tedious to enumerate: and they may be almost as readily shewn by the negative evidence. Besides the species already mentioned as not occurring below 2000 or 3000 feet; the following seem to reach their lower limits above 1000 feet. Arabis petræa, Azalea procumbens, Betula nana, Carex rigida, Epilobium alpinum, Hieracium alpinum, Juncus trifidus (rare below 2000) J. triglumis, Luzula spicata, Potentilla alpestris, Saussurea alpina, and Silene acaulis. A few others are observed below 1000 feet in the north and west of Scotland; but so soon as we quit the Highlands they disappear from the low grounds. They are; Alchemilla alpina, Arbutus alpina, A. Uva-Ursi, Carex capillaris, Cornus suecica, Draba incana, Dryas octopetala, Epilobium alsinifolium, Galium boreale, Meum athamanticum, Oxyria reniformis, Pyrola secunda, Rubus Chamæmorus, Saxifraga aizoides, S. stellaris, S. oppositifolia, Thalictrum alpinum, Tofieldia palustris.

Species of undetermined Height.—Besides what are enumerated in the previous lists, there are some other mountain plants which I have not seen growing; but which are most of them probably to be found between 2000 and 3000 feet. They are the extremely rare plants discovered by Mr George Don, and one or two other botanists; Ajuga alpina, Arabis ciliata, Arenaria fastigiata, Bartsia alpina, Carex Mielichoferi, C. angustifolia, C. stictocarpa, C. hordeiformis, C. ustulata, Elyna caricina, Eriophorum alpinum (said to grow on Ben Lawers) E. capitatum, Gentiana nivalis, Hieracium cerinthoides, Hierochloe borealis, Lychnis alpina, Menziesia cœrulea, Poa laxa, Potentilla opaca, P. tridentata, Ranunculus alpestris, Salix (various species), Saxifraga denudata, S. elongella, S. lætevirens, S. cæspitosa, S.

pedatifida, S. muscoides, Stellaria scapigera, Thlaspi alpestre, Veronica fruticulosa. Omitting these, and including all those previously mentioned, we have 306 species enumerated as growing above 1000 feet of elevation. Had we a perfect catalogue, they would probably amount to 400 or 500; the whole Flora of Scotland being about 1100 phænogamous species. Cryptogamous plants have been entirely omitted in these lists. If we now arrange them according to the Natural Orders, as given in Loudon's *Hortus Britannicus*, we have the numbers and proportions, at the different heights, as follows;

TABLE of the Altitudinal Elevation of Highland Plants.

Natural Orders.	Numbers.			Proportions.			Natural Orders.	Numbers.			Proportions.		
	1000–2000 Ft.	2000–3000 Ft.	3000–4320 Ft.	1000–2000 Ft.	2000–3000 Ft.	3000–4320 Ft.		1000–2000 Ft.	2000–3000 Ft.	3000–4320 Ft.	1000–2000 Ft.	2000–3000 Ft.	3000–4320 Ft.
Ranunculaceæ	8	6	3	$\frac{1}{34}$	$\frac{1}{30}$	$\frac{1}{27}$	Vaccinieæ	4	4	3	$\frac{1}{68}$	$\frac{1}{46}$	$\frac{1}{27}$
Cruciferæ	9	7	5	$\frac{1}{30}$	$\frac{1}{26}$	$\frac{1}{16}$	Ericeæ	10	9	2	$\frac{1}{27}$	$\frac{1}{20}$	$\frac{1}{40}$
Cistineæ	1	...	...	$\frac{1}{273}$	...	...	Gentianeæ	2	...	...	$\frac{1}{136}$	...	...
Violariæ	4	3	1	$\frac{1}{68}$	$\frac{1}{61}$	$\frac{1}{80}$	Boragineæ	4	1	1	$\frac{1}{68}$	$\frac{1}{183}$	$\frac{1}{80}$
Droseraceæ	3	1	...	$\frac{1}{90}$	$\frac{1}{183}$	...	Scrophularineæ	14	8	3	$\frac{1}{19}$	$\frac{1}{23}$	$\frac{1}{27}$
Polygaleæ	1	1	...	$\frac{1}{273}$	$\frac{1}{183}$	...	Labiatæ	7	2	1	$\frac{1}{39}$	$\frac{1}{91}$	$\frac{1}{80}$
Caryophylleæ	9	12	9	$\frac{1}{30}$	$\frac{1}{15}$	$\frac{1}{9}$	Lentibularieæ	1	1	...	$\frac{1}{273}$	$\frac{1}{183}$	...
Lineæ	1	...	...	$\frac{1}{273}$	...	...	Primulaceæ	3	1	...	$\frac{1}{91}$	$\frac{1}{183}$	...
Hyperacineæ	1	...	...	$\frac{1}{273}$	...	...	Plumbagineæ	1	1	1	$\frac{1}{273}$	$\frac{1}{183}$	$\frac{1}{80}$
Geraniaceæ	2	1	...	$\frac{1}{136}$	$\frac{1}{183}$	...	Plantagineæ	3	...	...	$\frac{1}{91}$	...	...
Oxalideæ	1	1	1	$\frac{1}{273}$	$\frac{1}{183}$	$\frac{1}{80}$	Polygoneæ	7	3	3	$\frac{1}{39}$	$\frac{1}{61}$	$\frac{1}{27}$
Leguminosæ	13	7	1	$\frac{1}{21}$	$\frac{1}{26}$	$\frac{1}{80}$	Euphorbiaceæ	2	...	...	$\frac{1}{136}$	...	...
Rosaceæ	20	12	5	$\frac{1}{14}$	$\frac{1}{15}$	$\frac{1}{16}$	Urticeæ	3	1	...	$\frac{1}{91}$	$\frac{1}{183}$	...
Onagrarieæ	4	3	1	$\frac{1}{68}$	$\frac{1}{61}$	$\frac{1}{80}$	Amentaceæ	14	10	2	$\frac{1}{19}$	$\frac{1}{18}$	$\frac{1}{40}$
Halorageæ	1	...	...	$\frac{1}{273}$	...	...	Coniferæ	2	2	...	$\frac{1}{136}$	$\frac{1}{91}$	...
Portulaceæ	1	1	...	$\frac{1}{273}$	$\frac{1}{183}$	...	Empetreæ	1	1	1	$\frac{1}{273}$	$\frac{1}{183}$	$\frac{1}{80}$
Crassulaceæ	1	1	1	$\frac{1}{273}$	$\frac{1}{183}$	$\frac{1}{80}$	Juncagineæ	1	1	...	$\frac{1}{273}$	$\frac{1}{183}$	...
Saxifrageæ	7	9	8	$\frac{1}{39}$	$\frac{1}{20}$	$\frac{1}{10}$	Orchideæ	5	5	...	$\frac{1}{55}$	$\frac{1}{37}$	...
Umbelliferæ	5	...	...	$\frac{1}{55}$	...	...	Melanthaceæ	1	1	...	$\frac{1}{273}$	$\frac{1}{183}$	...
Caprifoliaceæ	3	2	...	$\frac{1}{91}$	$\frac{1}{91}$	...	Junceæ	10	10	6	$\frac{1}{27}$	$\frac{1}{18}$	$\frac{1}{13}$
Rubiaceæ	4	2	1	$\frac{1}{68}$	$\frac{1}{91}$	$\frac{1}{80}$	Cyperaceæ	18	20	7	$\frac{1}{15}$	$\frac{1}{9}$	$\frac{1}{4}$
Valerianeæ	1	...	...	$\frac{1}{273}$	...	...	Gramineæ	25	13	7	$\frac{1}{11}$	$\frac{1}{21}$	$\frac{1}{11}$
Dipsaceæ	1	1	...	$\frac{1}{273}$	$\frac{1}{183}$	...							
Compositæ	32	18	6	$\frac{1}{9}$	$\frac{1}{10}$	$\frac{1}{13}$	Total of Sp.	273	183	80			
Lobeliaceæ	1	...	...	$\frac{1}{273}$	...	...							
Campanulaceæ	1	1	1	$\frac{1}{273}$	$\frac{1}{183}$	$\frac{1}{80}$	Total of Ord.	48	38	25			

Geological Remarks upon the Neighbourhood of the Caspian Sea. By M. Eichwald of Wilna.

(Concluded from page 132.*)*

All around we observe the same tertiary shell limestone. On the south side of the Lake of Sich, about two versts from the shore of the Caspian, there is a high hilly chain, composed of shell limestone, containing numerous rolled pieces of quartz, some of them the size of a child's head. A similar shell limestone occurs in front of Ssarachani, near the perpetual fire, while on the opposite side a loamy earth prevails. Sandstone does not appear in this neighbourhood. In this loam we find fragments of shells principally of the *Mytilus edulis*, *Cardium edule* and *rusticum* species, at present met with in a living state in the Caspian Sea. The sea appears to have retired from this quarter at no very remote period. From Bakir to Sallian, the hills and plains are composed of tertiary limestone, sandstone, and various clays, and steppes of loam. Springs and rivulets, naphtha, and also salt lakes, occur around Sallian, as around Baku.

Island of Tschelekaen.—The naphtha springs of the island of Tschelekaen, on the east coast of the Caspian Sea, are not less numerous than around Baku, but the naphtha is far from being so pure, and, on burning, emits a much more offensive smell. They occur chiefly in the sand-hills, so numerous in the island. Some wells are twenty or thirty fathoms deep. The Black well is remarkable on this account, that it has afforded for 100 years the same quantity of naphtha, viz. ten pud daily. It swims on a saline water, which is somewhat sulphureous, and is used as a remedy in many diseases by the Truchmener. The greater number of wells continue for 2—4, seldom 20—40 years. Other naphtha wells are situated in a greyish clay, which forms horizontal strata. The sand is sometimes concreted into a kind of sandstone. The other rocks in the island are boulders of rocks different from the surrounding formation, brought from a distance by some natural agent, or thrown upon the coast by the waves. The salt in the island, occurs chiefly at its eastern extremity, in very numerous lakes, which, like those at Baku, are very productive of salt. It is deposited in the bottom in masses sometimes a foot thick, which are transparent or muddy, and consists of closely aggregated crystals. It is dug as at Baku; masses generally an ell in length and one foot thick are hewn, and in this form sent into Persia. Its colour is white; sometimes it has a bitter taste, and occasions diarrhœa, a proof of its containing glauber and epsom salt. Some of these salt-lakes are several thousand feet in circumference; and in some of them the water is so warm, so hot indeed, that we cannot keep our hand in it. The beds of salt which are deposited from the water, resemble rock-salt. As the salt is generally pure muriate of soda being seldom mixed with foreign matter, it crystallises more readily than the salts from sea-water. The many naphtha wells, as also the hot water of the springs on the island, show that its salt, like rock-salt, owes its origin to a volcanic heating process. Hence, we find every where on the Continent, where salt-mines occur, volcanic productions as proofs of a former igneous process. Thus there is a small range of hills some miles from Wieliczka, in which we find at the same time sulphur and pumice, and springs of sulphureted hydrogen gas. At Burgos in Spain, a bed of rock-salt has been formed in the crater of an extinct volcano; we find in it pumice, puzzolano, and other volcanic products, which are intermixed with the salt. At Baku, and in the Island of Tschelekaen, we observe, as volcanic phenomena, very distinctly heatings of the interior of the earth. This salt can only be distinguished from rock-salt, in this respect, that the latter originates at once from a pretty widely extended volcanic eruption, and forms at the same time beds extending for miles, which are consequently proofs of former igneous action. But the salt of the Caspian is formed in a different manner, through long still continuing heating of the interior of the earth, which decomposes the salt water.

The Bay of Balchan.—At Krasnowodsk, on the north coast of the Bay of Balchan, all the projecting points of land are composed of coarse granular granite; and a little into the anterior, there rises a steep and rough porphyry mountain. This granite, and various porphyries along with a compact limestone, without petrifaction, and an old and new sandstone, form the coast and neighbourhood of the Balchan Bay.

South Coast of the Caspian.—Messenderan.—This coast, as far as examined, appeared composed of porphyry, with compact limestone and sandstone. Here, as in the Caucasus in general, the lower hills are composed of limestone, and the more lofty of porphyry, which often rises into mountains of enormous altitude: the same arrangement of rocks are repeated on the south coast of the Caspian, and also on the east coast. Frazer's observations show that similar geognostical relations occur in other parts of Persia.

Sketches of South European Nature—Italy. By Professor HAUSMANN*.

In order to understand the characters of a country, we must first inquire into the external and internal constitution of the mineral masses of which it is composed. These form the basis on which rests every thing that lives and moves in a country, affording the principal requisites for the support of vegetables and of animals, and even for the existence of the men who inhabit it. As in animals, the frame-work of their bones, and in trees the stem and branches, have the chief influence upon the shape of the whole, so does the aspect of a country depend chiefly upon the nature of its elevations. The character of the land is determined by the variety or uniformity of these elevations, by their absolute as well as by their proportional height; by their more or less flattened summits; likewise by their extent, their direction, and by their union or separation. But these external relations arise from the internal structure, whereon, therefore, the nature and the properties of the loose fruit-bearing soil are entirely dependent. From this circumstance, the internal structure presents to us one of the principal conditions which regard the animated surface of the soil †.

* Translated from the German original by George F. Hay, Esq.

† The author refers to a treatise published by himself at Gottingen, regarding the mutual relations of geology and agriculture, entitled Specimen de rei agrariæ et salutariæ fundamento geologico; this was translated into German by Professor Karte, at Berlin, in 1825.

How great the influence is which the mountains of a country really possess over all its other peculiarities, cannot easily be made more striking than by a comparison between Spain and Italy. Both countries extend themselves toward the south, bounded by the same seas, and under not very different degrees of latitude. The separation of both from the neighbouring parts of the European continent, is by lofty mountain chains; and mountains of great height elevate themselves throughout their whole extent. But how different are the mountains of Spain from those of Italy? The following representation will suffice to shew, that it is exactly the different constitution of the mountains that causes the great dissimilarity exhibited in so many respects by Spain and Italy*.

ITALY.

The long and narrow chain of the Apennines, which, in its general extent, is simple and uniform, and does not reach the limit of perpetual snow, is, in the case of Italy, necessarily connected with the long narrow shape of the country. And, likewise, the principal direction of the chain from north-west towards the south-east, occasions the extension of the peninsula to be similar. Where the mountain-chain is not divided, the sea-coasts are in general parallel. Where, on the contrary, as at the southern extremity, the mountains advance in two principal ranges, the external limit of the country follows likewise this division. The upper part of the Apennines, together with the Alps, encloses a hollow space, which may be regarded as a wide valley, formed by the above mountain chains. The direction of those ranges, and the manner of their union, prescribe the principal direction of the largest Italian rivers, which is from west to east.

The plains, which stretch from the banks of these rivers towards the mountains, and which plains are not much above the level of the sea, and are watered by many small streams connected with the rivers, are the only plains of any extent in Italy, since the inclination of the Apennines towards the sea permits no great space for flat land elsewhere. Numerous ri-

* The sketch of Spain was communicated to us on a former occasion, and is published in the 1st vol. of this Journal for 1830.—Edit.

vers run on both sides of the mountains towards the sea, and afford in most districts a plentiful supply of water; but they also occasionally form marshes over considerable tracts of country. In this part of Italy only a few rivers, as the Arno and Tiber, have a course of much length, and thus afford a large and valuable supply of water.

From the limited breadth of Italy, and the generally uniform external condition of the chain of the Apennines, we might be led to expect a similarity among the various other natural objects of the country. There is, however, no small variety, which is effected chiefly by means of the peculiar relations of the mountain range. The chain of the Apennines differs essentially in the following respect, from most other great mountain ranges—the system of the rocky strata does not extend in the direction of the chain, and the changes among their formations do not thoroughly correspond with the transverse section of the strata.*

The high land of the Apennines which terminates at the Sea Alps, and extends from thence into Tuscany, without materially differing from the Alps in geological characters, consists, as regards the principal mass, of various older rocks, which are partly crystalline. The mountains in Southern Calabria likewise shew a similar composition. On the contrary, the middle, and by far the largest part of the chain, is in a high degree uniform, as regards its internal composition; the principal mass consisting of only one rock formation, and this is a white limestone, which appears to be without any striking variations. From this distribution of the mountain formations, it follows, that the Upper Apennines, like their southern extremity, differ from the principal middle divisions, in the forms of the mountains, as well as in those of the valleys. The principal elevations belong to the calcareous formation; for the limestone summit of Abruzza, according to the measurement of Schouw, reaches to a height of nearly 9000 feet above the level of the

* The author says, I have taken notice of this unusual relation in a publication of mine, entitled "Commentatio de Apenninorum constitutione geognostica," (to be found, like that mentioned in the last note, in the Transactions of the Royal Society of Gottingen), and wait for a new opportunity of being able more exactly to develope the geological appearances referred to.

sea. On the contrary, the other parts of the Apennines, as to individual summits, may indeed reach a height of 6000 feet; but, in general, are not higher than from 3000 to 4000 feet.

The calcareous Apennines would undoubtedly be more uniform in their contour, and resemble the Jura range, which consists of a similar principal formation, were not the relations of their strata in a high degree various and irregular. As in the Jura range, the long parallel ridges of the high arched strata with parallel axes correspond; and it is only in the transverse rocky valleys and ravines, that we find more variety in the physiognomy of the mountains. So, in a great part of the Apennines, the various changes in position, in the curvature, and in the trough and saddle shapes of the strata, form evidently one of the principal causes of the great variety in the form of the mountains and rocks, as well as of the shape, direction, and connexions of the valleys.

But Middle Italy also in another respect exhibits great variety in its external formation. At the foot of the mountain chain, masses appear heaved up by subterranean agency, and partly distributed by water, which, in form and internal structure, are different altogether from the Apennine range. The mountains of Bolsena and Viterbo, the hills and plain of Rome, the mountains of Albano, and beyond all the summit of Vesuvius, giving vent to smoke, and occasionally to fire and lava; all these attest an activity, which is partly extinguished and partly continues to operate, and is completely disallied from that which occasioned the limestone formation, and the separation and bending of its strata.

It will be at once allowed, that such a difference in the composition of the solid masses, which are the foundation of the cultivateable soil, must have an influence equally various upon the nature of the soil, and, by means of the soil, on the whole of the vegetation, as well as on the individual cultivated plants. The soil of the valley of the Po, which is partly of loam and partly of sand, and is formed by extensive alluvial washing and gradual deposition therefrom, shows, upon the whole, more uniform relations than the soil deposited upon the declivities in the valleys, and at the foot of the Apennine chain. Among the

Apennines, the soil possesses varying qualities, according to the difference of the rocks from which it proceeded, and which it still covers in its present situation, as well as according to the different ways in which its particles, borne forward by water, were deposited. The greatest difference is seen between that soil which belongs to the middle and principal limestone region of the Apennines, which is mostly of a clayey nature, and the fine, loose, and generally dark-brown coloured soil, which proceeded from the decomposition of volcanic products. If the clayey soil resembles those which generally cover our limestone strata; so, on the contrary, the volcanic kind, in its physical and chemical qualities, which are in general highly favourable to vegetation, essentially resembles our basaltic arable mould. Though great tracts, possessing a soil with these qualities, as the Campagna di Roma, still bear out a poor vegetation, the appearances afforded by our basaltic mountains are not contradicted; for the inconsistency is easily explained by other relations, which limit and oppress cultivation in those districts.

The influence of the differences of the soil, of which a general sketch is here given, upon vegetation and the state of cultivation in Italy, cannot indeed be mistaken, but there are yet other circumstances which have a much more powerful influence. The great extent of the country, according to its latitude, occasions upper Italy to possess an entirely different vegetation from the southern part: the height of the soil, too, above the level of the sea, from the mountain ridges to the plains and sea-coast, affords various vegetable regions.

The vegetation of Upper Italy has altogether much resemblance to that of the warmer regions of Southern Germany and Switzerland, as well as of those parts of France which have their boundary at the Alps. The *chestnut tree* is the ornament of the forest; the *vine* with its tendrils climbs the mulberry tree; *wheat* and *maize* in some districts, as well as *rice*, are the principal sorts of grain. Cultivation, which is favoured by the loose soil of the valley of the Po, derives considerable advantage from the water which flows abundantly from the Alps. An extensive and skilful irrigation is constantly employed, not only in watering the meadows, but likewise to maintain the cultivation of rice, which is entirely dependent on the arrangements for that irrigation. In order to preserve the necessary degree of dampness in the atmosphere, the fields are surrounded by high trees, whose stems support ivy and the vine.

While the great extent of well cultivated land, the careful husbandry, and the enlightened institutions for the promotion of tillage and pasture in the valley of the Po, unite to make an agreeable impression, still the whole exhibits a monotonous character. But this sameness in the physiognomy of the country is lessened, the nearer we approach the mountains; and when we have reached the valleys which open out of the Alps, we are captivated by the greatest and most varied natural beauties.

At the outlet of some of those Alpine valleys the streams become expanded into lakes, which indescribably increase the attractions of the scenery. At the lakes of Maggiore, Lugano, and Como, Nature exhibits a grandeur, a fertility, and a cheerfulness, that perhaps do not, in an equal degree, exist together in any other European country. Steep mountain walls reflect the rays of the sun, which enter uninterrupted from the openings of the valleys, being directed to the south. Yet the temperature, increased by the above means, is moderated by the cool breeze from the neighbouring high mountains. The *vine* overhangs the blue watery mirror, and *chestnut* trees cast their shadows along the base of the surrounding mountains. The *laurel* indicates the neighbourhood of the evergreen vegetation that particularly characterizes the south of Europe; and single *pines* and *cypresses* announce the peculiar forms of the trees which first appear more generally in middle and lower Italy. Rocks tower in picturesque forms above the trees. Torrents rush down from the deeply indented ravines; and, in the back ground, through the foliage of the pine-clad mountain, we see here and there sparkling on high the snow-covered summit of the more lofty Alps. Those districts around the lakes, with their towns, villages, and country seats, would deserve to be named paradisaical, were man there more in harmony with nature. When we compare the number and condition of a great part of the inhabitants of these blessed valleys, with the riches and means of happiness afforded by nature, the contrast, alas!

often disturbs the impression which the scenes have, notwithstanding, fixed indelibly in the mind of the foreign wanderer.

The Apennines, as far as they limit the Valley of the Po, draw a marked line of distinction between the natural productions of Upper Italy, and those of the southern parts of the peninsula. The mountain chain over the Po, maintains partly the direction from west to east; whence the difference of vegetation upon the opposite acclivities is particularly striking. The vegetation upon the northern declivities agrees entirely with that of the southern base of the Alps; whereas on the southern side of the mountains, which suddenly sinks towards the sea, the cultivation of the olive-tree is extensive, and many other evergreen trees and shrubs appear. In the farther continuation of the Apennines, where they follow the principal direction from the north-west towards the south-east, we scarcely find a more marked difference in the vegetation, than in that of the opposite declivities. The trees and shrubs, which are particularly characteristic of Middle and Lower Italy, are limited to the lower plains in the neighbourhood of the mountains, and extend from the sea to a height of 1200 feet. These plants include the *evergreen oak* (Quercus ilex, Q. suber), the *pistacio tree* (Pistacia lentiscus, and P. terebinthus), the *strawberry tree* (Arbutus unedo), *the myrtle* (Myrtus communis). The *olive tree* extends over the whole of this evergreen region, and the *laurel* and *orange-tree* likewise flourish in it. However, in the greater part of Italy, the orange-tree is found only in detached districts, which are peculiarly favourable from their situation, and is not cultivated to a considerable extent. Even where the culture of the orange-tree is of greater importance, as in Calabria, there are still no proper orange groves. Hence the cultivation of the orange-tree has far less influence than that of the *olive-tree* upon the general aspect of the Italian landscape. The great peculiarity of the Italian landscape arises from separate high overshadowing *pines*, with their broad-spreading tops being mingled with groups of *cypresses*. The regular lines of the cypress boughs form a singular contrast with the manner in which the branches of the pine shoot out on opposite sides of the stem. In a still higher degree, the landscape has a novel and entirely foreign character from the *date palm;* but this tree is found only in isolated and sheltered spots, especially on the coast, and even there it occurs only sparingly, generally only a few individuals growing together.

When we ascend above the level *evergreen region* already noticed, we find ourselves surrounded by a vegetation which resembles more that of the northern parts of Europe. The evergreen trees and shrubs disappear, and in their stead grow *oaks* that shed their leaves, and *chestnut* trees. These trees continue to a height of nearly 3000 feet; above them the *beech* becomes the prevailing tree, accompanied sometimes by various trees with pointed leaves *(Pinus picea, P. sylvestris, Taxus baccata).* At a height between 5000 and 6000 feet, we find the *beech* and the *pine* occasionally, with creeping shrubs and alpine plants. The above trees generally reach to a much greater height, so high as 7500 feet; and with them are associated *Vaccinium myrtillus, Arbutus Uva-Ursi, Juniperus nana.* Only a few mountain summits exceed the height of this region; these are the pinnacles of Abruzza, viz. Gransasso la Majella, and Velino *.

The vegetation of the middle and lower parts of Italy varies very much in regard to its richness and abundance. In many tracts of country it is most luxuriant, especially where many crystalline or volcanic rocks produce a more favourable soil; or where, as especially in some bays of the sea, rocks insure shelter against hurtful winds; or likewise where the supply of water maintains a peculiarly favouring humidity.

We are enraptured with the rich vegetation at the foot of the marble mountains of Carrara and Massa, and on the declivity of the Apennines towards Lucca; with that on the volcanic elevations of Frescati and Albano; at the rocky coast of Terracina, Molo di Gaeta, Sorrento, and Salerno; and with that at the waterfalls of Terni and Tivoli. But such luxuriance is not general. Only a stinted vegetation occurs over by much the greater part of the calcareous Apennines, which ranges so widely through Italy. *Myrtles*, which fix their roots in fissures, and

* The author quotes the above from the work of his friend Schouw (entitled, Grundzuge einer allgemeinen Pflanzen-Geographie, 1823), who, he hopes, will soon give to the world the result of his long and able researches, in order to establish the geography of the plants in the above districts; and expresses his admiration of his labours as to the geography of plants in general.

other evergreen shrubs, do not form any foliage so thick as to conceal the rocks on which they grow, particularly as regards the mountains which project beyond the others in the form of promontories; it is only in the interior of the mountain range that we find occasionally high and thick forests. When, notwithstanding this bareness, the mountains appear picturesque to the eye, it is, in general, owing to their outline alone. The indentations and projections can be exactly recognised from a great distance, and occasion the striking change of light and shade which give rise to the agreeable impression.

The extraordinary transparency of the atmosphere, which gives an indescribable charm to distance—the deep blue of the sky—the unusual forms of the vegetation—the enrapturing view of the warm sea—and the remarkable appearance of Vesuvius and its smoke—all taken together, fix the gaze of the observer upon Italy. Hence districts often appear beautiful, which, in regard to their surrounding objects, are, to speak truly, not so; while, after reflecting on the scenery with composure, and without prejudice, and thinking of what constitutes the beauty of a landscape, we consider them as inferior to many of our own country.

But it is not only what is produced by the spontaneous exertions of Nature that imparts a specific character to a landscape. The character is in a high degree modified by means of cultivation. In this respect, also, we see the greatest differences between the middle and southern parts of Italy. The regularly planted olive tree, with its stem often crooked and hollowed toward the root, and its small bluish-green leaves, can never give considerable beauty to a country. But the vine must ever be an ornament, where, as in Italy, propped up by elms and poplars, it has a much more luxuriant growth than in France and Germany. Sometimes, as in the fruitful plains of Naples, it climbs with its tendrils around the well cultivated fields, bearing wheat, maize, or pulse, and forms for them a sheltering roof. In various parts of Italy, especially in Tuscany and in the district of Lucca, we are gratified, not only by the agricultural industry, though that would suffice for gardens; but even a hermit would feel satisfaction when he viewed such culture, with which the beauty of the people, their neat and tasteful dress, showing their comfortable circumstances, as well as the clean appearance of their flat-roofed dwellings, are all in unison. With so much the greater melancholy should we be again impressed, when we found ourselves transported out of those beautiful fields into the brown wilderness of the Campagna di Roma, and the greater part of the tracts of country from thence to the borders of Tuscany, near Radicofani; or into the Pontine Marshes, or the marshes of the low coast of Pæstum. Equally sad would be our feelings, in travelling through the districts of the Neapolitan States, and those of the Church, where the ill-cultivated soil affords a scanty subsistence to the plundering rabble, that, wretched in filth, inhabits the fallen cities. The aqueducts excite our wonder, and numberless other architectural remains of the Campagna attest the neighbourhood and the former greatness of Rome. These address themselves to the wanderer, as the temples of the blooming Possidonia, existing during thousands of years, still remain to inspire astonishment and enthusiasm. On this soil, originally blessed by Nature, but now neglected by men, there once lived a numerous and thriving population. Such seem to be the words addressed to us. It may appear a riddle difficult of explanation, why the same soil, which, in other parts of Italy, bears the richest fruits, should, in the above districts, make us look back with regret on ancient times. But the reasons of that decay are not remote from observation. Italy instructs us, by the strongest contrasts, that the welfare of countries is not dependent upon nature alone, but in a still higher degree upon wise institutions, directing and protecting the activity of the inhabitants.

Meteorological Observations made on the summit of the Faulhorn in Switzerland. By Professor L. F. Kämtz *.

The Faulhorn is a rather isolated mountain in the Bernese Oberland, between the Valley of Grindelwald and the Lake of Brientz. From its summit we enjoy an admirable view of the Swiss glaciers, of the lakes, and surrounding country. The

* Mr Kämtz is author of a valuable System of Meteorology, now in the course of publication.

summit is about 1350 toises above the level of the sea, or rather more than 70 toises higher than the Hospice of the Great St Bernard. The fine weather was particularly favourable for the residence of Mr Kämtz on this beautiful station, and allowed him to prolong his stay to the 6th of October, which afforded him twenty-five entire days for observations, during which period corresponding observations were made at Zurich, Bern, and Geneva. He addressed a letter to the celebrated Gautier of Geneva, dated, Unterseen, 9th October, from which the following extract appeared in the Bibliotheque Universelle, for September 1832.

'Although,' say Mr Kämtz, 'I have not rigorously calculated my observations, it appears that many instruments have a different *marche* upon the Faulhorn from what is observed in the plains.' The barometer appears to have a single minimum at 6 A. M., and a single maximum at 6 P. M.; the daily oscillations of the thermometer are smaller than in the plains during clear days, and the maximum of temperature appears to occur shortly after the culmination of the sun. The dryness was so great that Daniel's instrument could not be used for several days; on a mean, the moment of greatest dryness during the day was some time after sunrise, that of greatest humidity appeared to be three and four o'clock in the evening. The action of the direct solar rays has been enormous. I have several times suffered much from the heat of the air, when exposed to the full action of the sun, while the temperature of the thermometer in the shade was under zero. The transparency of the air was so great, that I frequently saw Jupiter before sunset; the polar and some other stars near the zenith were visible, at a mean, ten minutes after sunset. The progress of twilight, as to duration, was very different from what is observed in the plains, and I have endeavoured to determine it, by means of a sextant of reflection. The firmament, after sunset, exhibited a slight red tint only once when thin clouds were present; in general it and the yellow colour of gold. But what is worthy of notice, neither the sun nor the moon, at rising or setting, exhibited the great apparent diameter which we observe in the plains.

You know that the apparent figure of the sky is not a sphere, in the centre of which we are. Smith has discussed this topic fully in his Treatise on Optics. I have made several measurements, and, when I divide into two parts the arc of the heaven from the zenith to the horizon, the *angle* which that central point of the heaven makes with the horizon was not 46°; but it varied a little according to circumstances, having an elevation of about 20°.

I made observations during fogs on the diameter of the vesicular vapour, and convinced myself, by a comparison of one hundred measurements of this kind, that the diameter depends on the seasons being nearly double in winter to what it is in summer.

The phenomenon of a coloured ring around the shadow of the head, when that shadow falls upon a cloud, as observed by Bouguer, occurred to me several times. I made several measurements of it, and the following is the most complete: On the 4th of October a fog appeared in the south of the Valley of Grindelwald, and, having passed before the sun, I could observe a halo by means of a blackened mirror; the first circle red, had a radius of 1° 55′. Some minutes after, the fog being to the north of me, and the sun shining brilliantly, I saw my shadow surrounded by many coloured rings; the radius of the first red circle was about 1° 54′. These two measures give for the diameter of the vesicular vapour about 0.00095 Fr. inch. Mr Kämtz also made on a fine day, during each hour of the day, observations with an instrument invented by Sir J. Herschell, named *Actinometer*, intended to measure the calorific power of the direct rays of the sun. Mr Forbes of Edinburgh, who had entrusted him with one of these instruments, made at the same time corresponding observations with a second actinometer, at Brientz.

Remarks on Borda's Geometrical Measurement of the Height of the Peak of Teneriffe. By Mr WILLIAM GALBRAITH, A. M. Communicated by the Author.

THE disagreement of the various late barometric measurements of the height of the Peak of Teneriffe, made by careful observers, with good instruments, from the height deduced trigonometrically by M. Borda, in 1776, induced me to examine that measurement carefully, as given by Baron Humboldt in his Personal Narrative, translated by M. Williams.

It is there concluded to be 1905 toises, or 11430 French feet, which are equivalent to 12,182 English feet. I have also examined all the calculations, so far as the data have enabled me, and in every instance, except in some which appear to be typographical errors, the results seem to be exact. It is to be regretted, however, that the vertical angles are not recorded in the document from which Baron Humboldt obtained his data, and which he entitles *Manuscrit du Depot.* But as all the other results have been computed accurately, there is every reason to believe that the heights of the summit of the Peak above each extremity of the *extended base*, derived by calculation from the *measured base*, are also correct. The depressions of the sea from the same points, allowing 0·08, or about $\frac{1}{12}$th, of the intercepted arc for the effect of refraction, conformable to the observations of Mudge, Colby, and Delambre, are also correct. The effect of refraction upon the height of the Peak above the base, amounting to about 14 French feet, is also applied. These embrace all the corrections except one—the deviation of the circle of curvature from the tangent. Of this I can find no trace in any part of the extract above quoted, and for that reason, I am inclined to think it has been entirely omitted. It amounts to 66 French feet from the one point of observation, and to 70 from the other. From the well-known ability of M. Borda, it is difficult to suppose that he had neglected so important an element; but as no mention is made of it, and in his *first* measurement a much greater error existed, from an angle being erroneously noted, there is some reason to fear that, through some oversight, this correction has been neglected. At all events, such omissions do sometimes occur, as I found in Captain Sabine's computation of the height of a hill in Spitzbergen, as recorded in the Philosophical Transactions for 1826. The height, in this instance, was computed from two points, nearly equidistant, and also from a third, about double the distance of these. Now, as the deviation of the curve from the tangent increases as the square of the distance, it would be about four times as great at the latter point as it was at the two former, and, consequently, without this correction, the height from the last place was so much smaller than the other two, that it was rejected as inadmissible; whereas, had this correction been applied to all of them, the latter would have fallen between the former two.

In like manner, if the same corrections be applied to M. Borda's height, and reduced to English measure, it would be trigonometrically . . . . . 12254 feet.

Lamanon's barometric height . .	12190
Cordier's	12289
Napier's	12306
Mean of all these	12260 feet.

This mean, from observations that deserve the greatest confidence, differs from Borda's corrected geometrical height only 6 feet, and is therefore a strong confirmation of the justness of my conjecture. If, however, I am mistaken, I shall be happy to be set right, either by Baron Humboldt, should this meet his eye, or by any other individual, upon satisfactory grounds, as my object will be gained by arriving at the truth. It may be added, that it would be desirable to have this height again determined geometrically, with modern improved instruments, as the accuracy of Borda's charts of the Canary Isles depends, in a great degree, on the correctness of his estimate of the height of the Peak of Teneriffe.

Eloge of Baron George Cuvier, *delivered in the Chamber of Peers on the* 17*th December* 1832. By Baron Pasquier, President of the Chamber of Peers *.

The sentiment which fills your minds on reassembling within these walls, must doubtless be that of profound sorrow for the numerous losses which the Chamber of Peers has recently sustained. Under the pressure of such severe and repeated bereavements, nothing seems left to us but to bow our heads in silent submission; but feelings of despondency ought not to be so far indulged as to lead to the abandonment of a custom which

* We are indebted to the Baroness Cuvier for this elegant outline of the life of her late illustrious spouse, which, however, reached us so late, that we are forced to defer the conclusion until next Number. The circumstance of the President of the Chamber of Peers leaving the Chair to pronounce an Eloge of one of his colleagues, is, we believe, unprecedented, and a proof of the honour paid to genius in France.—Edit.

should be dear to us, that of pronouncing from this tribune a last and solemn adieu to such of our friends as are successively called upon to cross that awful passage, to which we are all so rapidly approaching.

Permit me, therefore, to occupy your attention this day with one of these losses, the recollection of which must necessarily press heavily on your thoughts.

M. Cuvier has been removed from the sciences, the boundaries of which he never ceased to enlarge; from the public administration, the highest duties of which have formed, during thirty years, the object of his cares and unremitting labours; and, finally, from this assembly, of which he constituted one of the brightest ornaments. Scarcely had you time to shew your satisfaction at seeing him take the seat which he would have occupied so worthily;—and already he is no more! He was merely allowed to shew himself among you. How striking a proof of the frailty, even of the noblest works of Providence, of which the year just about to close has exhibited so many and so affecting instances!

The homage which I have rendered to such a memory cannot fail, I am aware, to evince my inability for the adequate performance of the task which I have undertaken. And it is due, perhaps, to the Chamber, that an explanation should be given of so unusual a proceeding on the part of him who has the honour to preside over it.

I have sought in this assembly, which has so long gloried in possessing among its members talents on which would have naturally devolved the duty of celebrating in M. Cuvier its strongest title to fame, those who had secured to themselves a permanent reputation in literature and science; the Lagranges, the Fontanes, the Laplaces, the Lacépèdes, the Casinis, have gone before him to the grave, whither also M. Chaptal has so soon followed. From another quarter, therefore, must the words, which Europe has a right to expect, be pronounced over an individual who has so long and indisputably marched at its head; but shall this be assigned as a reason for silence on the subject? No, gentlemen, this illustrious colleague belonged to us, as well as to the whole French nation, by a multitude of conspicuous excellences, which we are the more able, and we ought to be the more willing, to celebrate, because, in rendering him almost of universal usefulness, they brought him within the reach of all who could feel and appreciate the value of a vast and superior mind, equal to the comprehension of the loftiest subjects, and not despising what was worthy of attention even in the most humble; which could seize upon what was most valuable in each, and convert to the furtherance of its own plans; and which, above all, enabled him, in the exercise of the varied functions which he had to fulfil, to promote and secure the final success of all wise and profitable views. It was thus that the same individual who originated a new order of ideas in the natural sciences, and who added a new science to those which already formed the riches of the human mind, could take the lead for twenty years in the Council of State, and exhibit, in the midst of so many pursuits, such powers of debate in matters of legislation, as to render him the most able organ which the government of a great and enlightened nation could employ, in either Chamber, for the defence of its plans.

In this, gentlemen, I advance nothing of which you have not yourselves been witnesses on many occasions; but I may be permitted to state, that no one of my auditors has enjoyed advantages equal to myself for appreciating and admiring the talents of M. Cuvier, from so early a period of his life, and for such a length of time. I witnessed his elevation to the Council of State, where I had preceded him some years, and I venture to say, that, although the paths that had conducted us were so widely asunder, I could immediately perceive the place which he would occupy in the management of affairs; yet it excited surprise in many that he took any part in these, so difficult is it to understand or to admit that one who has gained an undisputed superiority in one department, should aspire to pre-eminence in another. On leaving the period, when I was no longer personally associated with M. Cuvier, his labours were nevertheless carried on so near me, that neither their nature, nor their various merits, escaped my notice. The connexion I had with him in public life could not fail to inspire me with a strong attachment to him, joined to the highest esteem; feelings which I am the more happy to avow, as they were so justly due. You now know, gentlemen, on what grounds I have ventured to present myself before you. I hope that the difficulty of the task I have undertaken will procure for me the indulgence of which I stand in need, and which I shall endeavour to deserve, by confining myself to as short a space as is consistent with the extent of the subject, and the eventful nature of the life which I am called upon to delineate.

George Leopold Chretien Frederick Dagobert Cuvier was born on the 23d of August 1769, at Montbeliard, a French town, but belonging at that period to the Duke of Wurtemberg. His family originated from a village on the Jura, which still bears the name of Cuvier. His father had retired, after forty years of distinguished service as an officer in a Swiss regiment in the pay of France, from which country he enjoyed a moderate pension, and held the command of the artillery at Montbeliard. It was in this town that the young Cuvier received, under the superintendence of a mother who devoted to him all her care, those elementary instructions which form the basis of all education. He was brought up in the Protestant religion, which was that of his family. From a very early age he gave indications of those mental qualities, the subsequent development of which rendered his career so famous. He was endowed with a memory of extraordinary power, an instrument of so much value when regulated by a superior understanding. He had likewise an aptitude for drawing. His taste for this art was inspired at twelve years of age by the works of Buffon: it is thus that men of genius excite each other.

The study of the Greek and Latin languages occasioned him but little difficulty; the German was attained with equal facility; and in succession the different modern languages, an acquaintance with which must have been of the highest utility in aiding his scientific researches. He had a passion for every kind of reading, particularly that of history; and while scarcely beyond the age of infancy, the driest details of nomenclature, and the lengthened lists of sovereigns, princes, and men who, by whatsoever title, have governed the different parts of the world, were so strongly impressed on his mind as to be never afterwards effaced: to these may be added upwards of 2000 words, applicable only to the natural sciences, which, when once acquired, never failed to present themselves to his memory whenever he had occasion for their use. At the age of fourteen he had acquired nearly all the instruction which the school of Montbeliard could supply, although conducted with considerable ability. He closed his classical studies with all the eclat which could be obtained in the society of a small town, and had taken the lead in what is called the study of humanity and in mathematics, branches less cultivated at that time than they have been since, but of which he did not fail to perceive the full importance. This natural superiority, which was so conspicuous in him on all occasions and on every subject, had procured for him a high degree of influence over the youthful companions of his studies, which he turned to the best account, by establishing among them a little academy, over which he presided, and directed the proceedings. His sleeping apartment was the place of meeting, and the foot of his bed formed the seat of dignity for the president. There they perused books of travels and of general history; but natural history was their favourite pursuit. Discussions ensued, and observations were made on the subject of reading; after which the young president summed up, and pronounced a judgment, which was generally the law. Who would not take pleasure in tracing the earliest inclinations of a mind like this, which thus formed a certain prelude to the glorious destiny which awaited it on the more extended theatre of science and literature?

The end of his fourteenth year, however, produced an important change in his situation. The Duke Charles of Wurtemberg, on visiting Montbeliard, had not failed to hear of the expectations which the young Cuvier had inspired: he examined him, and inspected his drawings; and immediately declaring his intention of taking him under his protection, sent him to Stuttgard, where a place was assigned him, free from all expense, in the Academy of Carolina, where he was entered in the month of March 1784, and remained four years. It was an excellent establishment, where every thing was conducted on an extensive scale. The progress of the young pupil corresponded to the superior advantages which he there enjoyed; and he penetrated into every department of knowledge which formed the subject of instruction, with that reach of comprehension and soundness of judgment for which he was always so remarkable.

Superior instruction was given in five different faculties, one of which was exclusively devoted to the study of government. It was to this that he attached himself most. The principal subjects were the elementary and practical departments of law, and the more useful details of finance, police, agriculture, and technology. So sensible was he of the advantages of such a branch of education, that he has always lamented that a corresponding practice has not been established in France. I have oftener than once heard him express his regret at the little assistance afforded among us to those who were employed in acquiring a knowledge of this subject.

"Quand la science des lois, dont les tribunaux font l'application, est partout, disait-il, l'objet d'études pour lesquelles tous les genres de secours et d'encouragemens sont prodigués, d'où vient qu'on dédaigne, ou au moins qu'on néglige de fournir à la jeunesse les moyens d'acquérir méthodiquement la connaissance de cette foule de dispositions, de reglemens qui influent si puissamment sur un nombre infini d'intérêts publics et privés? d'où vient qu'on ne s'occupe pas de lui apprendre de la même manière les principes sur lesquels repose, ou devrait reposer cette legislation administrative? Je me plais à rapporter cette vue de M. Cuvier, parce qu'elle indique déjà l'attrait que devaient avoir pour lui les travaux auxquels il s'est en effet livré avec tant de zèle, toutes les fois que l'occasion lui a été offerte de prêter à l'administration publique le secours de ses talens et de ses lumières."

He had the happiness to find among the teachers composing the faculty which was the object of his predilection, a Professor of Natural History. The name of M. Cuvier's first master in this department deserves to be recorded; it was Abel; and the lively interest which he took in the young Frenchman, whose genius he had not failed to perceive, contributed materially to supply the latter with the means of indulging an enthusiastic inclination, which, in the midst of so many different occupations, continually brought him back to the study from which he derived the most tranquil enjoyment; sometimes engaged in reading and meditating on the works of the great masters in this department of knowledge, at other times in drawing the insects which he met with in his walks, or in forming an herbarium, which speedily acquired a character of importance. Although this favourite occupation was pursued with so much assiduity, it did not prevent him obtaining the most decided success in all the studies prescribed by the rules of the Academy; for, at the termination of the course, he received, in addition to the highest prizes, an order of chivalry, an honour conferred only on five or six of the four hundred pupils whom the establishment contained. Having thus closed with so much distinction the term of education, for which he was indebted to the munificence of the Duke of Wurtemberg, circumstances rendered it necessary to turn his thoughts to the active business of life.

One of his friends introduced him to a Protestant family in Normandy, in which he was engaged to superintend the education of one of the children. This situation had at least the recommendation of leaving him sufficient leisure for the prosecution of his scientific pursuits. Who does not know how many of those who have done most to extend the domain of science and literature, have, at some period of their lives, derived the means of promoting their own education, from being employed in instructing others? A few months before his death, M. Cuvier expressed, from the tribune of the Chamber of Deputies, the pride he felt in his title of Professor; and never did he decline the recollection of his humble entrance on a path which conducted him to so much celebrity.

When scarcely nineteen years of age, he went, in July 1788, to reside in Normandy, in a house situated near the sea, in the middle of a very insulated district. His retreat was so profound, that, when the terrible events of the Revolution of 1789 took place, a more secure asylum could not have been chosen; and even during the days of dismal memory with which the history of that period is stained, M. Cuvier not only escaped the danger which threatened all, especially such as were conspicuous for virtue and excellence, but was able to avail himself of the opportunity which the vicinity of the sea afforded, to prosecute his researches into a science, which of all others was the best calculated to prevent the approach of those melancholy and overwhelming thoughts which so many found to be insupportable.

A fortunate accident procured for him, at the same time, the acquaintance of M. Jessier, whom terror had driven to his neighbourhood. Knowing how to appreciate the talents which he soon discerned in the young naturalist, he hastened to put him in terms of correspondence with many scientific men in Paris, particularly MM. Lamétherie, Olivier, Lacépede, Geoffroy, and Millin de Grandmaison. As soon as the reign of terror was past, these gentlemen invited him to Paris, where the re-establishment of literary and scientific institutions was now becoming an object of attention. He repaired thither in the spring of 1795, and nearly at the same time, by the intervention of M. Mellin, he was appointed a member of the Commission of Arts, and shortly after Professor to the Central School of the Pantheon. For this situation he was chiefly indebted to M. Jessier. It was for this school that he prepared the first work which the public knew to be his, under the title of *Tableau Elémentaire de l'Histoire Naturelle des Animaux*. His principal object, however, was not yet attained: he wished to enter the Museum of Natural History, which alone could furnish him with the means of realizing the scientific plans which were already matured in his mind. This satisfaction was not long withheld; a Professor who had obtained the newly established chair of Comparative Anatomy, and whose advanced age unfitted him to teach a science which was new to him, yielded to the entreaty of his colleagues MM. de Jussieu, Geoffroy, and Lacépede, and accepted of M. Cuvier to supply his place. You cannot fail to remark, gentlemen, the number of eminent men who conspired to promote his interests, actuated by a noble emulation, and a generous ardour for science, which exempted them from the petty jealousies which would have been excited in inferior minds by the appearance of a new rival in their own sphere of excellence.

Having thus attained to the object of his desire, M. Cuvier had no other ambition than to shew himself worthy of the confidence placed in him. He laboured incessantly to form, for the use of comparative anatomy, the collection which is now known throughout all Europe; and the lectures by which he rendered it so useful, soon attracted a numerous concourse of auditors, who spread his fame to a distance as an eminent teacher. These lectures have since been published. This was the first grand epoch of M. Cuvier's life; and here I begin to feel the great difficulties of the task which I have imposed on myself. It was greatly more easy, gentlemen, to speak to you of his infancy and early youth, than to trace his progress to the height of scientific eminence, where he maintained an undisputed pre-eminence for forty-seven years; or to present him to your view in the midst of a multiplicity of occupations, the minutest details of which his enthusiasm did not permit him to neglect; and which, whether they related to public instruction, the deliberations of the Council of State, or the Committee of the Interior, have procured for him the reputation of being one of the most useful, as he was one of the most illustrious, of citizens.

That I may proceed with more accuracy and brevity, it is necessary to arrange in some order the extensive materials at my disposal. It would be inexcusable to be destitute of method in speaking of an individual who turned it to such good account. M. Cuvier may be regarded as moving in three different spheres, —that of science and literature,—that of public instruction,—and that of administration. I shall enumerate, with all the care the subject demands, the principal steps which he took in these departments, and endeavour to form an estimate of the varied excellences he displayed in each.

We left M. Cuvier Professor of Comparative Anatomy in the Museum of Natural History. The National Institute was established in 1796; he was soon invited thither, in consequence of the reputation he had acquired by his course of lectures, and the publication of some memoirs.

At this period the secretaries were temporary, not holding the office longer than two years. He was the third. It was in 1800 that Bonaparte, after his return from Egypt, being then First Consul, and aspiring to every kind of glory, assumed the title of President of the Institute. M. Cuvier thus found himself placed in intimate relationship with that individual, from the time when he began to turn his views towards sovereign power. During this same year M. Daubenton died, and the Professor of Comparative Anatomy was appointed to teach in his room the Philosophy of Natural History. "L'eloge de M. Daubenton, de cette célébrite contemporaine et auxiliare de celle de Buffon, ouvre avec une sorte de solennite le recueil de ceux que M. Cuvier a prononces durant les cours de trente-deux années."

In 1802, the First Consul, wishing to remodel the system of public instruction, nominated six general inspectors, to establish lyceums in thirty French towns. In this capacity, M. Cuvier was commissioned to superintend the establishment of the lyceums of Marseilles and Bourdeaux, which are now royal colleges.

During his absence from Paris the Institute was reorganized; perpetual secretaries were appointed, and M. Cuvier learned that he was elected to fill that office in the class of Natural Sciences. It was in this capacity that he drew up, in 1808, his historical report on the Progress of the Natural Sciences from the year 1789. We were present when it was read to the Emperor in the Council of State; and such scenes are never effaced from the memory. Napoleon had asked merely a report, and, under that unassuming title, the skilful reporter has raised a monument, which stands like a Pharos between two ages, shewing at once the road which had been traversed, and that which ought still to be pursued. In the course of the same year, 1808, the Imperial University having been added to the institutions established since 1800, M. Cuvier was nominated one of the councillors of that body for life. In 1809 and 1811, he was commissioned to establish academies in those parts of the Italian provinces annexed to the empire; and the important arrangements which he made at Turin, Genoa, and Pisa, were so well adapted to the wants and conveniences of these towns, that they have, for the most part, survived the existence of the French power by which they were introduced. In 1811 he undertook a similar mission into Holland and the Hans Towns, where the same success attended him. In 1813 he was sent to Rome, in order to organize a university. "M. Cuvier etait Protestant; j'ignore si la reflection en fut faite, mais elle ne fut certainement amenée, dans le cours de cette mission, par aucun de ses actes. Son respect pour les croyances qu'il put jamais s'en ecarter, et il etait tolerant, non pour obeir a tel systèma philosophique ou politique, mais par une conviction qui emanait de la conscience."

These successive journeys into so many different parts of Europe, could not fail to be very profitable to such an observer, and the intimate connexion which they were the means of establishing with distinguished men of all countries, enabled him to amass valuable materials for every kind of work in which he engaged. His talents for administration, however, had not escaped the penetration of Napoleon, and he received at Rome the news of his being appointed a Master of Requests.

Once a member of the Council of State, he was not long in raising himself to the first rank; and the events of the year 1814, which led to the overthrow of the imperial power, did not retard his further advancement. In the month of September, in the same year, he became a Counsellor of State; and soon after had the offer of a situation which he repeatedly declined, that of Superintendent of the *Jardin du Roi*, an office on which Buffon had conferred much celebrity. He believed that the plan which vested the management in the Professors was preferable to that previously followed, and would not therefore permit any attempt to be made, at least in his favour, to supersede it. In the month of February following, the University having been remodelled on a new plan, a place was assigned him in it, under the name of Counsellor, in the Royal Council of Public Instruction. But the new revolution occasioned by the return of Napoleon, prevented him from continuing a member of the Council of State: he was retained, however, in the Imperial University, where the absence of his name would have caused too great a void. Four months afterwards, when it became necessary to re-establish what the hurricane of a hundred days had laid in ruins, it was found that neither the system of the Imperial University, nor that of the Royal University, as ordained in February, could be carried into effect to their full extent; and a provisionary arrangement having been judged necessary, a commission of Public Instruction was created, to exercise the powers which had been previously vested in a Grand Master, a Council, a Chancellor, and a Treasurer. M. Cuvier was a member, and the duties of Chancellor devolved on him from the first. He took a very active part in the labours of this commission, the important services of which can neither be misunderstood nor forgotten, since it maintained, under very difficult circumstances, the laws of the University, and enabled it to enforce its rights, in opposition to inveterate prejudices, and sometimes the most determined opposition. M. Cuvier acted as president on two occasions, each of them of more than a year's duration, but always provisionally, as the religion he professed disqualified him for being regularly appointed to that office. In 1818, he travelled into England, and learned, on his arrival in London, that he had been nominated a member of the French Academy. This was an important accession to the high gratification which he must at this moment have felt, from the flattering reception he met with in one of the most enlightened cities of the world, from men who may be considered the best judges of the merit which they honoured. In 1819 he was made President of the section of the Interior in the Council of State. From the moment that he entered upon this presidency, the duties of which were so important and laborious, he never left it till his death.

In 1824, when a minister for Ecclesiastical Affairs was appointed, and the place filled by a Bishop who had been previously Grand Master of the University, the duties of the latter office, as far as they related to Protestant Theology, were exclusively intrusted to M. Cuvier, by whom they continued to be performed ever afterwards. In 1827, the superintendence of that department of the administration of the interior relating to forms of worship not Catholic was conferred on him; and, finally, he was raised to the peerage about the close of the year 1831.

We have now, gentlemen, taken a rapid survey of the series of situations which M. Cuvier filled, and the titles which he bore; and this hasty summary will give you an idea of the extent and laborious nature of his employments. On taking a review of them, it is natural to suppose that the almost incessant demands on his attention made by his public duties in the administration—so many journeys undertaken in the service of the University, together with an assiduous attendance on the sittings of the Council of State, and the Committee of the Interior—must have interfered with his scientific pursuits; but this supposition cannot be entertained, when we enumerate the works which he published or undertook during the same period, nor when we recollect the splendid lectures, which were interrupted only by his death. It may even have been of advantage that his attention was occasionally diverted from his favourite studies. A mind of such deep reflection required some moments of relaxation, and this he could only enjoy by a change of mental occupations. He needed something of a less engrossing nature to refresh his faculties; but what was of a useful character could alone furnish the conditions necessary to secure his attachment. The Committee of the Interior, of which he was president, afforded ample resources of this description. He had thus an opportunity of reading nearly all new productions of every kind, and this employment he regarded as of considerable importance. He was aware how much light might be thrown on the social condition of a country even by its most frivolous literary productions; and his instinctive love of knowledge led him to study and understand every thing in the moral as well as the natural order of things.

I have named the earliest works which procured him distinction in the Natural Sciences. In 1811 he published his *Recherches sur les Ossemens Fossiles de Quadrupèdes.* This work has gone through three editions, and the preliminary discourse has been often reprinted. In 1817 appeared his *Mémoires pour servir à l'Histoire des Mollusques*, and the *Règne Animal*, arranged according to its organization. During the last years of his life he was occupied with a great work on the Natural History of Fishes, in twenty volumes, eight of which have already appeared, and materials necessary for five others were prepared. Three years since he undertook a course of the History of the Natural Sciences, which he delivered from notes, and which, according to the testimony of all who heard him, were remarkable for eloquence, precision, and luminous arrangement. He was occupied, besides, with a new edition of his Lectures on Comparative Anatomy, and wished to devote the remainder of his life to a great treatise on the same science, for which he had brought together the immense collection of the *Jardin du Roi.* The greater number of the drawings necessary for this work were already completed, and the most considerable proportion of them were executed by his own hand.

Will it be said, then, that he has been unfaithful for a single day to the science that had attracted his earliest regard, or will it be thought that he did not allow it sufficiently to occupy his time, and engross his attention? Whoever desires to form an idea of the extent of the knowledge which he had acquired in its cultivation, let him peruse the three volumes of eloges which I have already mentioned, where will be found an account of nearly all the scientific discoveries of our times. In consequence of the nature and variety of the subjects therein discussed, there is scarcely a department of the natural sciences, the principles of which he has not analysed, and described its origin and progress, with such a degree of precision and perspicuity as to bring it to the level of every capacity. Of this kind of composition some beautiful examples had already appeared; Fontenelle, D'Alembert, Condorcet, Vicq-d'Azir, were each distinguished, although for different qualities; M. Cuvier was perhaps more fitted to excel in it than any of his predecessors. Aiming less at effect than Fontenelle by brilliancy of thought or studied elegance of style; free from the disdainful and ill disguised scepticism which so often deprives the writings of D'Alembert and Condorcet of an air of freedom, and gives to them the dry and tedious character of a philosophical disquisition; possessed of more profound and varied knowledge than Vicq-d'Azir (whose eulogium on Buffon, however, is equal to the subject, and therefore sufficient to establish his reputation,) he could intersperse, in the most attractive manner, his instructive and able exposition of the labours and discoveries of those whom he celebrated, with numerous details of their history and private life, which generally attested the humble origin from which they had emerged to usefulness and celebrity. It is easy to conceive a style more correct and skilfully laboured than his, but it is difficult to imagine one better adapted to his extensive erudition, or more serviceable, since it was always most appropriate to the subject of which he was treating, and to the thought he required to express. There is doubtless something paradoxical in the celebrated axiom of Buffon, that style is the man himself: it must, however, be acknowledged that no one can give efficiency to the talent he possesses, unless heaven at the same time has endowed him with the power of rendering his ideas as vivid to another as they are to himself, as it is only by the expression of them that he can obtain an influence over those whom he undertakes to instruct and convince.

M. Cuvier had received from nature a due proportion of this invaluable endowment: one whose thoughts were spread over so vast a field, required an instrument for enabling him to diffuse them as readily as they were conceived, and to communicate them to every mind capable of following him; and you are aware that his success in this respect left nothing to be desired. Since I have mentioned the name of Buffon, I cannot help alluding to the feelings of sincere gratitude and admiration which M. Cuvier entertained towards that individual. More sensible than any other of the errors into which his illustrious predecessor had fallen, and having even exposed these as often as he thought advantage would arise from so doing, he was at the same time so fully alive to the incalculable obligations which science owed him, from the impulse it had received from his extensive and persevering labours, combined with the brilliancy of his eloquence, that he never lost an opportunity of doing honour to his memory. He has said, while celebrating the eloquence of another, although of a less illustrious character: 'That science, from its very nature, was making daily progress; that every observer was in possession of a richer store of facts than his predecessors, and could do something towards the improvement of systems, but that great writers had equal claims to immortality.'

The advancement to which he contributed so much, never led him to despise the efforts of those who had gone before him, and his opinion on this subject cannot be better expressed than in a passage of one of his eloges:—"Half a century will produce a change in all, and it is very likely before that period elapse, that we shall have become antiquated in the eyes of the rising generation; inducements for us to keep in mind the respectful gratitude due to our predecessors, and also, not to reject without examination the new ideas of an enthusiastic youth, which, if they are just, will prevail against all the efforts of the present age to suppress them."

This disposition of gratitude for the past and encouragement for the future, derived its principal origin from the soundness of M. Cuvier's judgment, and the philosophical impartiality which was one of the distinguishing features of his character. These qualities, we ought to confess, had probably been fostered by his education in Germany, a country remarkable for honourable feeling; where every subject is studied, and elaborately investigated, with inexhaustible patience and conscientiousness, and where learning is held in the highest estimation. There M. Cuvier acquired the useful habit of hearing and investigating every thing with patience; along with a love for labour, his natural uprightness and perseverance were likewise increased;

and when these valuable qualities were united to a remarkable clearness in the explanation of systems, a perfection in methodical arrangement, a precision, and an elegance such as had never been witnessed in an equal degree in France, they conferred on him so much reputation, that all Europe sought for and received his instructions with full confidence and satisfaction; since they thus formed a most valuable connecting link between ancient and modern science, and between national and foreign literature. But I have already perhaps given too much extension to this part of my subject, notwithstanding my resolutions to the contrary. I cannot, however, refrain from making some remarks on one portion of M. Cuvier's scientific works, which seems more within my reach than the rest.

I select it, because it affords a clear explanation of his great discovery in comparative anatomy, and exhibits the wonderful results of that discovery, which throw such a flood of light on geology,—a science, you are aware, which has been but recently founded on secure principles. It must be perceived that I am about to speak of the dissertation prefixed to his *Histoire des Ossemens Fossiles*, which has been so often reprinted. Accuracy of views and reach of conception are conspicuous on every page of that work. With what perspicuity does he explain and review the various systems which have been successively promulgated for so many years, on the noblest subjects which can occupy the human faculties—those that relate to the wonders of the creation, and the early condition of the world on which man has been placed! With what powers of reasoning does he oppose many of these views to each other, and shew their futility by bringing together facts of the most simple and apparently trivial nature! How beautifully does he display the advantages to be expected from pursuing the path he points out, and prosecuting researches which lead to such remote and important issues!

But these researches themselves were founded on a profound moral and religious conviction. M. Cuvier believed, in common with every superior mind, in a First Cause, which has ordained and presides over all. Proceeding on this principle, he never entertained a doubt that the existence of organized beings was due to a Supreme Intelligence, which has furnished them with the organs necessary to fulfil the end of their creation; and from this necessary connexion, he has deduced the means, when certain parts of a whole were known, of acquiring an accurate knowledge of those which remained to be discovered. In this admirable introduction, M. Cuvier rises above all prejudices, even those which attach to science, and shews the complete independence and vigour of his mind, whether he undertake to render to ancient historical monuments their just degree of authority, which has oftener than once been disputed on too slight grounds, or to overthrow the rash and foolish theories which have long been in vogue, and whose authors have been so much applauded. He also could originate and create, but this rare and specious talent he owed to the superiority of his reason and judgment. A belief has too commonly prevailed, that habits of minute observation have the effect of weakening the imagination; and there was a time when it would have even been said that they entirely destroyed it. The example of M. Cuvier confirms the proof which Newton had already afforded, that the strength of this noble faculty is, on the contrary, increased by patient and laborious investigation, and plumed as it were for a more lofty flight. This was the case with Aristotle, and, like the Grecian philosopher, M. Cuvier applied it to every branch of human knowledge, there being no subject of which he was ignorant, and which he did not seem, to those most qualified to judge, to have studied *ex professo.* No man was ever better qualified to stand at the head of those who conducted the education of a great nation, and the services which he rendered in this respect are confessedly so important, that although previously alluded to in the enumeration of his other labours, I shall be excused for reverting to the subject, and speaking of it more at length.

M. Cuvier entered upon the office of inspector-general of public instruction, at that brilliant period of the consulship, when every thing in France was remodelled and placed on a new foundation. The power in which the government was centered, although subsequently the object of so much hostility, was exercised for the time with extraordinary energy and discrimination. I will not speak of the physical difficulties which stood in the way of the new measures which were undertaken; these, however great, were surpassed by the moral impediments which it was necessary to surmount. To introduce a change into the system of study, and to regulate the new discipline of schools, so as to adapt them to the wants of a new social condition, and render them most favourable to those principles of public and domestic order, without which there can be neither tranquillity nor happiness in a family nor in a state; to triumph over a revolutionary and subversive spirit, by giving to the rising generation knowledge and habits tending to counteract it; add to these the delicate task of selecting the means most fit and worthy to be employed; and you will have a brief representation of the duties undertaken by those with whom M. Cuvier co-operated. But in all bodies formed for the management of a complex and difficult business, the actual labour falls on such as are best fitted by their tastes and talents to execute it successfully. Accordingly, there is scarcely any portion of what composes the vast edifice of public instruction in France, where traces of his hand are not perceptible. He was interested particularly in the higher departments of learning, or academical instruction, for the regulation of which, in the departments of medicine, science, and literature, he prepared the judicious laws which foreign nations have studied to imitate. I have mentioned his missions in 1809 and 1810 to Italy, Belgium, and Holland. In order to become acquainted with his proceedings in these places, we have only to consult the documents he drew up, which are fortunately preserved. Three printed reports, addressed to the grand-master, furnish much interesting matter even to the general reader, and afford valuable information on foreign universities, and the state of learning among our neighbours. I can take upon me especially to recommend that relating to Holland. The views and opinions of M. Cuvier are explained in it with unusual felicity. He touches on the true causes of the inferiority in classical learning then observable in that country He shews, that the indifference with which the subject was pursued, ought to be attributed to the limited nature of the subject. The greater scope that is given to the mind of youths, he says, they will become more diligent, more studious, and more desirous of knowledge: a gratifying homage to the human faculties, which are invigorated and ennobled in proportion as they are furnished with opportunities worthy of calling them into exercise.

I will not follow M. Cuvier in his exposition of the means suggested to remedy the evil which he exposes, and to secure the advantages which he holds out; but I cannot refrain from drawing your attention to the prominence assigned in these reports to the examination of the schools of the people. He had every where an opportunity of examining them, and they always attracted his liveliest attention. With how much interest does he sketch the picture of the initiatory schools of Holland; of those happy children, honouring God and their parents, loving their country, and possessing, along with the elementary branches of education, knowledge calculated to promote the comfort of social life, and the means of acquiring an honest livelihood: with what devotion to the subject does he explain the means which have been employed for the establishment and maintenance of these schools, and point out, with the minutest attention, the advantages of the mechanism put in operation to foster and develop the dawning faculties of infancy! We cannot fail to perceive, in this beautiful recital, the unintentional manifestations of the deep sorrow which he felt from a comparison of this satisfactory condition with that of the greater proportion of our own provinces, even those that are most flourishing, where the lower classes still labour under a disgraceful ignorance. Let it ever be mentioned, to the glory of M. Cuvier, that during the whole period of his connection with the University, and under every variety of discipline, the instruction of the people was the object of his consideration, and even of his preference. How often has he interrupted the studies which were most dear to him, to examine the elementary books of our juvenile schools, and to give his advice to those who were engaged in composing them. The general diffusion of instruction, adapted to the wants and prospects of each, appeared to him the only certain guarantee of order and public morality. He never ceased to act on this idea; and in 1821, when the University, favoured by the popular feeling, and the support of the government, proposed a primary scheme of instruction applicable to the whole of France, the care of maturing the plan was intrusted to him. To him we likewise owe the useful institution of the "Comités Cantoneaux," which place the education of the poor under the direction of the more enlightened classes; and the enactment of 27th February 1821, contains the necessary regulations on this important part of the public administration. The man of the state by whom the plan had been elaborated, faithful to the good sense which forms an important element of genius, confined himself, as was usual with him, to what was simple, practical, and consequently truly useful; and it is to this cause that his labours owe their success. The higher branches of learning received a similar service from M. Cuvier, by an establishment destined for the support of professors disabled from age or sickness; an institution which was at the same time a nursery, from which the faculties selected candidates to fill the different chairs. It is likewise owing to his exertions that France has enjoyed, for a considerable period, a faculty or school of instruction for teaching the branches of knowledge which have an immediate relation to the art of government.

I have already mentioned, that the want and advantages of such an institution had occurred to him at an early period. He formed the plan of it in 1821; but was prevented from carrying it into effect, by the retirement of the minister in conjunction with whom it had been prepared. The management of the protestant schools, of which he took a particular charge, received under his direction obvious improvements: and he was engaged in collecting the requisite information for drawing up the rules which were necessary for regulating the discipline of the protestant churches. To conclude this sketch of his active and useful labours, I may add that, for a long period, the state of public feeling in France, regarding the place which M. Cuvier occupied in the University, has been such, that it could not be conceived of apart from him. He superintended all the branches of knowledge which it was appointed to diffuse, uniting in his own person the studies of several lives, the knowledge of many men, and never bending under the weight of this astonishing and diversified mass of knowledge. His clear and powerful intellect which acquired it without effort, communicated it to others with equal facility. Of this all can bear witness who have had the happiness to enjoy his rich and instructive conversation; and where is the youth possessed of any love for science, who was not permitted to avail himself of it?—Let us now bestow a brief consideration on his appearance in the Council of State.

To be continued.

Meteorological Table, extracted from the Register kept at Kinfauns Castle, North Britain, Lat. 56° 53′ 30″. Above the level of the sea 150 feet. By the Right Hon. Lord Gray.

1832.	Morning ½ past 9. *Mean height of*		Evening, ½ past 8. *Mean height of*		Mean Tempr. by Six's Therm.	Depth of Rain in Garden.	Number of Days	
	Barom.	Therm.	Barm.	Therm.			Rain or Snow.	Fair.
January,	29.729	39.484	29.725	39.710	40.290	.85	7	24
February,	29.801	41.483	29.832	40.379	41.034	1.20	9	20
March, ...	29.584	42.742	29.597	37.387	42.774	1.60	10	21
April, ...	29.869	48.733	29.883	45.800	47.600	2.20	12	18
May, ...	29.778	52.548	29.796	47.387	49.871	1.49	13	18
June	29.643	60.833	29.709	55.533	56.933	2.96	14	16
July, ...	29.878	65.161	29.890	57.226	59.000	1.20	8	23
August	29.683	59.871	29.687	58.226	59,484	3.00	18	13
September,	29.823	56.367	29.839	54.733	56,467	2.20	12	18
October, ...	29.689	50.581	29.746	49.839	50.581	4.25	14	17
November,	29.560	40.800	29.579	40.667	40.533	2.40	10	20
December,	29.567	39.387	29.614	38.387	39.548	2.90	16	15
Average of the year,	29.717	49.832	29.741	47.106	48.709	26.25	143	223

ANNUAL RESULTS.

MORNING.

Barometer.			Thermometer.	
Observations.	*Wind.*			*Wind.*
Highest, 10th Feb.	SW.	30.40	14th June,	SE............67°
Lowest, 29th Nov.	SW.	28.70	6th January,	SW............25°

EVENING.

Highest, 10th Feb.	SW.	30.40	29th July	SE ...... 65°
Lowest, 5th Oct.	SW.	28.65	5th January, ...	SW ...... 24°

Weather.	*Days.*	*Wind.*	*Times.*
Fair, ...	223	N. and NE	17
Rain or Snow, ...	143	E. and SE.	81
		S. and SW.	213
	366	W. and NW.	55
			366

Extreme Cold and Heat by Six's Thermometer.

Coldest, 6th January ....Wind SW.........20°
Hottest, 9th August .... do. E...........75°
Mean temperature for the year 1832..........................48°710

Results of Two Rain Guages.

	In. 100.
1. Centre of Kinfauns Garden, about 20 feet above the level of the sea, ...	26.25
2. Square Tower, Kinfauns Castle, 180 feet, ...	26.15

Account of an Apparatus for Maintaining an Uniform Temperature. By GEORGE MERRYWEATHER, Esq. Communicated by the Author.

I HAVE the honour this evening of presenting to the Royal Society an apparatus which I hope will be the means of solving an important problem, that has long remained an insurmountable obstacle in the path of science.

When the French chemists promulgated their nomenclature to the world, Fourcroy published the following:—

'Heat is now regarded only as an auxiliary agent, by which combinations are forwarded. As it is employed in different degrees, it would be a valuable acquisition if we knew how to apply it with uniform intensity. A furnace of this kind has long been a desideratum among chemists, and the manipulations of artists have hitherto been the only guide to the chemist, but it is impossible by this means to have the degree of precision so much to be desired.'

It is nearly half a century since Fourcroy wrote the above, since which time the most gigantic progress has been made in science; yet this important point appears to have been lost sight of, or has been considered, like perpetual motion, an object never to be attained. Indeed, when we reflect that fires and furnaces are constantly consuming, and must be constantly renovated with fuel, and when we consider that flame must ever be in agitation, from the very atmosphere from which it derives its existence, it is not astonishing that all attempts should have proved futile, to arrive at a steady temperature, for a length of time, by these means.

The mode which I have made use of to arrive at the solution of the difficulty is quite novel, and will be best understood when the apparatus is before the Royal Society, when all the minutiæ can be explained.

In a philosophical point of view, I trust this apparatus will be considered interesting, as proving the fact, that a uniform temperature *can* be steadily maintained in despite of external in-

* Read before the Royal Society of Edinburgh.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

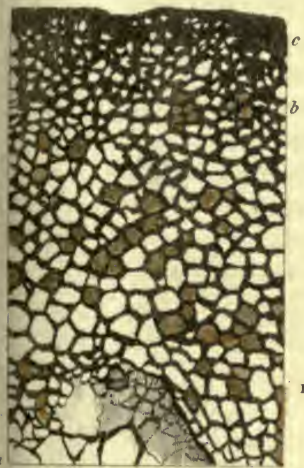
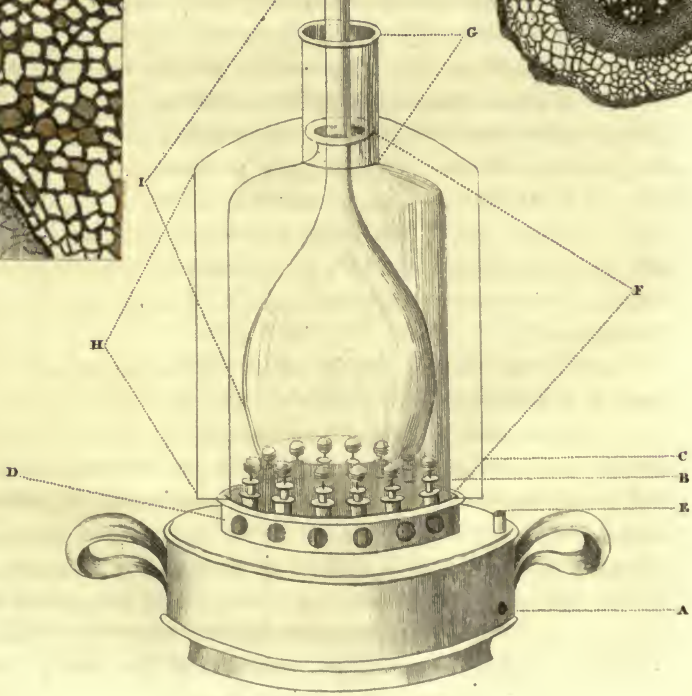


Fig. 5.

Fig. 6.



M^r MERRYWEATHERS LAMP. —

E. Mitchell Sculp^t

fluences; and that it can be kept in constant operation, for an indefinite period, without requiring any one to attend to it.

It remains for scientific men to prove what its utility may be in chemistry and in pharmacy; and whether phenomena, at present unknown, may not be produced by submitting different substances, for a length of time, to the uniform temperature, that this apparatus will maintain. Boerhaave first produced the red oxide, by keeping mercury at the steadiest temperature he could procure for many weeks.

I rather anticipate an objection that may be made to this furnace, *i. e.* the expense of the spirit consumed: but every one who has observed the constant attendance and watchings, which every process requires where fire is employed, will easily perceive, that what is expended in spirit will be more than economized in time. It will, I hope, be sufficiently obvious, that, in conducting experiments by this apparatus, there will be no fires to mend,—no chimneys to sweep, (as it causes no smoke); and, from the precision of temperature, there will be no danger of explosions or boilings over. For instance, a practitioner may commence his process of distillation in the morning,—he may attend to the calls of his profession, and be satisfied during his absence that all is going on steadily.—But, as the expense of all processes is an important consideration, I have been induced to make the following calculation: I find that one gallon of spirit, twenty-two over-proof, which costs 9s. from the distiller, will keep one of the balls incandescent for two months, night and day; or a fraction less than a penny for twelve hours. Three burners cause a temperature of 160° of Fahrenheit;—six produce a temperature of 215°; therefore, the expense of supporting the former for twelve hours will be 3d. and the latter 6d. The apparatus, which is at present before the Royal Society, has fifteen burners elevating the temperature to nearly 396°, making the expense 1s. 3d. for the same period.

I am indebted to Dr Duncan, the Professor of Materia Medica, for suggesting to me the amount of temperature I have produced this evening before the Royal Society. And, I have no doubt, if it had been necessary, I could have produced a temperature of 1000°; but I am informed, that a heat of 300° to 350° is the most desirable temperature.

It perhaps will be expected that I should give an analytical account of the process of combustion, but this I leave with deference to the more refined chemist; and I will only venture the conjecture, that it will be found, that the intense heat, produced by apparently such small bodies, is from the combustion of oxygen and hydrogen by the means of spongy platina, and that water will be found to be the product, mingled with a portion of acetic acid, and derived from the spirit.

As my attention was first drawn to this subject by the writings of a French philosopher, I feel some degree of pleasure in thinking, that when this apparatus is made known to the scientific men in France and on the Continent, it will be freed from the objection of expense, which, in this kingdom, may prove an obstacle, but, in the other European States, the expense will be a mere bagatelle.

I do not present this furnace to the Royal Society as a perfect apparatus, because I am aware that it admits of various improvements and modifications. My sole object has been to produce a uniform and lasting temperature; and the means by which I have accomplished this, I have endeavoured to render as simple and as little expensive as possible. If the members of the Royal Society are satisfied that I have done so, it will ever be a gratifying reflection to me, to think, that the few leisure hours I have devoted to this subject have not been spent in vain. I have the honour to be, Mr President and Gentlemen, your most obedient servant,

George Merryweather.

EXPLANATION OF THE PLATE OF THE APPARATUS FOR MAINTAINING UNIFORM TEMPERATURE.

A. A reservoir made of tin, nine inches in diameter, concave at the bottom interiorly, and deep enough to hold one gallon of spirit. The hole at the side and lower part is to connect, by means of a tube, the reservoir, with one containing a larger supply of spirit. This extra supply will be necessary, when an experiment is to be conducted for a length of time.

B. Are the cotton wicks, which perforate fifteen brass tubes, each of which is similar to the brass work accompanying a common spirit lamp. When the wick is drawn through, it is to be spread and flattened. Each wick is to be sufficiently long to touch the bottom of the reservoir. The fifteen brass tubes are to be inserted into fifteen tin tubes, three quarters of an inch in diameter, which are soldered to the top of the reservoir; namely, twelve in a circle, and three in the centre, the latter to be shorter and lower than the former, in order that a globular retort may approximate equally to each wick.

C. Is the platina wire about the hundredth part of an inch in diameter, coiled into the form of a cup, the upper part of which is one-third of an inch in diameter; this cup is supported by a pin, formed by a continuation of the wire. A large headed common pin is pricked into the centre of the wick, to make an opening for the insertion of the pin of the wire-cup. The head of the large pin is then placed in the bottom of the cup to depress it, nearly in contact, but not to touch the wick. When all the coils of wire have been thus arranged, a piece of well compressed spongy platina is to be cut into small blocks, of sufficient size, to rest in each wire cup.

D. Is a tin rim soldered to the top of the reservoir, perforated with twelve holes, each three quarters of an inch in diameter, for the admission of air.

E. A tin tube for supplying the reservoir with spirit.

F. Is a glass cover with a wide neck, (this glass is precisely similar to the common deflagrating jars,) it rests upon a tin ledge, soldered inside round the rim D, above the air-holes.

G. Is a tin tube or chimney, which rests upon the shoulders of the glass cover F.

H. Is a screen made of tin, which is large enough to surround the glass cover, and to leave a space an inch distant all round it. This screen is supported by a projecting rim of tin at the bottom, on the same ledge that the glass cover F rests upon. It is advisable to have the interior surface of this screen lined with some material that is a bad conductor of heat.

I. Is a glass flask or retort, rounded at the bottom, which is placed upon a brass ring, supported by three legs. It is necessary to have all retorts that are used, perfectly rounded at the lower part, in order that, when the apparatus is adjusted, the retort will be at an equal distance, not to touch, but to be nearly in contact with each of the platina balls.

Belonging to the furnace is a tin cover, which is used when the apparatus is at rest. The screen and glass cover are withdrawn, and a tin cover is placed over all the burners, and rests upon the top of the reservoir, covering the rim perforated with air-holes. This tin serves as an extinguisher, it prevents the spontaneous evaporation of the spirit, it protects the platina balls from injury, and preserves all clean. The whole of the tin-work is japanned externally.

When an experiment is about to be performed, the tube G. is taken off, then the screen H., afterwards the glass cover F. The wicks are then to be saturated, by dropping stronger alcohol upon each of them, after which they are to be lighted; in a few seconds the platina balls become red hot, the flame is then blown out, the retort with its contents is fixed on the brass stand, which is placed within the circle of the twelve burners. Then the glass cover, screen, and tube, are replaced as before.

The best and neatest mode of setting the apparatus into operation, is to render each of the platina balls incandescent, by means of the blowpipe and spirit lamp; as soon as the balls are red hot, the vapour of the spirit is excited, and renders the dropping of stronger alcohol quite unnecessary. For this suggestion I am indebted to Professor Christison.

When it is wished to have any lower degree of temperature, the experimenter has only to withdraw some of the brass tubes, in doing which he takes away at the same time the wicks and platina balls; corks must then be placed in the tin tubes, to prevent the unnecessary evaporation of the spirit.

Thoughts on the Casting of Statues in Metal. By JOHN ROBISON, Esq. Sec. F. R. S. E.

WHEN we consider, in a superficial manner, the comparatively small number of ancient bronze statues which have reached to our times; or read the animated, though somewhat ludicrous, account given by Benvenuto Cellini, of the obstacles he encountered in casting the statues of Perseus*; and when we advert to the large sums required in the present day for casting works of art in bronze, we are at first apt to imagine that the great cost of such works must be the consequence of some mysterious difficulty in the process; but if we go on to examine more closely into the grounds on which this opinion is founded, we begin to perceive the anomaly of any such difficulty being supposed to exist in this country, where immense works have been executed in cast-metal, works requiring a rigid accuracy of ultimate dimensions not at all necessary in statuary, in which, if the relative proportions be truly kept, no injurious effect is produced by the shrinking of the metal which takes place in cooling †.

On farther consideration, we are compelled to admit, that where skilful founders and capacious furnaces abound in every district, where the most intricate castings are daily and hourly

* Cellini's difficulties must have arisen from want of power in his furnace, as he says he overcame them by debasing his bronze with pewter, and by getting some well-dried firewood from a neighbour.

† The casting of a cylinder for a steam-engine of 200 horses power, is a more delicate operation than that of a group of statuary; an air-hole or flaw, which might be imperceptible, is easily repaired in the statue, would be fatal to the other, though it might not be discovered until great expense had been incurred in finishing it.

made in masses varying in weight from a few grains to many tons, the difficulty, *if any really exist*, should not be sought for in the moulding-pit of the founder.

The question then comes to be asked, What is the reason that we see so few great statues in metal, and why are modern ones so costly in their execution? We apprehend, the true reply is, That bronze, the material usually employed in statuary, is dear; and, That as casting in bronze is not a common operation, furnaces have to be erected, and workmen collected, at a great expense for each separate occasion.

If it be allowed that these are the principal causes of the comparative rarity, and of the great cost of bronze statuary, it is surely worth inquiring, whether, by employing cast-iron instead of bronze, we may not materially diminish the cost; and whether, if, in making this substitution, there be any thing likely to arise to counterbalance the advantage which we should gain from the great saving of expense.

In employing iron as the material instead of bronze, we should make a double profit, *first*, From the cost of the one metal being about a twentieth part of that of the other: and, *secondly*, From the circumstance, that, in the immediate vicinity of most places where such castings would be required, founderies would be ready with numerous workmen fully competent to undertake more difficult tasks than would have baffled Cellini with the aid of the driest fire-wood which Florence could have furnished him *.

One component part of the price of an original statue still remains to be adverted to. We mean the remuneration to the artist who designs the model, and superintends the moulding. This, every lover of the fine arts would wish to be liberal; but when the aggregate expense is unnecessarily great, and when the sculptor is forced to assume the (to him) foreign employment of a brass-founder, he may often be obliged to sacrifice a

* Where fuel is scarce, and of inferior quality, artists will necessarily prefer that metal of which they can accomplish the fusion. If the Greeks or Romans had possessed pitcoal and iron, they would probably have used them in their founderies; having only wood, they used bronze. The Dutch, who have turf for fuel, make statues of lead, while the Belgians having coal mines, are now making them of iron.

portion of what he would be entitled to expect as the reward of his talent, or the recompense for the risk and anxiety he is made to undergo.

If, by adopting a cheaper material, and a less expensive method of casting, we should succeed in greatly reducing the cost of statuary, we could more easily afford a liberal remuneration to the genius of the sculptor, the natural consequences of which would be, that more talent would be called forth, and the public places of our cities would soon be enriched by numerous works of art; perhaps we should by degrees come to vie even with those countries whose more favourable climates have led to a greater development of talent in this branch of the arts, than we have hitherto been able to boast of manifesting.

It will perhaps be objected by some persons, that iron is too mean a material to be used in the higher classes of statuary, but we apprehend that this is a prejudice which will yield on a little reflection. We do not think iron is too mean to form the main-spring of a chronometer, the sabre-blade of a hussar, or the sword-hilt of a courtier, in which latter form, we learn from Mr Babbage, it has increased its original value 973 times *. If fitness for the end be the criterion we are to judge by; and if iron be susceptible of taking a sharper impression from a mould than bronze, (which no one can doubt who examines the Berlin and other similar castings), we are bound to admit, that, in this respect at least, it is a better material for doing justice to the model of the artist; we may then proceed to inquire, whether there be any thing in the nature of the metal to make it likely to be less durable than bronze.

In one material point, iron-statues must have the advantage, as the labour which would be required to overthrow and break up a large figure, would scarcely be repaid by the price obtainable for its fragments; while the experience of ages shows us, that the marketable value of bronze affords an irresistible temptation in times of popular tumult, and that gods and goddesses, when made of that material, are not always immortal.

* Many of those beautiful miniature statues in French clocks, which we consider as bronzes dorés, are, in point of fact, made of cast iron; but as the gold cannot be applied by amalgamation, as in the case of bronze, the iron ornaments may be detected by the inferior appearance of the gilding.

If danger be apprehended from the liability of the surface of iron to deteriorate by oxidation, we would say, that there is not much difference in this respect between bronze and *cast*-iron; and that if the same means be taken to prepare and preserve the surface of an iron statue, as is usual with a bronze one, the weather would make little impression on it. We see around us examples of coarse castings, to the preservation of which little or no attention has been paid, and in which no sensible degradation of the surface has taken place, even in long periods of time: It may therefore be fairly inferred, that, by the exercise of a little skill, and of a moderate degree of attention, the external appearance of a grand work of art in iron, may be made pleasing to the eye of taste, and may be preserved uninjured for generations.

If we be not greatly mistaken in the effects which must flow from the late improvements in the smelting of iron-ore, which have been introduced in some of the furnaces on the Clyde, cast-iron of the finest quality for such purposes, will soon be so cheap that we shall see it largely employed in architectural decoration. We should take advantage, therefore, of the means which nature and art have so liberally bestowed on us; and we should strive to make Britain as distinguished for her display of the Fine Arts, as she has hitherto been for her success in the Mechanical ones.

On the Lepidodendron Harcourtii. By Henry Witham, Esq. F. G. S., &c.*

In the month of January 1832, Mr Phillips, of York, having sent me a fragment of a Lepidodendron, which had been presented to him by the Reverend C. G. V. Vernon Harcourt, rector of Rothbury, whose zeal and activity has induced me to take the liberty of naming this fossil plant after him, I felt anxious, by means of slicing the stem, to obtain an insight into its internal structure. I had so repeatedly examined the stems of vascular cryptogamic plants without

* The above is an extract from a paper published in the Transactions of the Newcastle Natural History Society, which we lay before our readers on account of the important fact it contains.—Edit.

detecting any traces of organization, that I cannot refrain from mentioning the delight which I experienced when I observed a structure so perfect.

I am the more gratified, as it affords me an opportunity of corroborating the opinion of so distinguished a fossil botanist as Mr A. Brongniart, although founded solely upon the external markings of the peculiar plants.

To ascertain the correctness of his views, it became necessary for me to examine into the internal structure of recent Lycopodiaceous plants, of which, however, I have only obtained specimens of a single species. In so far as I have discovered, the structure of this species is analogous, in most respects, to that of the stem presented to me by Mr Phillips.

The specimens of this plant which I have seen, consists of subcylindrical or slightly compressed dichotomous stems. The surface is covered by a thick envelope of carbonaceous matter, presenting indistinct spiral protuberances, and beneath which are observed numerous small papillæ of an elliptical form, higher than broad, and very regularly arranged in spiral series. Fig. 1. Plate IV. represents a portion of one of the stems, with some of the carbonaceous envelope remaining.

Viewed in relation to its structure, the stem presents a central axis, which may be seen in the transverse section, and in the longitudinal section, Fig. 2. Pl. IV., in the latter of which it is entirely filled by calcareous spar, and a tube of carbonaceous matter. This axis consists of a central portion, which, in the transverse section, presents rather an irregular cellular texture, around which is a layer of cellular tissue, of large irregular polygonal cells, and lastly, a layer with very small meshes.

From the central column or axis, emanate on all sides cylindrical bodies, consisting of cellular tissue, with central fasciculi of vessels. They proceed obliquely upwards and outwards, and terminate in the papillary eminences of the surface of the stem. They are seen cut obliquely, in the transverse section of the stem, Fig. 3. Pl. IV., where they constitute the white oblong markings dispersed in the brown parenchymatous substances.

These processes, from the central axis or pith, are imbedded in celluar tissue, constituting the great mass of the stem. In the transverse section of the stem it presents the appearance of pretty regular meshes, assuming more or less of a polygonal form, as seen in Fig. 4, Pl. IV. The cellular tissue is more condensed towards the surface of the stem, as is represented at *c* of the same figure, which also shews, at *a*, the appearance of one of the processes, in which the cellular substance and vessels have been thrust aside, and the cavity filled by calcareous spar.

The meshes of the general mass of cellular tissue are somewhat elongated in the longitudinal direction of the stem, but present the same general appearance.

The Lepidodendra are generally supposed to be Lycopodia, or plants allied to them, and there is nothing in the structure of the present species that might tend to invalidate the opinion. A transverse section of Lycopodium clavatum is represented by Fig. 5. Pl. IV., but as I have had no opportunity of examining the structure of any large recent species, and as no figures of such exist, it does not become me to institute any comparison. Whatever light may be thrown on the nature of the Lepidodendron by the anatomy of the present species, I must leave to others better qualified than myself to point out; but, I trust, the figures which I have given will be useful for comparison, should other species occur, in which the structure may be found to have remained. This much is certain, that the plant here described evidently belongs to the vascular cryptogamic class, and that in its structure there is nothing to invalidate the opinion derived from the external configuration of the Lepidodendra, that they are Lycopodiaciæ.

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.

March 10. 1833.

Acacia decipiens, var. præmorsa.

A. *præmorsa;* stipulis spinescentibus, deciduis; phyllodeis triangularibus, passimque trapezoideis, nervo lateri inferiori approximato in spinam producto, margine superiore dente acuto unico glandulifero (varietate, sæpius præmorso dentibus duobus vel tribus glanduliferis) capitulis subsolitariis multifloris.

Description.—*Shrub* erect, twigs arched, angled, glabrous; bark on the stem brown, on the twigs green. *Phyllodium* with one nerve, which passes near its lower sied, triangular, the upper angle, excepting at the apices of the branches, truncated, and terminating in two or three short points tipped with glands, the lower angle extended into a prickle, the continuation of the nerve. *Stipulæ* spinescent, spreading, subdeciduous. *Peduncles* glabrous, pellucid, spreading, longer than the phyllodia. *Flowers* yellow, capitate, numerous in each capitulum. *Calyx* 4-toothed, teeth blunt and ciliated. *Corolla* 4-petaled, petals lanceolate, reflexed. *Stamens* numerous, longer than the corolla. *Pistil* longer than the stamens; germen ovate, tomentous.

We received in 1831, at the Botanic Garden, Edinburgh, from Mr Knight of the King's Road Nursery, the plant here described, under the name of *Acacia præmorsa.* I presume it was imported by Mr Baxter. I cannot, however, consider it other than a variety of *A. decipiens*, distinguished chiefly by its paler flowers, by the petals being more reflected, allowing the stamens to spread more, and thus producing a capitulum less distinctly lobular, and further, by the upper angle of the leaf being more frequently irregularly truncated than in *A. decipiens.*

It flowered very freely with us in the greenhouse, with the usual treatment of New Holland acacias.

Baccharis alata, mas.

B. *alata;* fruticosa, caule interrupte tri-alato; foliis sessilibus, cordatis, obtusis, integerrimis, lateribus reflexis; floribus fasciculato-spicatis, terminalibus.

Description.—*Stem* (in our specimen above 5 feet high) shrubby, interruptedly 3-winged, branched, branches erect, and, as well as the wings, green, rigid, scabrous. *Leaves* erect, often oblique, placed at the interruptions of the wings, sessile, cordate, blunt, reflected at their sides, subscabrous, obscurely veined. *Flowers* pale yellow, sessile, fasciculato-spicate at the extremities of the branches, fasciculi 3–4-flowered. *Anthodium* orbiculato-ovate, scabrous. *Florets* all male, funnel-shaped, limb spreading, segments acute, at length revolute. *Anthers* exserted. *Pappus* simple, as long as the florets. *Receptacle* slightly conical, somewhat hispid.

We received this plant at the Botanic Garden in 1829, under the name here adopted, from the Berlin Garden, but without any statement of its native country. It flowered freely in the greenhouse in December 1832, but is curious rather than ornamental.

Combretum grandiflorum.

C. *grandiflorum*; inerme scandens; foliis oppositis breve petiolatis, oblongo-subcordatis, acuminatis, integerrimis, utrinque ramulisque parce hirsutis; spicis secundis, axillaribus terminalibusque; bracteis ovatis, acutis; floribus 5-petalis, 10-andris, erectis, confertis, calycibus subglabris, staminibus inclusis.

Combretum grandiflorum, *G. Don*, in Edin. Phil. Journal, 1824, p. 346. —*De Cand.* Prodr. 3. 21.—*Bot. Mag.* t. 2944.

Description.—*Shrub* low, somewhat climbing, unarmed. *Branches* long, slender, pendulous, their extremities covered with very short tomentum, mixed with longer hairs. *Leaves* (5 inches long, 2½ broad) opposite, bright green, paler below, tinged red when young, shortly petioled, oblong, occasionally cordate at the base, acuminate, sparingly pubescent on both sides, entire; middle rib and veins with their reticulated branches prominent behind, and more abundantly covered than the leaves, especially in the angles which the veins form with the middle rib, with yellow hairs; petiole pubescent, woody at its base. *Spikes* axillary and terminal, half the length of the leaves, bracteate. *Bracteæ* ovate, acute, entire, pubescent, veined, deciduous. *Pedicels* very short. *Flowers* secund, reflected upon the peduncle, and therefore erect, as the branches are pendulous. *Calyx* (9 lines long) funnel-shaped, superior, 5-cleft, slightly pubescent, 5-nerved, veined, herbaceous, thickened at the lower part of the tube, where on the inside it is brown; segments acute, ciliated. *Petals* 5 (7½ lines long, 2½ broad) spathulate, vermilion-coloured, connivent, carinate, veined, alternate with the segments of the calyx and inserted into the bottom of its fissures. *Stamens* 10, about equal in length to the petals; filaments arising from slightly dilated bases, alternately opposite to the petals and segments of the calyx, the former five immediately below the insertion of the petals, the latter somewhat lower, very slightly tapering; anthers versatile, yellow, notched at their lower part, lobes bursting along the edges. *Pistil* single; stigma minute, terminal; style green, longer than the petals, glabrous, slightly compressed, tapering at the apex, adhering to one side of the calyx at its base; germen inferior, slender, resembling a peduncle, green, 5-angled, slightly pubescent, unilocular; ovules three, suspended from the apex of the germen by long funiculi, which cohere for a little way, nucleus inverted.

This plant was discovered by Mr George Don when at Sierra Leone, growing plentifully near Free Town, on the road to Congo Town. It flowered for the first time in Scotland in the stove of his Grace the Duke of Buccleuch at Dalkeith, in December last, and continued to expand its blossoms in succession during six weeks, producing in that time above 100 splendid clusters.

Where there is taste to admire the works of Nature, combined with the power of gratifying that taste—where wealth is only valued in its enjoyment, and its enjoyment felt in doing good—I cannot fear that the support given to what is considered a characteristic employment of Scotsmen, will be measured parsimoniously. It is impossible to doubt, that the new energy infused into the horticultural department at Dalkeith, will be farther extended to introduce into our country many of the unseen beauties of little known regions, and that we shall not long have to say, that all the private establishments which in this way have embellished our gardens, or advanced our knowledge of botany, are to be found at the southern extremity of our island. I take great pleasure in acknowledging the vast obligations I owe to the Countess of Dalhousie, for the numberless additions made to my herbarium from Canada and from India; and I rejoice in the expectation that botany will receive support from another noble patroness in this neighbourhood. Of the specimens received from Lady Dalhousie, many of them are undescribed, and all are preserved with an unrivalled degree of excellence. With a kindness characteristic of her Ladyship, she has, at my request, conferred a similar boon on my friend Dr Wight, to whose forthcoming Flora of the Peninsula of India, to be published conjointly with Mr Arnott, it will give additional value.

Corydalis longiflora.

C. *longiflora;* caule simplici, squamigero; foliis biternatim sectis, segmentis subtrifidis, lobis obovato-oblongis; racemo terminali, laxifloro; bracteis ovato-lanceolatis, pedicello brevioribus; calcare subulato, pedicellis longiore.

Corydalis longiflora, *Pers.* Synops. 2. 269.—*Decand.* System. 2. 116.—*Ibid.* Prodr. 1. 127.—*Spreng.* Syst. 3. 160.—*Link et Otto,* Icones Pl. Rar. pars i. p. 3. t. 2.

Fumaria Schangini, *Pall.* Act. Petropol. 1779, 2. p. 267. t. 14. f. 1–3.

Fumaria longiflora, *Willd.* Syst. 3. 860.

β, Fumaria caudata, *Lam.* Dict. 2. 569. fide DC.—*Ibid.* Encycl. 3. 563. ? fid. Willd.

Corydalis caudata, *Pers.* Synops. 2. 269. fid. DC.

Description.—*Tuber* globular, about the size of a hazel nut. *Stem* (to the uppermost flower, 6–8 inches high) suberect, subpellucid, subglaucous, leafy at its base, sheathed. *Leaves* shorter than the stem, elongating somewhat after the flowers have faded, glaucous, biternate, leafets subtrifid, lobes obovato-oblong. *Raceme* terminal; rachis tapering, flowers scattered loosely; pedicels (½ inch long) gradually elongating as the fruit forms, suberect, round, glabrous, reddish. *Bracteæ* single at the base of each pedicel, rather shorter than the pedicels when in flower, ovato-lanceolate, obtuse, gradually diminishing upwards, nerved. *Flower* (1¾ inch long) pale rose-coloured, petals slightly cohering at the base, limb concave, that of the three upper parts fleshy, the upper and lower subequal, upper suberect, lower nearly straight, alæ shorter, their limb oblong, keeled, blood-red in the upper half, cohering at the apex, keel, when placed under the microscope, found to be tubercled near the apex, claw long, slender, linear; spur tapering, nearly straight. *Filaments* diadelphous, three cohering within the upper, and three within the lower petal, free for a very little way at the apex only. *Anthers* yellow; pollen granules spherical. *Stigma* green, compressed, blunt, sagittate at the base, crowning the anthers. *Germen* oblong-linear, angled; ovules numerous.

Tubers of this plant, which is a native of the Altai mountains in Siberia, were received at the Botanic Garden, Edinburgh, from Berlin, in 1832, and flowered in the greenhouse during December and January following.

Dodecatheon integrifolium.

D. *integrifolium;* pedicellis erectis; floribus nutantibus; filamentis anteras obtusas subæquantibus, connectivis extrorsim subulatis.

Dodecatheon integrifolium, *Mich.* Fl. Bor. Amer. 1. 123.—*Pers.* Synops. 1. 171.—*Pursh,* Fl. Amer. Septent. 1. 136.—*Nutt.* Genera, 1. 119.—*Roem. & Schult.* Syst. Veg. 4. 141.—*Torrey,* Fl. of Mid. and North. Sect. of United States, 1. 214.—*Spreng.* Syst. Veget. 1. 573.

Description.—*Leaves* all radical, spathulato-elliptical, glabrous, repandodenticulate. *Scape* erect, subviscid, purplish towards the top. *Umbel* involucrate. *Involucrum leaves* deltoideo-subulate, fleshy at the base. *Pedicels* erect. *Flowers* nodding. *Calyx* 5-cleft, glabrous, segments acute reflexed with the deep purple limb of the *corolla,* the throat of which is yellow, divided into five spaces by five coalescing, obcordate, orange lines. *Filaments* yellow, wrinkled, monadelphous. *Anthers* blunt, little longer than the filaments; connective subulate, dark coloured, and on the outside generally broader than the loculaments of the anthers, even to the apex. *Stigma* blunt. *Style* glabrous, filiform, longer than the stamens. *Germen* cylindraceo-oblong, glabrous, longer than the tube of the calyx, unilocular; ovules numerous, inserted into the central receptacle.

The essential character usually assigned to this plant seems to me so inadequate to distinguish it from *D. Meadia*, that I more than doubted whether they ought to be considered specifically distinct; and I was only induced to examine them with greater care last summer, after the repeated assertion of Mr Macnab, that, when cultivated in precisely the same way, and in the same border, the *D. integrifolium* always produced abundance of perfect seeds, the *D. Meadia* never one. It flowers later than *D. Meadia*, and is darker in the colour of the flower, but the chief essential distinction, if there be any, must, I think, be taken from the blunt anthers, the greater length of the dark connective, and the longer filaments.

Pogostemon plectranthoides.

P. *plectranthoides;* caule fruticoso, ramulis tomentosis; foliis ovatis, inæqualiter serratis, subacuminatis, utrinque pubescentibus; paniculis terminalibus, coarctatis; bracteis ovatis, acutis, ciliatis, utrinque pubescentibus, calyce longioribus; corollæ tubo calycibus longiori.

Pogostemon plectranthoides, *Desf.—Spreng.* Syst. Veg. 2. 721.—*Benth.* in Wall. Cat. Herb. Ind. No. 1530, *a*, specimen from Kamoun.—*Ibid.* Bot. Regist. fol. 1282.

Description.—*Stem* woody erect, obscurely four-sided, more distinctly so in the branches, very slightly swollen at the joints; bark pale brown, striated, tomentoso-pubescent on the young shoots. *Leaves* (5 inches long, 2½ broad) opposite, petioled, spreading, ovate, subacuminate, coarsely and unequally serrated, entire and subcuneate at the base, pubescent on both sides, veined, the middle rib and primary veins (which pass obliquely forward) prominent behind; petiole about a fourth part of the length of the leaf, channelled above, pubescent. *Flowers* in terminal bracteate panicles; *rachis* and its branches tomentoso-pubescent, sprinkled with purple spots, which are also seen on the back of the uppermost leaves and the lower side of their petioles; *bracteæ* ovate, acute, strongly ciliated, pubescent on both sides, spotted with purple. *Calyx* green, scarcely spotted, clavate, pubescent, shorter than the bracteæ, 5-cleft, segments acute, subequal, the lowest rather the longest. *Corolla* white, tube slightly compressed laterally, declined; limb scarcely so long as the tube, bilabiate, upper lip erect, trifid, segments blunt, pubescent on the outside, slightly reflexed at their apices, the central the smallest; lower lip simple, lanceolate, acute, glabrous, deflected. *Stamens* exserted, distant deflected; filaments twice as long as the corolla, lilac, and covered on their outer sides at the middle with long lilac moniliform hairs; anthers pale yellow, unilocular, and bursting by a slit a little to one side of their vertex, forming two rather unequal valves. *Style* lilac, glabrous, bifid. *Stigmata* minute, terminal. *Germen* 4-lobed, placed on a cylindrical disk.

The seeds of this plant, communicated by Lord Meadowbank, were received at the Botanic Garden, Edinburgh, from the Mauritius in 1830. It blossomed in the stove for the first time in January and February 1833, the blossoms coming in succession for a long while. Whatever it has of beauty is derived from its long, lilac, bearded stamens.

I have referred above to the Kamoun specimen in Wallich's herbarium, because our plant is identical with this; but more careful examination may induce Mr Bentham to consider the specimens from the other stations distinct. It is possible that it may have been introduced into Mauritius from India.

I do not know in what work Desfontaines described the species, and have not been able to quote it. The number of species in my possession is too small to enable me with confidence to draw up a specific character, and that given by Sprengel is in several respects inaccurate.

Celestial Phenomena from April 1. *to July* 1. 1833, *calculated for the Meridian of Edinburgh, Mean Time.* By Mr Geo. 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.*

APRIL.

D.	H.	′	″	
1.	16	20	–	☌ ☉ ♃
3.	1	26	28	☌ ☽ ν ♍
3.	2	18	47	☌ ☽ ♄
4.	14	31	5	○ Full Moon.
5.	15	–	–	☌ ♀ Pleiadum.
6.	13	37	–	☌ ♀ η ♉
6.	14	23	11	☌ ☽ ξ ♎
7.	7	43	8	☌ ☽ γ ♎
7.	11	32	25	☌ ☽ η ♎
7.	15	52	21	☌ ☽ ϑ ♎
9.	6	12	43	☌ ☽ ρ Oph.
9.	16	45	44	☌ ☽ D Oph.
10.	6	24	40	☌ ☽ 1 μ ♐
11.	0	40	52	☌ ☽ 1 ν ♐
11.	1	6	30	☌ ☽ 2 ν ♐
11.	2	21	30	☌ ☽ 2 ξ ♐
11.	5	31	28	☌ ☽ ο ♐
11.	7	52	44	☌ ☽ π ♐
11.	23	56	11	☾ Last Quarter.
13.	23	3	47	☌ ☽ ι ♑
14.	7	56	34	☌ ☽ γ ♑
14.	8	57	19	☌ ☽ ♅
14.	11	26	8	☌ ☽ δ ♑
14.	21	18	50	☌ ☽ ι ♒
16.	4	7	–	Inf ☌ ☉ ☿
16.	10	20	33	☌ ☽ 2 ψ ♒
16.	10	53	16	☌ ☽ 3 ψ ♒
17.	9	30	28	☌ ☽ r ♓
17.	11	17	22	☌ ☽ s ♓
18.	20	22	14	☌ ☽ ♃
19.	9	42	27	☌ ☽ ☿
20.	1	34	54	● New Moon.
20.	8	14	34	☉ enters ♉
21.	8	54	–	☌ ♂ ε ♊
22.	13	9	44	☌ ☽ ♀
22.	17	8	38	☌ ☽ 1 δ ♉
22.	17	39	15	☌ ☽ 2 δ ♉
22.	18	14	58	☌ ☽ 3 δ ♉
22.	19	34	34	☌ ☽ ε ♉
23.	20	34	22	☌ ☽ c ♉
24.	0	44	44	☌ ☽ ζ ♉
24.	15	55	28	☌ ☽ η ♊
25.	7	21	33	☌ ☽ ♂
25.	18	6	56	☌ ☽ δ ♊
25.	19	11	4	☌ ☽ μ ♊
27.	5	18	6	☽ First Quarter.
28.	19	13	–	☌ ♂ ω ι ♊
30.	7	37	25	☌ ☽ ♄
30.	9	10	2	☌ ☽ ν ♍

MAY.

D.	H.	′	″	
2.	19	45	–	☌ ♂ m ♊
3.	23	58	3	☌ ☽ 2 ξ ♎
4.	0	31	13	○ Full Moon.
4.	17	21	21	☌ ☽ γ ♎
4.	21	10	7	☌ ☽ η ♎
5.	1	29	6	☌ ☽ ϑ ♎
5.	5	13	–	☌ ☿ μ ♓
6.	15	56	47	☌ ☽ ρ Oph.
7.	1	50	52	☌ ☽ D Oph.
7.	2	10	–	☍ ☉ ⚵
7.	15	16	52	☌ ☽ 1 μ ♐
8.	9	14	51	☌ ☽ 1 ν ♐
8.	9	40	3	☌ ☽ 2 ν ♐
8.	10	53	52	☌ ☽ 2 ξ ♐
8.	14	0	56	☌ ☽ ο ♐
10.	22	0	52	☌ ☽ η ♑
11.	6	49	24	☌ ☽ ι ♑
11.	15	40	16	☌ ☽ γ ♑
11.	18	31	18	☾ Last Quarter.
11.	19	9	22	☌ ☽ δ ♑
11.	20	57	26	☌ ☽ ♅
13.	18	10	17	☌ ☽ 2 ψ ♒

MAY—*continued.*

D.	H.	′	″	
13.	18	43	21	☌ ☽ 3 ψ ♒
14.	5	37	–	☿ greatest W. [elong.
14.	17	28	57	☌ ☽ r ♓
14.	19	16	37	☌ ☽ s ♓
15.	15	50	–	☌ ♂ κ ♊
16.	16	51	43	☌ ☽ ♃
16.	21	15	35	☌ ☽ ν ♓
17.	8	49	–	Inf. ☌ ☉ ♀
17.	10	42	36	☌ ☽ ☿
18.	11	7	–	☌ ☿ 1 ξ Ceti.
19.	4	43	43	☌ ☽ ♀
19.	13	23	52	● New Moon.
20.	23	16	–	☌ ☿ 1 ξ ♈
21.	3	26	24	☌ ☽ o ♉
21.	7	31	2	☌ ☽ ζ ♉
21.	8	28	55	☉ enters ♊
21.	22	21	10	☌ ☽ η ♊
22.	1	32	11	☌ ☽ μ ♊
22.	23	59	3	☌ ☽ δ ♊
23.	17	11	–	☌ ☽ ♂
26.	11	25	9	☽ First Quarter.
27.	12	31	8	☌ ☽ ♄
27.	15	5	13	☌ ☽ ν ♍
30.	3	50	–	☌ ☿ ♀
30.	7	45	35	☌ ☽ ξ ♎

JUNE.

D.	H.	′	″	
1.	1	8	–	☌ ♃ o ♓
1.	1	26	44	☌ ☽ γ ♎
1.	5	19	4	☌ ☽ η ♎
1.	9	41	43	☌ ☽ ϑ ♎
2.	0	27	31	☌ ☽ ρ Oph.
2.	11	37	24	○ Full Moon.
3.	10	22	15	☌ ☽ D Oph.
3.	23	46	42	☌ ☽ 1 μ ♐
4.	7	33	–	☌ ♂ η ♋
4.	17	39	19	☌ ☽ 1 ν ♐
4.	18	4	21	☌ ☽ 2 ν ♐
4.	22	23	22	☌ ☽ o ♑
7.	5	57	38	☌ ☽ η ♑
7.	23	31	40	☌ ☽ γ ♑
8.	3	0	9	☌ ☽ δ ♑
8.	4	5	21	☌ ☽ ♅
9.	4	16	–	☌ ♂ δ ♋
10.	2	5	56	☌ ☽ 2 ψ ♒
10.	2	39	7	☌ ☽ 3 ψ ♒
10.	12	8	43	☾ Last Quarter.
11.	1	36	52	☌ ☽ r ♓
11.	3	25	38	☌ ☽ s ♓
12.	4	50	6	☌ ☽ *m* Ceti.
13.	6	2	31	☌ ☽ ν ♓
13.	12	38	52	☌ ☽ ♃
13.	21	50	45	☌ ☽ 1 ξ Ceti.
14.	5	25	48	☌ ☽ 2 ξ Ceti.
14.	13	30	53	☌ ☽ μ Ceti.
15.	5	10	43	☌ ☽ ♀
16.	9	42	52	☌ ☽ 1 δ ♉
16.	10	12	43	☌ ☽ 2 δ ♉
16.	10	47	33	☌ ☽ 3 δ ♉
16.	12	5	2	☌ ☽ ε ♉
17.	18	59	–	Sup. ☌ ☉ ☿
17.	22	58	17	● New Moon.
17.	23	15	22	☌ ☽ ☿
18.	7	50	42	☌ ☽ δ ♊
21.	3	42	51	☌ ☽ ♂
21.	17	4	47	☉ enters ♋
23.	1	23	–	☌ ☿ ε ♊
23.	19	10	14	☌ ☽ ♄
23.	20	28	2	☌ ☽ ν ♍
24.	15	18	6	☾ Last Quarter.
26.	1	25	34	Im. II. sat. ♃
26.	1	50	29	Im. I. sat. ♃
27.	13	45	22	☌ ☽ 2 ξ ♎
28.	7	45	10	☌ ☽ γ ♎
28.	11	41	40	☌ ☽ η ♎
28.	16	8	57	☌ ☽ ϑ ♎
29.	22	44	–	☌ ☿ κ ♊
30.	7	31	12	☌ ☽ ρ Oph.
30.	17	32	56	☌ ☽ D Oph.

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

APRIL.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	13 6	14 5 N.	14 46	23 33 N.	17 6	25 16 N.	12 6	3 37 N.	23 0	4 54 N.	8 54	15 3 S.
5	12 54	14 37	14 41	24 29	17 0	25 17	11 54	4 0	22 43	5 0	8 45	15 0
10	12 31	13 59	14 32	25 25	16 52	25 15	11 39	4 28	22 22	5 8	8 26	14 57
15	12 1	12 3	14 22	26 6	16 45	25 9	11 23	4 56	22 1	5 15	8 6	14 54
20	11 31	9 33	14 9	26 29	16 38	25 0	11 8	5 23	21 41	5 21	7 47	14 50
25	11 5	7 25	13 52	26 33	16 31	24 47	10 53	5 50	21 20	5 26	7 28	14 48

MAY.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	10 39	5 51 N.	13 26	26 8 N.	16 23	24 25 N.	10 35	6 21 N.	20 55	5 31 N.	7 4	14 46 S.
5	10 30	5 43	13 5	25 30	16 16	24 10	10 22	6 42	20 40	5 34	6 50	14 44
10	10 22	6 25	12 35	24 18	16 8	23 45	10 7	7 7	20 19	5 36	6 29	14 42
15	10 20	7 36	12 9	22 42	16 1	23 18	9 51	7 32	19 59	5 38	6 11	14 42
20	10 22	10 4	11 33	20 51	15 54	22 46	9 36	7 56	19 39	5 38	5 51	14 41
25	10 29	12 41	11 4	18 59	15 46	22 11	9 23	8 19	19 20	5 37	5 32	14 41

JUNE.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
5	10 44	16 48 N.	10 29	16 45 N.	15 37	21 15 N.	8 58	8 51 N.	18 51	5 35 N.	5 3	14 41 S.
1	11 0	19 10	10 13	15 49	15 32	20 41	8 46	9 8	18 37	5 32	4 48	54 42
10	11 22	21 52	9 54	15 5	15 25	19 55	8 29	9 28	18 17	5 28	4 28	14 43
15	11 47	23 52	9 37	14 45	15 16	19 6	8 14	9 48	17 58	5 23	4 8	14 44
20	12 15	24 48	9 25	14 46	15 8	18 14	7 58	10 6	17 39	5 18	3 48	14 46
25	12 43	24 38	9 15	15 5	15 1	17 19	7 41	10 23	16 20	5 11	3 28	14 48

SCIENTIFIC INTELLIGENCE.

GEOGRAPHY.

1. *Southern Africa.*—Dr Smith, so well known for his zoological researches, in a letter to Sir James Macgrigor, communicates the following information :—Knowing well as I do the interest you take in the promotion of knowledge, I lose no time in making you acquainted with my successes during a late journey to Port-Natal and the Zoola country. On the expedition I was absent about six months, and, though constantly surrounded with difficulties and dangers, yet I have been more than compensated for all, by the great additions I have been enabled to make to my natural and geographical knowledge. The extraordinary characters of some of the tribes I visited, excited the most lively sensations, and furnished me with actual evidence of the existence of extreme *despotism*, such as I had never seen before. I think the account I shall be able to publish of them will amuse the world, and will raise the feelings of the humane, so as to suggest some means for putting a stop to the horrible practices of at least the Zoola tyrant. Every department of both the animal and vegetable kingdom offered much to attract attention, and I did not return without making an addition of many new species, particularly of reptiles and fishes. Of both the latter I may say I have obtained types for new genera, and some of them are not a little extraordinary. It is curious that, in the very southern parts of Africa, we have little of the Senegal zoological productions, but at Natal they are abundant, and though there be but little difference of latitude, yet there is considerable change in the animal forms. This discovery has set me to observe the geographical distribution of our creation, and if I can trace the causes of the changes, it may throw some light upon the natural system. The geological structure of the south east coast is also very interesting. The granite, which disappears immediately to the eastward of Cape Town, rises again near Natal; and between these points, we have extensive formations of quartzose sandstone, clayslate with quartz rock, and old red sandstone; the extent and form of those will be shewn in the geological map which I am at present constructing. —*Cape Town*, 6*th October* 1832.

2. *The New Continent.*—The discoveries of land towards the South Pole, mentioned in the public journals, were made by Captain Biscoe, in the brig Tula, accompanied by the Lively cutter; both vessels belonging to Messrs Enderbys, extensive owners of ships in the whale fishery; and the log, together with other particulars, were communicated to the Royal Geographical Society. It is supposed that this land forms part of a vast continent, extending from about long. 47° 30′ E. to long. 69° 29′ W.; or from the longitude of Madagascar, round the whole of the southern and south Pacific Ocean, as far as the longitude of Cape Horn. On the 28th February 1831, Captain Biscoe discovered land, and during the following month remained in the vicinity. He clearly discerned the black peaks of mountains above the snow; but he was, from the state of the weather and the ice, unable to approach nearer than about thirty miles. The stormy petrels were the only birds seen, and no fish. It has been named Enderby's Land, long. 47° 30′ E., lat. 66° 30′. An extent of about 300 miles was seen. The range of mountains E.N.E. In consequence of the bad state of the health of the crew, Captain Biscoe was compelled to return into warmer latitudes. He wintered at Van Diemen's Land, and was rejoined by the cutter, from which he had been separated during the stormy weather in the high south latitude. In October 1831 he proceeded to New Zealand. In the beginning of February 1832 he was in the immediate neighbourhood of an immense iceberg, when it fell to pieces, accompanied by a tremendous noise. On the 15th of the same month, land was seen to the south-east, long. 69° 29′ W. lat. 67° 15′. It was found to be an island, near the headland of what may hereafter be called the Southern Continent. On the island, about four miles from the shore, was a high peak and some smaller ones; about one-third of the highest was covered with a thin scattering of snow, and two-thirds completely with snow and ice. The appearance of the peaks was peculiar; the shape was conical, but with a broad base. This island has been named Adelaide Island, in honour of her Majesty. Mountains were seen to the south, at a great distance inland, supposed about ninety miles. On the 21st of February 1832, Captain Biscoe landed in a spacious bay on the mainland, and took possession in the name of his

Majesty William the Fourth. The appearance was one of utter desolation, there being no vestige whatever of animal or vegetable life.—*Lit. Gazette.*

ZOOLOGY.

3. *Illusions in Maniacs.*—M. Esquirol has deposited a memoir relative to this distinction of maniacs, considered in a medico-legal point of view, and has read another paper, entitled *Illusions in Maniacs.* The design of the author is to distinguish clearly in this new work hallucinations from illusions. In the former, every thing, according to him, goes on in the brain; the visionaries are persons who rave quite awake, and whose cerebral activity is so energetic, that it invests with substance and reality the images which are produced by the memory, without the intervention of the senses. In illusions, on the contrary, the patients are deceived with respect to the nature and cause of their sensations. Illusions are not at all rare in the state of health, but reason soon destroys them, whilst in maniacs the case is not so. Two conditions, in fact, are necessary for the perception of a sensation; integrity of the organ which receives the impression, and integrity of the instrument which reacts on the impression. If the sensibility and activity of the organs are disturbed, the impressions made by external objects must be modified; and if, at the same time, the brain is diseased, it cannot rectify the error of the senses; hence arise illusions. The very volatile attention of maniacs cannot rest long on external objects, and then the perception is incomplete; the patient perceives but badly the qualities and relations of the objects which make impressions on them. In monomania, on the contrary, the attention is too much concentrated, and cannot carry itself successively over the objects which are external and foreign, from the prepossessions and conceits which predominate over the patient's thoughts. In a word, the mind and the passions concur with the senses in producing the illusions of maniacs; but it is from the senses that the process commences. Hypochondriacs have illusions arising from internal organs; they are deceived with respect to the severity of their suffering, but they are not actually bereft of reason (de raisonnent), unless the case be complicated with lypemania

or melancholy. M. Esquirol has examined the body of a woman at the Saltpétrière, who for a long time fancied she carried an animal in her stomach; she had cancer of this organ. An aged woman, who was very devout, and who laboured under monomania, imagined that she carried in her abdomen all the personages of the Old and New Testament; when her pains became very severe, she sometimes figured to herself that Jesus Christ was being crucified in her abdomen, and she said that she distinctly heard the blows of the hammer; when she was opened after death, they discovered the existence of a chronic peritonitis, which formed extensive adhesions to all the intestines, so that they formed one mass. The same alteration existed, though less marked, in a demonomaniac, who was extremely emaciated, who fancied that she carried in her abdomen several devils, who were tearing her and exciting to self-destruction. Her skin was as insensible as if it had been tanned, and M. Esquirol several times stuck pins into it, without causing any pain. This woman stated that the devil had taken away her skin from her, and that he replaced it by his own. Irritation and pains in the organs of generation are oftentimes the cause of illusions in maniacs, particularly in women. The painful constrictions of the throat in hysterical monomaniacs are often attributed by them to the effects of some jealous person who wishes to strangle them. The wandering pains which maniacs sometimes feel in their limbs also give rise to illusions. A medical student, in an attack of mania, caused by the presence of worms in the intestinal canal, felt acute pains all over the body, and attributed them to darts with which he fancied himself constantly pierced. The illusion went off after the expulsion of the worms. The author next passes in review the cases where the illusion arises from the external senses. The derangement of the digestive functions, and the perversion of taste almost invariably observed at the onset of mental diseases, often make the patients, who find fault with their food, fancy that they have been poisoned, a circumstance which contributes to inspire them with an aversion to those who have charge of them. This illusion disappears when the digestive functions are restored to their natural state. It is very important to distinguish this refusal of food from that which results from a fixed determination, as, for instance, from a vow, &c. The first has nothing alarming in it; the second, on the contrary, is very difficult to overcome. The dryness of their mouth causes many maniacs to think that earth has been mixed up with their food, or that spoiled meat has been given them, &c. &c. After a very interesting examination of the illusions which arise from the alteration of the other senses, the author closes his memoir with the following conclusions: 1*st*, Illusions are the result of the actions of the sentient extremities, and of the reaction of the nervous centre. 2*d*, Illusions are caused as frequently by the anomalous excitement of the internal organs, as by that of the external senses. 3*d*, Illusions set reason astray, with respect to the nature and cause of the impressions actually received, and excite the individual to acts more or less irrational. 4*th*, Sex, education, profession, habit, by modifying cerebral action, modify the character of illusions. 5*th*, Illusions assume the character of the ideas as well as of the passions which predominate in the persons affected. 6*th*, Illusions cannot be confounded with hallucinations, since, in the latter, the brain alone is excited. 7*th*, Finally, reason dissipates the illusions of the man who is sound in mind, whilst it is unable to destroy the illusions of maniacs.—*Dublin Jour. of Med. and Chem. Hist.* No. vii. p. 136.

4. *Remarkable case of Obesity in the Human Species.*—At a late meeting of the Royal Society of London, a relation by Mr Pettigrew of the occurrence of a remarkable case of obesity in the person of J. H. Kirman, a boy about eleven years old, was read. The subject of the paper was present at the meeting. His features are pleasing, and expressive of that simplicity which frequently marks the countenance of early boyhood, and contrasts strangely with his bulky person. He was born in Lincolnshire, and was not remarkable at his birth, nor, indeed, until three years ago. He had then a fractured limb, or something of that sort, and was obliged to remain much in a state of rest; a similar accident followed, which met, of course, with similar treatment: then it was that he began to increase so remarkably in size. He weighs 14 st. 2 lb., and measures—

In height, ...	5 feet.
Across the chest, . . .	45 inches.
Across the abdomen, . .	44 inches.
Calf of the leg, . . .	10½ inches.

His muscular action is great, appetite and sleep moderate: in manner and other respects he is perfectly juvenile. Mr Pettigrew follows up his paper by a few remarks in connexion with its subject. He observes, that cases of obesity are more numerous in marshy places than in those distinguished by dryness of the atmosphere; for one fat person in France we have in England one hundred, occasioned chiefly by a too free use of animal food and fermented liquor, which tend much to the formation of adipose substances. He points out some of the ills attendant on corpulence, which may be looked on as a chronic disease; these are—congestion in various parts, epilepsy, lethargy, apoplexy, &c.; and closes this paper with some observations, having for their object to decrease its occurrence, viz. simple diet, fish and vegetables, free exercise in the open air, as little sleep as possible, the cold bath and friction.—*Lit. Gaz.*

5. *Seal found in the interior of New Holland.*—At a meeting of the Zoological Society, R. Owen, Esq. in the Chair, Mr Bennett called the attention of the meeting to a *seal*, of a well-known genus, but which was remarkable as having (on the authority of the gentleman who brought it home) been procured in the interior of New Holland; a circumstance which would imply the existence of a salt-water lake, or perhaps an inlet of the sea, in the unexplored regions of that immense island.

6. *On the Respiration of the Inferior Animals.*—The following are the conclusions deduced from several experiments made with great care and accuracy, by G. R. Treviranus, on the respiration of the inferior animals: 1. The production of carbonic acid gas during their respiration, depends on the temperature of the medium in which they are placed; on the strength of the individual; and on the frequency and violence of its voluntary motions.—2. The absorption of oxygen is not always proportional to the excretion of carbonic acid gas; it is certainly, in general, increased and diminished under the same circumstances; but its proportion to the other depends on the strength of the respiration, the time of its continuance while the respirability of the air is diminishing, and the volume of the air in which the respiration is performed. The more carbonic acid there is developed while breathing in the open air, and the less the power of continuing in a medium deficient in oxygen, the

less is the proportion of the consumption of oxygen to the production of carbonic acid gas, whence a small quantity of atmospheric air is respired for a moderate period. But when the respiration is continued for a longer period in the same air, and the strength of the individual begins to sink, the excretion of the latter diminishes more rapidly than the absorption of the former. We know that the higher classes of animals, when inclosed in a certain quantity of air, die long before all its oxygen has been exhausted. The case is very different with many of the *mollusca* under the same circumstances; for they not only consume all the oxygen, but actually continue afterwards to expire carbonic acid gas; consequently, after the respiration has been continued for some time, there has been more of the latter excreted than there has been consumed of the former; nay, sometimes this occurs even before all the oxygen has been consumed.—3. The volume of the respired air generally remains unaltered. In some cases, where it was diminished, the portion missing had evidently been swallowed; in others, it must have been decomposed and absorbed.—4. When the volume of air remained unaltered (as it mostly did), there was always either more or less oxygen consumed than carbonic acid produced. The fact of the volume continuing the same under these circumstances, can only be accounted for by supposing the secretion or absorption of some other gas, which could have been no other than nitrogen. In some cases there was even far more nitrogen than carbonic acid excreted.—5. Insects transpire as well as the higher orders of animals. In one experiment, an humble bee lost in this manner the 17th part of its weight in 48 hours.—6. From a comparison of these experiments with those of others on the respiration of amphibia, fishes, and warm-blooded animals, it appears that, while the cat breathes stronger than the guinea-pig and the rabbit, and the dove stronger than the cat; the bee, even at a temperature of 11½° R., produces almost as much carbonic acid in proportion; and at a temperature of 22° R. far more. A butterfly, even after having been for some days without food, excretes a still greater quantity, at a temperature of 15° R. Earth-worms and snails, at a temperature of 11° to 17° R., fall short of the warm-blooded animals in this respect, but equal the toad, and exceed the tench.—7. If it always held good that the degree of animal heat varies as the quantity of carbonic acid gas produced during respiration, the bodies of bees and butterflies should be greatly heated when their respiration becomes stronger; however, it is not; being the case only when an inconsiderable quantity of nitrogen is produced at the same time. The former has a less, and the latter a greater, capacity for caloric than oxygen. Consequently, if a great quantity of nitrogen is excreted along with carbonic acid, the caloric that escapes at the development of the one, must become latent again at that of the other. Now, insects often expire not merely as much, but even twice as much, nitrogen as carbonic acid.—8. From computing the weight of the carbonic acid and nitrogen that is developed, and of the oxygen that is consumed in a given time, and comparing that of the two former with that of the latter, we find that the weight of what is taken in, exceeds that of what is given out; but by so small a quantity that the mass of the body cannot be sensibly increased by it. The loss by transpiration, however, much more than compensates for this, particularly in the higher classes of animals.—9. This comparison of the loss and gain of ponderable elements during respiration leads to another, and a very striking result. In one of the experiments, a butterfly weighing two grains, which had previously been upwards of three days without food, gave out in 90 minutes 0.0078 gr. of carbonic acid gas, which contained 0.00022 gr. of carbon. Now, supposing it to have breathed in the same manner for the three preceding days, it must have lost 0.1 gr. carbon; but it had been breathing so much stronger, that the loss may be estimated at least 0.15 gr. The hard parts of the insects could have had but little share in this; and as they weighed in another of the same size, which had been well dried, 1.4 gr., the weight of the soft and more vital parts can have been but 0.6 gr. However, allowing it to have been 1 gr., the half of that at least was water, and the remainder consisted chiefly of albumen, fibrine, and fat. These may have contained about 60 per cent., that is 0.3 gr. of carbon, while there were 0.15 gr. excreted; consequently, the soft parts had lost the half of their carbon. Notwithstanding this, the butterfly was still so strong after the experiment, that it could, probably, have lived for some days longer without food. It follows, therefore, either that life does not depend on the existence of the organic elements in fixed and definite proportions, or that animated matter must have a power of generating carbon.—*Ibid.* No. ii. p. 127.

HYDROGRAPHY.

7. *A short Account of the Falls of Girsupah, in North Canara, on the Western Coast of the Madras Territories.* From the Notes of a Medical Officer, January 1832.—The Falls of Girsupah have been but seldom visited by Europeans in this country, and are almost entirely unknown in our own. They are peculiarly worthy the notice of the traveller, from the unparalleled depth of the chasm into which they fall, a depth of no less than 892 feet; thus ranking, as far as history or travels have informed us, as the highest falls in the known world, and, if so, as one amongst the great curiosities. They are not so remarkable for the great body of water that rushes over the precipice, as for being "unique" in point of height. The river is broad and rocky, flowing in separate streams, as it were, and continuing distinct till a short distance from the first or principal fall, where a stream branches off to form the second, third, and fourth falls. Advancing to the brink of the precipice, a projecting rock affords support to the astonished traveller, and enables him to look down into the awful abyss beneath him with some degree of confidence. From this point a view is obtained of three of the falls, two of these distinct, the other and nearest to the great fall rushing in a slanting direction over a rocky bed, till it joins the principal fall about 100 yards down the chasm. But the traveller seldom rests satisfied with this view, but creeps to a flat rock overhanging the principal fall, whence he sees the whole body of this precipitate itself into the chasm beneath. It presents the appearance of a huge crest of foam for about two-thirds down, when it appears like a sparkling sheet of spray, which in a measure obscures the bottom of the basin into which it falls. Indeed the bottom cannot be very distinctly seen from any point directly above, owing to the great volume of vapour arising from the broken water beneath. The light is strongly refracted by these particles of water or spray, presenting a variety of rainbow-like tints. The other two falls

have a smaller body of water, but are higher from the rocky sides of the chasm, rising to a greater height, but present similar appearances at the bottom. The chasm itself is strikingly curious, as if an enormous mass of rock had been suddenly rent asunder by volcanic influence; the sides are as nearly perpendicular as possible, and the breadth at the middle is said to be 300 feet. Few have descended into the chasm beneath, and in the number of those few we were resolved to be included. The passage across the river was tedious, from the number of rocks to be scrambled over and streams to be forded: this effected, we proceeded along a path, which led to the descent at the farthest end of the chasm. This piece of the journey was easy enough, but the descent was tedious, fatiguing, and not without danger, —now descending a series of rough and irregular steps, and then sliding over the slopping surfaces of huge rocks. Indeed, had it not been for the Nuggar Rajah, it had almost been an impossibility to have reached the bottom,—he placed these series of irregular steps which connect the rocks, and render the passage practicable. On arriving at the bottom we were amply repaid for our toil. The tremendous rocks in the basin, the stupendous precipices on every hand, the foaming streams precipitated from these, formed a grand and striking *coup d'œil.* The whole chasm was filled with moisture, floating like mist, rendering the rocks wet and the footing precarious. As we had but a short time to spare, our stay in the basin was limited to a period only sufficient to take a hurried view of this curiosity of Nature; besides having our bodies chilled by the cold moist currents, and our clothes perfectly saturated with perspiration in our descent. The height of the precipice was determined some time ago by some gentlemen of this (Madras) Presidency. The mode they adopted was, to erect a sort of stage or scaffolding, which projected over the margin of the precipice, and from which was let drop a rope, having a weight attached to its extremity; people were stationed below, who, on the weight reaching the bottom, pulled on the rope, discharged muskets, and waved flags; this was repeated by another gentleman, and the result was almost sufficiently corroborative of the correctness of the former measurement, varying only in 14 feet, a trifling difference, when we consider that a rope of the length necessary to reach such a distance generally stretched more or less, the measurement thereof may be considered as correct if taken at 892 feet. The ascent and descent, including the passage of the river, occupied nearly two hours. The period when our party visited the falls was in the month of January, when there was sufficient water to enable us to approach to the brink, and a better period, in our estimation, than in the monsoon, when the river is so full that the separate falls cannot be seen, the water rushing over in one vast sheet, which may be more terrific, but has the disadvantage of not permitting a near approach to the brink, or a descent into the basin. The journey to the falls of Girsupah may easily be effected from any part of the western coast, as the traveller can be landed at Ibonore by pattismas, *i. e.* native boats, from which he can proceed by the river as far as Girsupha (16 miles), at which there is a bungalow, and from thence ascend the pass Allawallah, and thence to the falls, distant 6 miles. The scenery in the pass is interesting to those fond of the picturesque.

GEOLOGY.

8. *Preparing for Publication by Subscription.*—In a folio volume, " A Memoir of the Ichthyosauri and Plesiosauri; with several splendid Lithographic Plates, copied from specimens in the Author's collection." By T. Hawkins, Esq. F.G.S.

9. *Preparing for Publication by Subscription.*—With map, sections, and numerous engravings and lithographs, " The Geology of the South-east of England: containing a Comprehensive Sketch of the Geology of Sussex, and of the adjacent parts of Hampshire, Surrey, and Kent; with Figures and Descriptions of the extraordinary Fossil Reptiles of Tilgate Forest." By Gideon Mantell, Esq. F.R.S., &c.

BOTANY.

10. *Inflammation of the Fraxinella (Dictamnus alba.)*—Among the physical phenomena which are produced during vegetable life, phenomena which might become a subject of curious study, there are few whose development appears more surprising than that which is generally attributed to the fraxinella, viz., that of being surrounded in hot days with a sort of etherial atmosphere, which can be ignited by the application of a taper without injuring the plant. Such a phenomenon, in fact,

would seem to require that the inflammable vapour should be, as it were, prevented from expanding by the vital action, or else that its emission continually renewed, should always keep it dense, around the plant, in proportion as it tended to expand in the external air, two states of things equally difficult to conceive. So singular a fact, however, is known only in a general way among botanists, without their having observed it themselves, and accurate details of it are to be found only in Deterville's Dictionary of Natural History, where Bosc thus says: "The extremities of the stalks, and the petals of the flowers of the fraxinella, are filled with an immense number of vesicles full of essential oil. On the hot days of summer they diffuse a strong scented vapour, inflammable and so abundant, that if, towards evening when a cooler air rendered it a little denser, we bring a lighted taper near the fraxinella, there appears all on a sudden a great light, which spreads over the entire plant, without injuring it." Chance having afforded me an opportunity of witnessing these phenomena of inflammation of the fraxinella, I determined to study their cause and physical conditions. At first, supposing with those who have described the matter, the reality of an ethereal emanation which encompasses the plant, I instituted, according to this view, different experiments, but none with any success. I then directed my attention to the examination of the cortical vesicles, whence it was said that this inflammable atmosphere emanated. These vesicles, when observed with the microscope, present the form of small bottles, terminated by a sort of conical neck, tapering to a point at its extremity. They have been very accurately described by M. Mirbel in his "Elements of Vegetable Anatomy and Physiology." These are found distributed more or less numerously over every part of the stalk: they are seen in greater abundance on the peduncles of the flowers, principally in their lower surface, at the extremity where the flower is inserted; we may still follow them on the borders of the leaves of the calyx, on the borders and nerves of the petals, and on the stamens and style; in fine, their grains, more condensed, thus cover all the surfaces of the ovaries, when they are enlarged by fecundation. Among these utricles, some are sessile, others pediculated, the latter in different parts, but more frequently on the most vigorous. Very small at the commencement of vegetation, they become enlarged according as the plant increased. Their surface, seen with a microscope in a strong light, exhibited itself commonly speckled with red and green, in the variety with the red flower; but it is all green in the white flower variety. The interior is filled with a colourless liquid, through which the light is refracted to a focus. I frequently saw at the extremity of this point a small limpid drop, as if a part of the interior liquid, dilated by increase of temperature, or secreted by the vital action, had flown out. These observations lead me to think, that the development of the flame around the plant might be the result of simultaneous inflammation, or almost instantaneously propagated from these numerous utricles filled with essence. On this supposition, the heat of summer was not necessary for the actual production of the phenomenon, but merely for the maturation of the inflammable liquid contained in the utricles; once the utricles were formed and ripened, the cold or heat of the time could not interfere any more than the time of the day. The ignition must be effected merely by the contact of the inflamed body, or at least merely by its contact, in order to make the utricles burst. In fine, it must be accomplished with the characters of suction and propagation suitable to small globules lying in juxtaposition, filled with an inflammable liquid, not with the instantaneous simultaneousness of a volume of gas. This is the mode of viewing the phenomenon, to which I have been led by all the experiments which I have made, some of which I shall here state. On the 26th of April 1830, I tried to apply the flame of a match to the peduncle of a flower of the red variety, which appeared to me already charged with a certain number of utricles considerably distended. I did not obtain continued inflammation, but mere local crepitation, similar to those produced by jets of the essence contained in the orange peel, when pressed and held near the flame of a taper. The remainder of the plant, where the utricles were smaller and fewer, did not present even this phenomenon. I repeated the experiment the following year, and at the same time of the year, with similar results. In the parts where the crepitations were produced, the utricles appeared obliterated and blackened. On the 15th of May 1830, several flower-stalks had acquired full development: the utricles were considerably expanded, and closely set on their surface.

The entire day was cold and dry. In the evening the temperature being at 49° F., I repeated the attempt to inflame. The attempt succeeded when the flame was applied beneath the peduncles of some flowers fully developed, or only partly expanded, particularly near the commencement of these flowers, where the utricles are always more abundant. The inflammation, though manifest, was not sufficient to pass spontaneously from the base of one flower to that of another; it was necessary to excite it at each point in succession, which I did with sufficient gentleness not to injure the stalks. Among those which presented the phenomenon, there were some which I had in vain tried the preceding April; some others, whose utricles having been inflamed were destroyed, might still, after the lapse of a week, be ignited anew, no doubt in consequence of other utricles having come to maturation since the preceding experiment. In the third attempt, on the 22d May, the development of the plant being more advanced, the inflammation was excited with great intensity over all the stalks. I have frequently since produced a repetition of the phenomenon on the same flower-stalk at different periods; and, having become more dexterous in conducting the process, I have been able to reproduce it seven or eight times this year in a sensible degree on the same stalk, by choosing successively its different parts to apply the inflammation to them. It is not necessary that the experiment should be made particularly in the evening any more than at any other time. In fine, the inflammation is always propagated from below upwards, over an entire bunch of flowers, but with much more facility from above downwards: it may also take place on the peduncles of the centre, without occurring on the lateral peduncles, though they may be in a fit state to receive the inflammation, by approximating the flame separately to their surface. This possibility of succession in the phenomenon of ignition, as well as of its insulation, is very easily understood for a system of globules separately distributed over all the parts of the plant; but it cannot exist for a continuous mass of inflammable vapour, such as that with which the fraxinella was supposed to be encompassed The phenomena just described are produced on all the varieties of the fraxinella, whether the red flower or white flower variety, less easily, however, and less abundantly, on the latter, its utricles appearing smaller and fewer. It is known that external temperature, by modifying the progress of maturation, considerably influences the absolute quantity of essential oil produced by the same vegetable. The cold constitution of this year seems to have thus acted on the phenomenon just described; the utricles of the fraxinella are smaller, and their inflammation appears less abundant, than in the preceding years.—*Dub. Journ. of Med. and Chem. Scien.* No. viii. p. 29.

11. *Influence of Coloured Rays on the Growth of Plants.* By M. C. Morren.—In a paper which the author read to the Academy about two years since, he had shewn that, of all the elementary colours, those which are most favourable to the manifestation and development of organized beings, belonging either to the animal or vegetable kingdom, are red and yellow, and that this property exists in a nearly equal degree in each. These, and other experiments, were verified at that time only in the case of the most simple organized beings, in masses of water subjected to the influence of the agents of the surrounding world. M. Morren has tried whether the same results would take place on making coloured rays act separately on earth in which some grains were put to germinate. The experiments were commenced on the 17th of March of this year. He took nine pots filled with well dried earth, and of the same kind for each, and in each pot he sowed twenty grains of cresses *(Lepidium sativum)*. These seeds were then covered with a bed of earth, three millimetres in depth. He sprinked each pot with the same quantity of water from day to day. He covered each with a tin vessel, blackened both inside and outside, twenty-two centimetres in height, of a cylindrical form, one decimetre in diameter, shut superiorly by a plate of tin, placed obliquely, and inclined at an angle of 45°. Each plate was perforated in the centre with a circular hole, before which was placed a circular pane of glass, four centimetres in diameter, and differing in colour for each vessel. These pieces of glass were such as are used in ornamenting the old windows of churches, and were all of the most beautiful tint: they were of the following colours, —violet, blue, grass-green (vert pré), sea-green, bright yellow, yellow, orange, red, purple. By the side of these vessels he placed another vessel, black, such as themselves, but with a white plate of glass. No ray passed through the solder, and care

was taken to sink each vessel one inch and a half in the ground. These were all placed on a shelf, raised to one-half the height of a lightsome window. The fourth day of the experiment the radicles had shot out under all the vessels, and attained the length of from one to two millimetres. The sixth day it was observed that the vegetation was much more advanced under the vessels than in the open air, and under the influence of the compound light. Under the yellow, and particularly under the bright yellow, the radicles were scarcely more developed than on the fourth day. Under the green rays there were some radical hairs towards their upper part, which was somewhat yellow. The small plumulæ were yellow; the radicles and hairs were also as under the yellow rays. The orange, red, purple, blue, and violet rays, corresponded to radicles of a centimetre, yellow in the neck, to radical hairs of a millimetre, to plumulæ frequently curved and well formed. On the seventh day the plumulæ were developed under all the vessels; they were very yellow. Under the white light they were becoming sensibly green; in the open air they appeared green. On the eighth day the shoots were from one to one and a half centimetre in length; under the yellow rays they were not so long, white all over, the plumulæ yellow, the leaves the same, and bent back, the radical hairs two millimeters in length. Under the white light the shoots were scarcely three millimetres in length; they were becoming green, as also the leaves. On the ninth day there was an identity of character with respect to all the plants under the vessels; shoots of three centimetres, leaves of four millimetres, curved back very much, entirely yellow. In the air, the shoots were scarcely a centimetre in length, the leaves very green. On the fifteenth day of the experiment there was observed, at length, a strange difference with respect to the plants developed under the yellow rays, their leaves were become green, though paler than those plants in the open air. Under the orange rays a slight greenness presented itself. Under all the other rays the plants were evidently suffering, and were yellow.—From these researches the author concludes, 1. That, in the same way as darkness favours the first period of germination, so also do the colours of the spectrum, acting separately, possess a specific influence which seconds this operation; but that among these colours, those whose illuminating power (with the exception of green) is greatest, are also those which least of all favour the act which causes the development of the rudimentary organs of the grain. 2. That, under the coloured rays of the highest illuminating power, the radicles are developed least, and most slowly; whilst, on the contrary, the plumulæ grow better, and more rapidly; and under the coloured rays of a weak illuminating power, the radicles and plumulæ take on a development similar to that which they attained in the dark; that, consequently, *the growth in length of vegetables under the rays of the prism is in the inverse ratio of their illuminating power;* that, under all the coloured rays, as in the dark, the radical hairs are developed towards the aërial part of the radicle, a sure sign of the growth occasioned by each of these circumstances; that the lengthening of the organs proceeds under the coloured rays as in the dark, and that the different parts grow much quicker there than under the influence of white light. 4. That the green colour of vegetables is developed much more rapidly under the influence of compound light than under any ray whatever of decompounded light; that under all these rays, the parts on the vegetable destined to become green, are yellow at first, then pass insensibly to the palest green, then to the deepest tint under such rays as enjoy the special property of suffering these changes to go on. 5. That these rays are on one side the yellow, and on the other side the orange; that the first possesses the *maximum* degree of this property, and the second the *minimum* degree, the other rays not at all producing the green colour; that the yellow ray promotes the green colour in proportion as it is less intense, but that it requires more time to produce greenness than would be required in white light, and that it never can produce it in the same degree as the latter. 6. It is, perhaps, allowable to state, that this *viridificating* property of the rays in the spectrum arises from their illuminating power, and it is immediately connected with it; but then, it must be acknowledged, that the green ray itself does not possess the property at all, though it shares with the yellow nearly in the *maximum* of illuminating power. In concluding his letter, the author asks whether it is solely by its *splendour* that light acts in the progressive colouring of vegetables, all the organic elements of which, though white at their formation, become subsequently covered with such lively and diversified tints.—*Annal. des Scien. Nat. Oct.* 1832.

Proceedings of the Royal Society of Edinburgh.

1832, *Dec.* 3.—Sir Thomas Makdougall Brisbane, President, in the Chair. At this Meeting the following communications were read:—

1. On the Colours of Natural Bodies. By Sir David Brewster, V. P. R. S. Ed.

The only Theory of the Colours of Natural Bodies that has met with reception in modern times, is that of Sir Isaac Newton, who considers them as identical with those of their plates, and as varying with the size of the ultimate particles of the body.

Although this theory, ingenious as it is, be liable to many great objections, and be not capable of explaining the phenomena, even if its postulates be admitted; yet the author of the present paper does not assail it with any arguments of this kind. He has, on the contrary, attacked it in its stronghold, and has endeavoured to bring it to the test of direct experiment.

Sir Isaac Newton considers the green colour of plants (the most general colour which nature presents to us) as a *green* of the *third* order of periodical colours, and has also given us the exact composition of this particular colour.

In order to determine the composition of the green colour of plants, the author dissolved their colouring matter in alcohol; and having analyzed it by a fine prism, he found it to have, in every case, the same composition. The portions of the spectrum, however, which entered into its compound tint, were totally different from its theoretical composition, as assigned by Sir Isaac Newton; and had no relation whatever to the colour of their plates. The green colouring matter exercised an arbitrary specific action upon different parts of the spectrum, and its green colour was owing to its having absorbed a certain number of rays, which, when subtracted from the white light, left the colour under consideration.

In order to render this result more general, the author examined an immense number of coloured solutions, obtained from plants and artificial salts, and a great variety of coloured solids, either formed by art, or obtained in nature; and in all these cases, he found no indication whatever of periodical colours. The colours were invariably produced by the absorption of certain definite rays taken arbitrarily and unequally from different parts of the spectrum; and, excepting in the case of certain imperfectly transparent and opalescent fluids, there never was the slightest trace of a reflected tint similar to that which might have been expected, had the Newtonian theory been true.

2. Notice respecting the Determination of the Geographical Positions of the Village of Chamouni, and of the Convent of the Grand St. Bernard. By James D. Forbes, Esq., F.R.SS.L.&Ed.

The author undertook the determinations of these positions at the suggestion of Professor Gautier of Geneva, who informed him, that they had not been fixed by any direct observations. The great discrepancies of the best maps of the Alps in laying them down, confirm this opinion; and the author has quoted the latitudes and longitudes, given by the best authorities, at the end of his paper.

The new determinations give for the positions,—

	Latitude.	Long. E. of Geneva.
Chamouni, ...	45° 55′ 54″ . . .	27m 25
St. Bernard, ...	45° 50′ 16″ . . .	28m 19

The latitudes were determined by successive altitudes of the pole star, taken with an altitude and azimuth circle, upon Captain Kater's construction, the circles being 4½ inches in diameter, and divided to 15″. The position of St. Bernard is the best determined, eight altitudes of the pole star having been taken, the results of seven of which agree closely.

The longitudes were determined chronometrically, in the *first* place, by comparisons with the Geneva Observatory clock, and in the *second*, by the time at the two places, calculated from altitudes of the sun taken with the instrument just mentioned. Though the rate of the chronometer was wonderfully steady, considering the shocks to which it was exposed, the author does not conceive that the longitudes are determined with very great precision.

Dec. 17.—Professor RUSSELL, Vice-President, in the Chair.

The time usually employed in the ordinary business of the Society having been occupied by a discussion on extraordinary affairs, the reading of the communications announced for this meeting was deferred.

1833, *Jan.* 7.—Sir Thomas Makdougall Brisbane, President, in the Chair.—At this meeting, the following communications were read :—

1. Researches on the Conducting Power of the Metals for Heat and Electricity, tending to establish a New Analogy between these principles. By James D. Forbes, Esq. F.R.SS.L. and Ed.

The paper began by pointing out the very limited class of bodies to which observations of the kind alluded to have been extended. The author was led to a careful examination of the existing determinations of the conducting powers of the metals for heat, by some collateral trains of experiment in which he was occupied two years ago. He points out the degree of confidence which may be placed in the *arrangement* of conductors given by different authors; for we appear to be far from reaching a correct estimate of their numerical values. In viewing those of M. Despretz as the best, he remarks, that the position of platinum, which is certainly erroneous, shews how imperfectly we can depend upon experiments on this point, made with even more than usual care. Platinum is placed, by this writer, almost at the top of the list, between gold and silver, whilst the commonest experiments serve to shew that it is really a very imperfect conductor.

In order to verify the conclusions of previous observers, and to determine the position of some metals upon which no experiments seem to have been made, the author employed Fourier's Thermometer of Contact, an elegant instrument, which he believes has not before been practically applied. His experiments, however, being only intended for the illustration of a subject of collateral inquiry, were not made with the detail that they would otherwise have been, nor are they presumed to be perfectly accurate. They served, however, to confirm previous experiments on the order of the metals, as conducting substances; to restore platinum to its right place, and to fix the positions of antimony and bismuth. From these and other data he considers the following as the most probable arrangement of conductors of heat, beginning with the best:—*Gold, Silver, Copper, Brass, Iron, Zinc, Platinum, Tin, Lead, Antimony,* and *Bismuth.*

In like manner, by a careful comparison of the results of Harris, Becquerel, and Pouillet, including some experiments on antimony and bismuth, made at the author's request by Mr Harris, he concludes, that the arrangement of the metals, as conductors of electricity, is the following, which he observes is probably better established than the corresponding one for heat:—*Silver, Copper, Gold, Zinc, Brass, Iron, Platinum, Tin, Lead, Antimony,* and *Bismuth.* He observes, that the deviations from a common arrangement only occur, where it is agreed by experiments on both points, that the metals are extremely closely allied; as, for example, Gold and Silver, Iron and Platinum. His general conclusion is this; *That the arrangement of conductors of heat does not differ more from that of conductors of electricity, than either arrangement does alone under the hands of different observers.*

2. The reading of a paper by Robert Knox, M. D. F. R. S. E., on the Natural History of the Salmon, has commenced.

Jan. 21.—Dr Hope, Vice-President, in the Chair. The following communications were read:—

1. On the Super-Sulphuretted Lead of Dufton. By J. F. W. Johnston, Esq. A. M. F. R. S. E.

The object of the author of this paper, was to shew that the mineral alluded to is not a new atomic compound, but that it consists merely of common galena, with a portion of pure sulphur, varying from 6 to 10 per cent.

2. The reading of Dr Knox's paper on the Natural History of the Salmon, was concluded.

The object of the author was a careful examination of facts in the Natural History of the Salmon, which hitherto have been taken merely upon opinion.—He watched and carefully observed personally the deposition of the ova or eggs of the salmon under the gravel, its long confinement in that situation,—its growth into a fish about an inch in length,—its ascent through the gravel, and rapid growth whilst in the rivers: the journals of observation were partly read to the Society. Twenty weeks was the period from the time of deposition to their bursting the outer shell; for nine days longer they continued under the gravel as fishes, drawing their nourishment from the yoke of the egg, which is of course attached to them by the umbilical vessels, or more properly, by the ompholo-mesenteric vessels. During this period, they do not eat or grow much, but without doubt acquire strength. When the yoke on which they have been feeding becomes nearly exhausted, they rise from their sandy and gravelly bed, making their way to the surface, through a thickness varying from one to two feet, and at last gain their new habitat in the waters. In ten days they may be caught in the rivers, very considerably grown, and in twenty days have attained a length varying from eight to nine inches.

An extensive personal inquiry shewed that they are never the prey of trout; and a more limited one renders it doubtful if they *ever* become the prey of kelt, or spawned salmon, on its return to the ocean. It is probably to avoid the effects of severe frosts, that the salmon selects the bed of the running stream as the spot for the favourable deposition of the ova. The beds of rivers, he conjectures, must vary somewhat in temperature; and the author supposes, that extreme frosts are less likely to reach the gravel under the stream than under the pool. Frequent experiment has convinced the author, that the opinions of Sir Humphry Davy, Jacobs and others,—opinions which maintain that the gravel below the stream is selected by the salmon, on the ground of the better aëration of the ova, have no real foundation whatever.

The food of the fry has been determined precisely, and their whole habits, by repeated anatomical examinations made by himself.

The salmon seems to hybernate somewhat in certain seasons; a great number of salmon and trout do not enter into the spawning condition, and consequently may be got in first rate order as food, at any time, provided they have the means of subsistence: now, this the salmon can always get at in the ocean, which is his true feeding ground. He cannot get food in rivers of the kind he desires. The salmon-trout, on the contrary, even at the mouths of rivers, will take to the fry of other fishes, to small fishes, and to worms; and in rivers, he will feed on the larvæ of insects, insects themselves, and, in short, on the ordinary food of trout.

The true salmon prefers a peculiar kind of food, the ova of the echino-dermata, and takes, with great reluctance, any other. Hence, the moment he enters rivers, having abandoned his natural feeding ground, he deteriorates constantly, refuses all kind of food, loses weight and flavour, and gets, in short, entirely out of order. Nor can he ever recover from this state, till he has revisited the feeding-ground in the ocean. It is easy to perceive in these few statements, how entirely they alter the whole question of the salmon-fisheries.

These inquiries led the author to examine into the history of the herling. They resemble in their habits the salmon-trout, haunting the feeding-ground of the salmon; and when fed on the peculiar food of the salmon, their flavour is excellent; but they take readily to coarser food, as small herrings, fry, sand-eels, and the fry of any other fishes. Their stomach and intestines get loaded with putrescent debris, their flesh loses its flavour, and their condition, as articles of human food, has changed materially. No two conditions can be supposed more opposite than the herling presents, when fed on salmon food, and when fed on fishes. They differ, therefore, from salmon-trout in this respect; that, when feeding on the food of the salmon, they attain almost the flavour of the salmon, which the salmon-trout never does.

The author discovered and exhibited the food of the Vendace of Lochmaben, which had never been before by any one; explained the reasons why this fish could not be taken with bait; proved the vendace to be male and female, and offers suggestions for the stocking of the various lakes in Britain with this exquisite fish, pointing out first the necessity of locating its natural food, without which, it cannot live. The discovery of these circumstances, with regard to the vendace, led the author immediately to think of the herring, whose food and natural history generally he believed to be unknown.

It was ascertained that the herring resembles the herling in its habits, as to food more particularly; and that whilst feeding on the incredibly minute entomostraceous animals, which it more especially affects, the condition of the herring is excellent, rendering it an extremely desirable food for man. In this state, the stomach seems as if almost altogether empty, though at the moment full of minute animals, to be discovered only with the microscope, and on which the animal has been feeding. The intestines also seem as if empty; the tunics of the whole digestive canal are fine and semi-transparent, and as free of intestinal and putrescent debris found in the stomach and intestines of animals, as if the herring actually fed on nothing but air and water. When he approaches the shores, thus quitting the proper feeding-ground, he, like the herling, takes to other and coarser food; his condition alters, and his flesh becomes soft and tasteless. The stomach and intestines are found loaded with putrescent remains, and gutted or ungutted, this fish could never be brought into the market as equal to the product of the Dutch fisheries.

Feb. 4.—Sir Thomas Makdougall Brisbane, President, in the Chair. The following communication was read:—

Account of some Optical Phenomena observed upon the Rigi, on the 16th October 1832. By James D. Forbes, Esq., F. R. SS. L. and Ed.

The object of this paper, was to describe an example of a class of phenomena, which is imperfectly understood. The author observed an indistinct mass of reflected light, surrounded by a faint glory, on the surface of a stratum of thick white clouds, 1000 or 1200 feet below him, when descending from the Rigi. The centre of the coloured circle was the point diametrically opposite to the sun, and consequently varied with the position of the observer. As he approached the level of the cloudy ocean, the colours became brighter, and the circle more distinctly formed, and the shadows of the author and his companion were thrown with distinct outlines upon the illuminated surface. The diameter of the red ring of the corona was about 18°, and he ascertained, by experiment, that the distance of the plane on which it was formed, was only 70 feet. The red occupied the interior of the prismatic circle. When completely immersed in the cloud, the shadow of the observer assumed a new appearance, owing to the want of a definite illuminated surface upon which it could be thrown; and the continuation of the shadow towards the interior of the cloud, presented the aspect of shadows when a sun-beam is admitted into an atmospheric space filled with light dust; and, by the effect of perspective, gave an appearance of a true convergence of rays, such as is occasionally observed on a great scale opposite to the sun.

The author pointed out that the theory of the coloured rings suggested by Mr Fraunhofer is untenable. It supposes the inflexion of rays, by watery particles round the head of the observer, whilst experience shews, that these effects are produced, when the observer stands in a perfectly pure atmosphere, and even at the distance of 1000 feet from the cloud. The theory of Dr Young was also noticed, which presumes a quadruple reflection in the interior of the aqueous drops; an opinion which, perhaps, it may be difficult to reconcile with the great brilliancy of the colours displayed.

Feb. 18.—Dr Hope, Vice-President, in the Chair. The following communications were read :—

1. Notice respecting the Application of Heated Air to Blast Furnaces. By Robert Bald, Esq. F. R. S. E. (To be continued.)

2. An attempt to illustrate the remaining monuments of the Ancient Etruscan Language. By the Rev. John Williams, A. M. F. R. S. Ed.

The principal object of this paper, was to defend some interpretations of words in the ancient language of Etruria, proposed by Lanzi, and attacked by Niebuhr; as well as to point out some new analogies with other dialects. The languages which the author proposes particularly to call to his assistance are, Greek, Latin, Anglo-Saxon, and Cambrian or Welsh. The paper concluded with an application of these aids to a variety of words in the Etruscan language.

March 4.—Sir Thomas Makdougall Brisbane, President, in the Chair. The following communication was read :—

On the Gradual Elevation of Land in High Northern Latitudes. By J. F. W. Johnston, Esq. F. R. S. Ed.

In this paper, the author shewed, by a number of phenomena observable within the coasts of Sweden, chiefly around Stockholm, and on the shores of the Lake Macler and its arms, that the conclusion of the Swedish surveyors in 1821, that a change of the relative level of the land and water along the coasts of the Baltic had in many localities taken place, could not reasonably be disputed. He then considered if it were possible that the level of the Baltic could have fallen, being, by its connection with the North Sea, a branch of the great ocean; and concluded, from the permanency of the respective level of the land and water on the coasts of Pomerania, among the Danish islands, and at some points on the shores of Finland, that the level of the Baltic Sea had undergone no change of level for the last six hundred years. The change observable on the coasts of Sweden, therefore, must be due to an elevation of the land, now gradually, though insensibly, in progress. This rising is estimated to proceed at present at the rate of about one foot in twenty-five years.

The absence of any record of violent volcanic action in the Scandinavian Peninsula, renders it improbable that the rise is due to such a cause. The author referred it, therefore, to the gradual cooling of the crust of the earth, which, by causing a contraction and compression in parts where the cooling was a maximum tending to elevate other portions of the earth's surface at points or in lines of minimum resistance.

The centre of the action in Scandinavia, he considered to be in the mountain chains which traverse Norway, and Sweden, and Finland respectively; and which are mutually connected beyond the head of the Bothnian Gulf: and attributing the original elevation of these chains with Elie de Beaumont, to the secular refrigeration of the earth, he found in the rise still observable in Scandinavia a relic only of that once powerful action by which these mountain ranges were originally projected. He suggested the probability also, that on other coasts where high mountain ridges ran parallel with the sea, accurate measurements of the mean level of the water, in reference to the scarped rocks on the coast, if repeated at certain distant intervals, might make known other gradual elevations still in progress, similar to those observable on the shores of the Baltic.

Proceedings of the Society for the Encouragement of the Useful Arts in Scotland.

The following articles and communications were laid before the Society during the month of January 1833:—

Jan. 9.—1. Description of a Turnip and Potato Slicer, invented by John Baird, Esq. of the Shotts Iron-works. Communicated by Dr D. B. Reid.

With this slicer a man and boy can cut as many turnips in about an hour and a quarter, as will serve eight score of sheep for twenty-four hours.

A model of the machine was exhibited.

2. Remarks on some prevailing Misconceptions concerning the Actions of Machines. By Mr Edward Sang, teacher of Mathematics, Edinburgh, Memb. Soc. Arts.

3. Donations of Specimens of Lithographic Printing, executed by Mr Samuel Leith, lithographer, Banff, Assoc. Soc. of Arts.

4. The following candidates were admitted Ordinary Members, viz.—

William Grierson, Esq. W. S. 22, Northumberland Street.
Mr George Buchanan, civil engineer, 14, Dundas Street.

Jan. 23.—1. Model and Description of a Windlass for Weighing Anchor in Steam Boats, by Steam. By John Henderson, Mayfield Loan, Edinburgh.

2. Observations on the Rotatory Steam-Engine recently invented and patented by the Earl of Dundonald; dated 12th October 1832. Communicated by the Right Honourable Sir John Sinclair, Bart.

3. Description and Drawing of a Machine for Bruising Corn or Malt. By Mr James Catleugh, millwright, Haddington, Assoc. Soc. Arts.

4. Communication from the Rev. William Taylor, York, Hon. Memb. Soc. Arts, &c. regarding a Cheap and Rapid Method of producing Imitations of Engine and Eccentric Turning; accompanied by a variety of specimens.

Also a Specimen of coarse Paper adapted for the use of the Blind.

5. Fac-similes of the Autographs of Mary Queen of Scots, Darnley, Bothwell, and others, from a Wood-block cut by Mr F. G. Bruce, Potterrow, Edinburgh.

6. A Plan of the Town and Citadel of Antwerp, lithographed by Mr Walter Ballantine, lithographer, Terrace, Leith Street, Edinburgh, from a correct foreign engraving, and showing part of the French trenches and batteries during the siege in 1832.

7. The following candidates were admitted Ordinary Members, viz.:—

William Beilby, Esq. M. D. Edinburgh.
Mr Robert Laidlaw, Brass-founder, Edinburgh.
Mr John Gellatly, Engraver, Edinburgh.

List of Patents granted in Scotland from 8th January to 13th March 1833.

1833.

Jan. 8. To William Gutteridge, of the Minories, in the borough of the Tower Hamlets, civil engineer, and George Stevens, of Norwood, in the county of Surrey, sugar-refiner, for an invention of "apparatus for the manufacture and refining of sugar and other extracts, and applicable also to other purposes."

22. To Charles Watt, of Clapham, in the county of Surrey, for an invention of "a new or improved method or process of preparing tallow and stuff from fatty materials, and refining the same, for the manufacture of candles, and other purposes."

Feb. 7. To Thomas Parsons the younger, of Furnival's Inn, in the county of Middlesex, gentleman, for an invention of "certain improvements in locks for doors, and other purposes."

16. To Joshua Wordsworth, of Leeds, in the county of York, machine-maker, for the invention of "certain improvements in machinery for preparing, drawing, roving, and spinning flax, hemp, wool, and and other fibrous materials."

21. To Sir Charles Webb Dance, of Hertsbourne Manor Place, in the county of Hertford, knight, Lieutenant-Colonel, for an invention of "certain improvements in steam boilers."

To Joseph Saxton, of Sussex Street, in the county of Middlesex, mechanician, for an invention of "improvements in propelling carriages, and in propelling vessels for inland navigation."

To William Lloyd Wharton, of Dryburn in the county of Durham, Esq. for an invention of "certain improvements in steam-engines, for raising or forcing water."

To John Reynolds, of Oakwood, near Neath, in the county of Glamorgan, iron-master, for an invention of "certain improvements in steam or other engines."

Mar. 11. To Jonathan Dickson and James Ikin, both of Holland Street, Blackfriars Road, in the county of Surrey, engineers, for an invention of "improvements in the process of making gas from coal or other substances."

To Richard Badnall the younger, formerly of Ashenhurst Hall, near Leek, in the county of Suffolk, now residing in the town of Douglas, in the Isle of Man, gentleman, for an invention of "certain improvements in the construction or formation of the trams or rails, or lines of rails or tram-roads, upon which locomotive engines shall or may be worked, or may be employed."

To John M'Curdy, of Southampton Row, in the county of Middlesex, Esq. in consequence partly of a communication by a certain foreigner residing abroad, for an invention of "certain improvements in machinery for acquiring power in rivers and currents."

To Richard Previthick, of Lamborne, in the county of Cornwall, engineer, for an invention of "an improvement or improvements on the steam-engine, and the application of steam-power to navigation and locomotion."

13. To William Thomas Shallcross, of Holt Town, within the parish of Manchester, in the county palatine of Lancaster, mechanic, for an invention of "certain improvements in looms or machines for weaving cotton, linen, silk, woollen, and other fibrous cloths and substances."

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